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— COMETa 2018 – The 4th International Conference on Mechanical Engineering Technologies and Applications, organized by Faculty of Mechanical Engineering, University of East Sarajevo, in Jahorina, BOSNIA & HERZEGOVINA, in 27–30 November, 2018. The current identification number of the papers are the **#1–2, #5** and **#9**, according to the present contents list.

— IIZS 2018 – The 8th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty "Mihajlo Pupin" Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 11–12 October, 2018. The current identification number of the papers are the **#13** and **#24–25**, according to the present contents list.

— ERIN 2018 – The 12th International Conference for Young Researchers and PhD Students, organized by Brno University of Technology, CZECH REPUBLIC and Slovak University of Technology in Bratislava at Faculty of Mechanical Engineering, SLOVAKIA, in Častá-Papiernička, SLOVAKIA, in 02–04 May, 2018. The current identification number of the papers are the **#21–22**, according to the present contents list.

— ICOSTEE 2018 – International Conference on Science, Technology, Engineering and Economy, organized by University of Szeged, Faculty of Engineering, Szeged, HUNGARY, in Szeged, HUNGARY, 25th October, 2018. The current identification number of the papers are the **#3, #16** and **#20**, according to the present contents list.

Also, the ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Tome XII [2019], Fascicule 2 [April–June] includes original papers submitted to the Editorial Board, directly by authors or by the regional collaborators of the Journal.

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APPLICATION OF MODERN TECHNOLOGY FOR INCREASING EXPERTISE OF EMPLOYEES IN MECHANICAL INDUSTRY

[1-4.]University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin, SERBIA

Abstract: Production system is often used as synonymous with manufacturing system and assembly system. Other notions used to describe different types and sizes of production systems are line, factory, plant and workshop. In hierarchy perspective production system is part of manufacturing system and parts production and assembly systems are part of production system. Basic elements in production systems are humans, machines and equipment. Software and procedures might be added to the list. In this paper it is shown the possibility of CAD/CAM application in order to educate employees in area of machining and design of mechanical parts. Practical example is done in order to show the way of usage and path for further development.

Keywords: CAD/CAM tools, education, machining, design

INTRODUCTION

The process of creating goods and/or services through a combination of material, work, and capital is called production.[1]

Production system is often used as synonymous with manufacturing system and assembly system. Other notions used to describe different types and sizes of production systems are line, factory, plant and workshop.[1]

In hierarchy perspective production system is part of manufacturing system and parts production and assembly systems are part of production system. Basic elements in production systems are humans, machines and equipment. Software and procedures might be added to the list. [2,3]

Today, computers are integral component of almost every system. Modern production can`t function without them. The vast types of software are being used to make production better, cheaper, simpler and more effective in every aspect – from organization to technical aspects of making parts and assemblies.

In order to be competitive on market, besides improving technology, we need to improve knowledge of employees.

CAD/CAM TECHNOLOGIES AND APPLICATION

Computer-aided design (CAD) and Computer-aided manufacturing (CAM) are two disciplines, of many, that are used by engineers and designers in wide variety of applications. CAD activities are a part of integrated management of development activities in the product lifecycle, and as such it is used with other parts, such as CAM, that can be as integrated modules or stand-alone products.[4]

In production, CAD software's are used to model parts, to make technical documentation and to make assembly of parts for better understanding of machine design. CAM software's are used for connecting design and production of workpiece. That is one of the application. They can also be used to assist in all operations of manufacturing plant (management, transportation, etc.). [5]

Today, successful companies are using integrated CAD/CAM systems to quickly place the product in market and reduce costs.

The interest of this paper are CAM software's for manufacturing workpiece, from CAD 3D model using CNC machines and that interest will be explain in further text.

Nevertheless, CAD design must be mentioned here in order to complete the process. It is not possible to use CAM software without created 3D model of part. The software used here is Inventor and Inventor CAM. Autodesk Inventor and Inventor CAM represent CAD/CAM software tools used in:

- parametric modeling, animation assemblies created from individual parts, creating technical documentation (Inventor). Parametric modeling helps designers to present their idea as a 3D model. The model is created based on the geometrical design features that can change at any time for necessary corrections in the design process.
- implementation of 3D models into production (software prepares 3D models for physical processing, generating G code used for programming CNC machines) (Inventor CAM). Inventor CAM is a certified integrated CAM engine for Inventor that has full connectivity with the model in Inventor. Inventor CAM is used in the mechanical manufacturing, electronic, medical and consumer products, machine design, automotive and aerospace industries, as well as workshops for the manufacture of molds, tools and rapid prototyping.

APPLICATON OF CAD/CAM TECHNOLOGIES IN EDUCATION OF ENGINEERS

Today there are numerous methods for learning how to work in CAD/CAM software's. One of the example are functions embedded in Autodesk Inventor (Figure 1):

- Online Support – represents online material in order to learn how to use Autodesk Inventor. Some of online material can be downloaded for offline usage.
- Interactive Learning – is series of video tutorial made for learning basics of Autodesk Inventor. Using this tutorials, users can view step-by-step examples for part modeling, creating assemblies, creating technical documentation and sheet metal working.

Using this principles, and CAD/CAM software, tutorial has been made in order to present machining of pump gasket. The purpose of this tutorial is to show a different way for exchange of knowledge between mechanical engineers for machining process.

In order to increase knowledge of engineer, tutorial of this type can be used to show them step-by-step machining of specific part that is needed in production. In that way the production technology of machine part can be presented and explained in detail. The goal is improving engineer's expertise, transfer of knowledge and, in the end better usage of available resources in production. The parts of tutorial are shown in figures 2-10.

Similar tutorial has been used to show faculty students what are the steps in machining of one part, and different machining technologies in order to improve the quality of education [6,7].

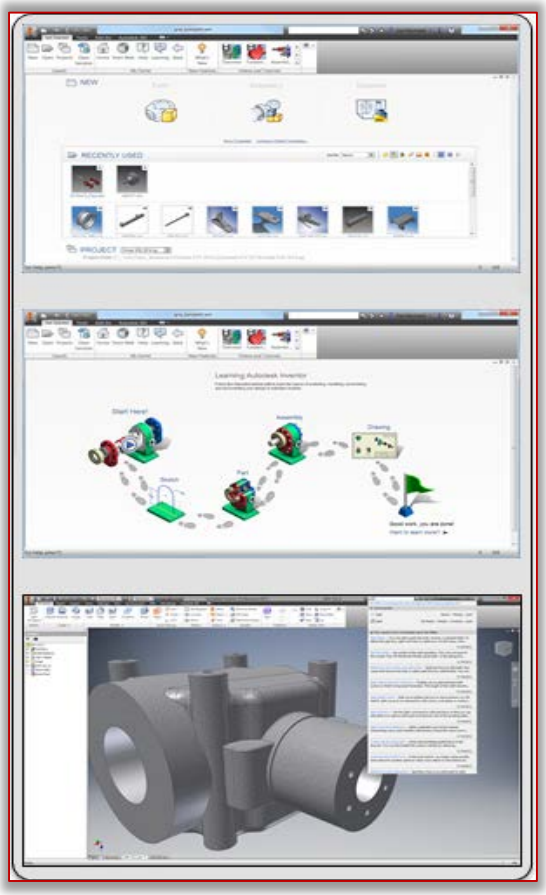

Figure 1. Different methods for learning functionality of Autodesk Inventor software

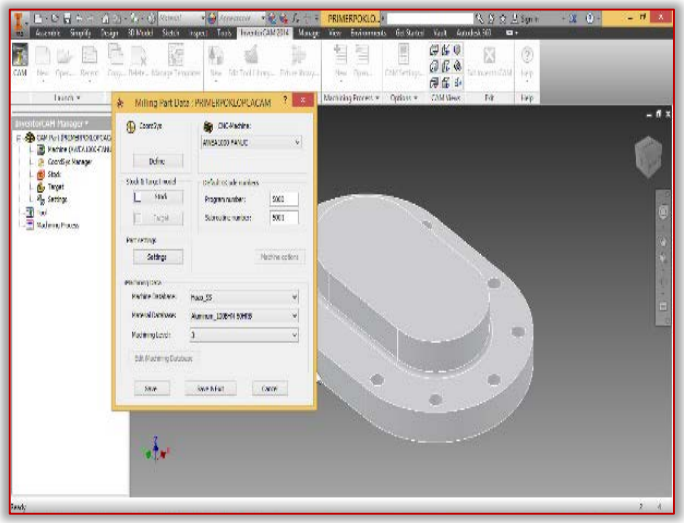

Figure 2. Settings of machining initial parameters

Figure 2 represents the beginning of part production. The first step is, after modeling the required part, importing the model in Inventor CAM module and defining the appropriate CNC machine and adjusting the coordinating system and part orientation.

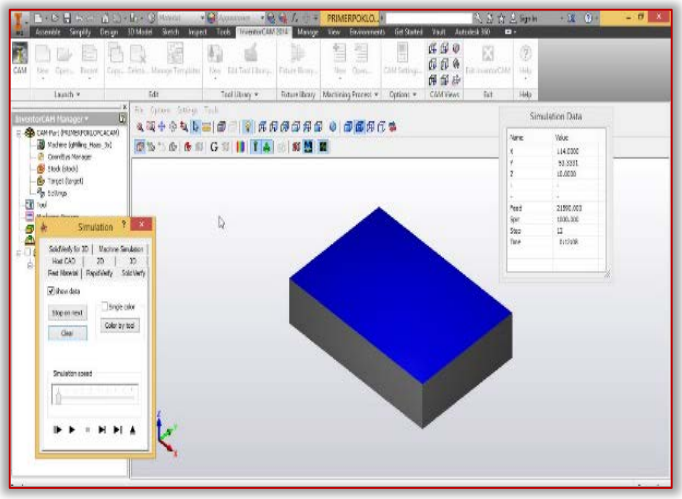

Figure 3. Face Mill simulation of upper surface

Figure 3 shows the next operation in machining of pump gasket, and that is the face milling of outside surface. The figure shows the animation of operation after the settings of operational parameters (the beginning position of tool, the type of tool and its characteristics, the tool path). After those settings, software have the possibility to animate the operation in which can be determined the errors of settings and visually see the operation (without direct operation on CNC machine).

The next operation is profile milling of outer side (Figure 4). Like the operation of face milling in this operation we also need to set operational parameters. The difference between these two operations, from the software point of view, is that it needs to be defined what is the type of milling (or machining operation) that is applying on part. The same procedure is used for milling of upper part in order to achieve the shape of gasket (Figure 5).

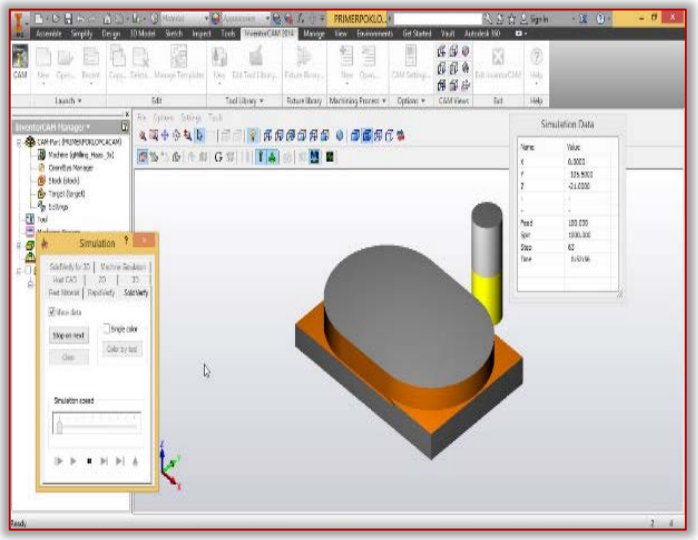

Figure 4. Simulation of profile milling of outer side

In order to produce the curve between two oval shapes, the operation of profile milling is applied to get the fine surface and required shape (figure 6).

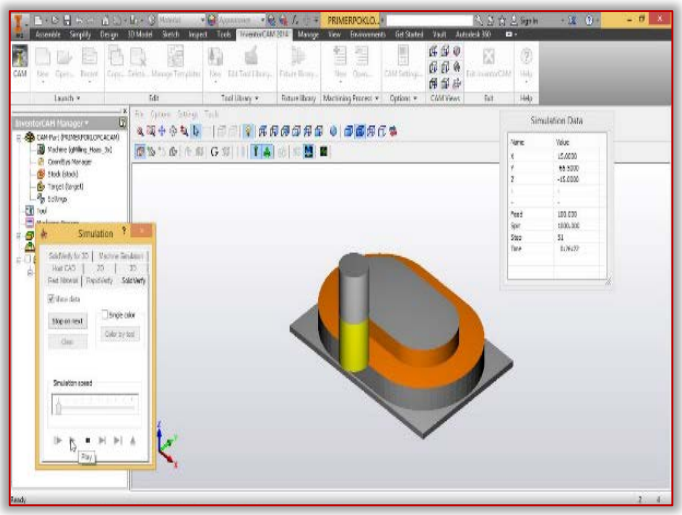

Figure 5. Simulation of profile milling of outer, upper side

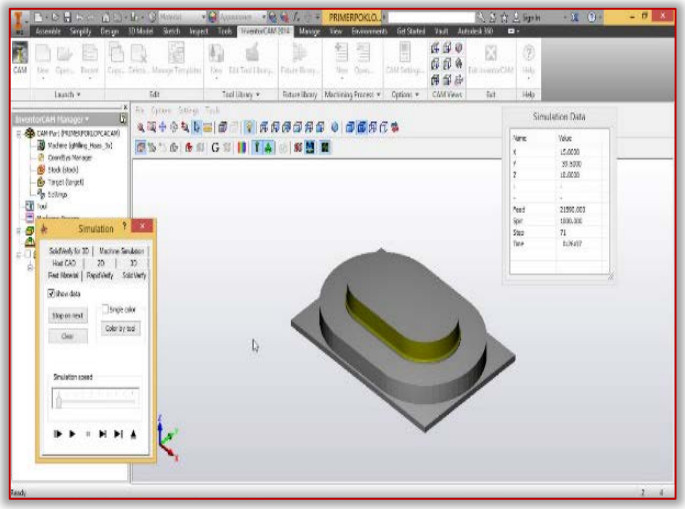

Figure 6. Simulation of milling of upper curve between two surface

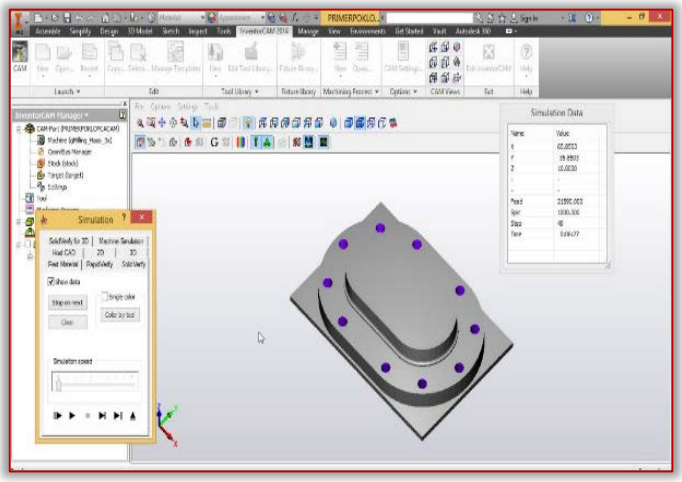

Figure 7. Simulation of drilling through workpiece

On figure 7 is the last operation that needs to be done from that side of part, the drilling of holes used to connect the gasket to the pump using screws. For this it needs to be defined the characteristics of tool and the order of holes. When the drilling is finished the part needs to be repositioned (in this case turned over) and new coordinate system needs to be defined for the definition of space (Figure 8).

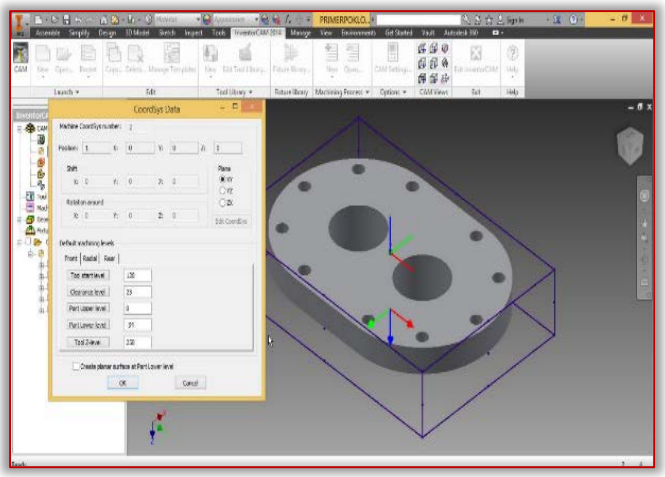

Figure 8. Changing of view and defining new coordinate system for machining

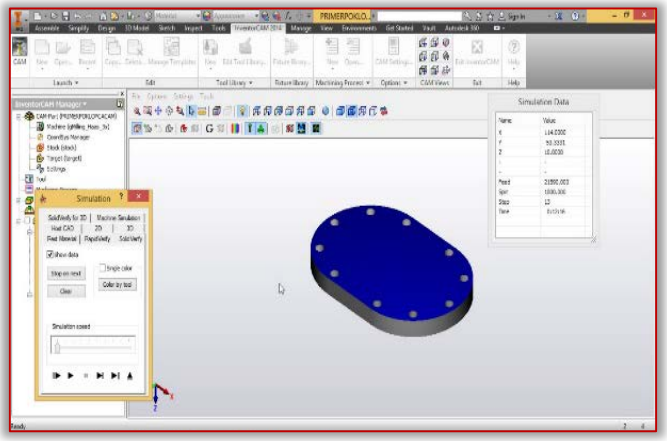

Figure 9. Face milling of bottom surface

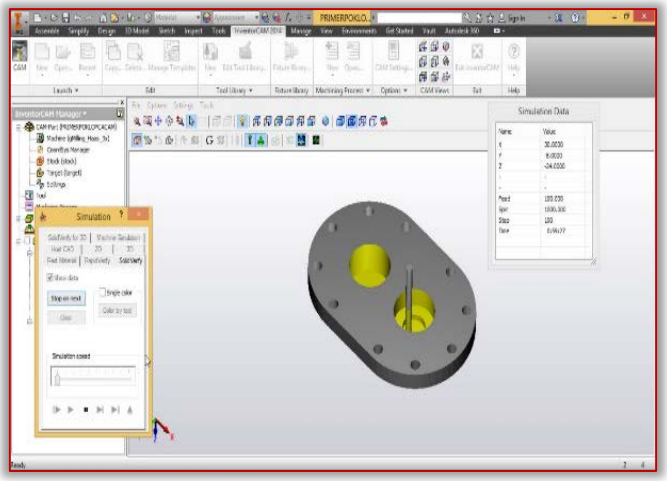

Figure 10. Pocket milling

Figure 9 and 10 presents the final two operations, the face milling of inner surface of gasket and the pocket milling of inner openings. The information and benefits of this types of tutorial are:

- Visual – complete 3D view of part, views from beginning to the end of machining, view of tool movement in process, information of type of tool and its characteristics, information on CNC machine that is used. It can even be seen possible errors in initial settings or tool settings
- Data – G – code can be presented for complete part machining.

All above informations presents valuable information in production, and can be used for education of engineers, for learning different production technologies in machining, for speeding up production process and better usage of raw material.

CONCLUSION

Improvement of production must be reflected in the improvement of production technology solutions, improvement of tools and improvement of the expertise of employees.

In this paper it was presented possible use of CAD/CAM software in knowledge exchange between engineers. The education can be through seminars, small courses, or online materials.

The benefits of these tutorials are:

- Constant learning and implementation of practical knowledge,
- Better usage of companies resources,
- Quicker adjustments of new engineers in their working places, and better understanding of specifics production technologies,
- Upgrade of production technologies by knowledge exchange.

This way of learning can be implemented through lifelong learning, not so much in areas of communication with others, but in two segments:

- *Learning to know* - mastering learning tools rather than acquisition of structured knowledge.
- *Learning to do* – equipping people for the types of work needed now and in the future including innovation and adaptation of learning to future work environments.

Note:

This paper is based on the paper presented at COMETa 2018 – The 4th International Conference on Mechanical Engineering Technologies and Applications, organized by Faculty of Mechanical Engineering, University of East Sarajevo, in Jahorina, BOSNIA & HERZEGOVINA, between 27–30 November, 2018.

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A CASE STUDY ON INFLUENCE OF TRAFFIC-INDUCED VIBRATIONS ON BUILDINGS AND RESIDENTS

[1-4.]Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering and Architecture Osijek, Osijek, CROATIA

Abstract: Vibrations induced by traffic on irregular or damaged pavement or tracks positioned near buildings, can be a source of annoyance for residents and source of damage to structural and non-structural elements. The traffic-induced vibrations, having different frequency content, propagate through the soil towards neighbouring buildings while attenuating in the process due to damping. However, when vibrations reach the basement wall or foundation of the building they are transmitted to upper floors and can be amplified in the process depending on the eigen frequencies of the building components. In this work, described is the procedure for experimental determination of the vibration measurement in comparison with the values allowed by the code provisions. Additionally an overview of the building damage due to traffic induced vibrations is given including the unavoidable description of the annoyance experienced by its residents.
Keywords: Damaged Roads, Damage To Building, Resident Annoyance, Traffic-Induced Vibrations

INTRODUCTION

Vibrations induced by traffic on irregular or damaged pavement or tracks positioned near buildings, can be a source of annoyance for residents and source of damage to structural and non-structural elements [1,2]. The traffic-induced vibrations, having different frequency content, propagate through the soil towards neighbouring buildings while attenuating in the process due to damping. However, when vibrations reach the basement wall or foundation of the building they are transmitted to upper floors and can be amplified in the process depending on the eigen frequencies of the building components (see Figure 1).

In this work elaborated is the case study on the influence of traffic-induced vibrations to buildings and residents that was a subject of a lawsuit [3,4].

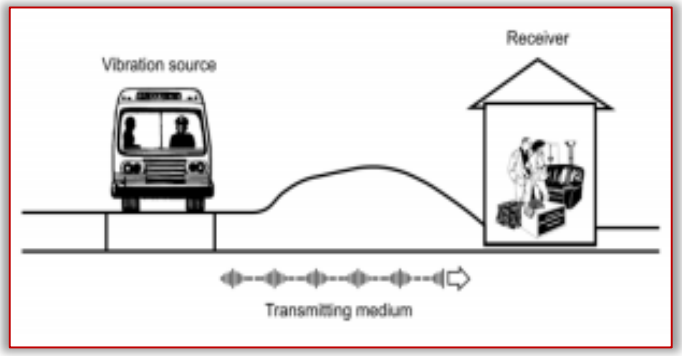

Figure 1. Path from vibration source to the building

During highway construction, the stone material used for the sub-grade and the sub-base of a future highway, was brought from a nearby quarry. The supply roads used to deliver the stone material to the construction site were partially the part of the main road system of the nearby small town. They were used over the period of three years. The traffic was intensive, having large number of trucks mostly loaded with crushed stone, passing towards the construction site and the way back. The quantity of the transported material usually had weight higher than by standards prescribed values. The traffic was ongoing whole day long, having usually the both road lanes occupied. Present was intensive breaking near the town crossroad and also unappropriated truck speed.

The town roads were deteriorated with bumps and holes even before the transport of building material started. The town buildings were positioned mostly very near the road. The town building stock consisted mostly of family houses built 50 or 20 years ago. The intensive material transport over town roads in poor condition had negative influence on them. They experienced slight or heavy damage in dependence on the building's age. Consequentially, present was the fear and uncertainty of the building owners due to possibility of the damage progression, vibrations and noise.

Soon after three years, the transport of the building material was shifted to another location as requested by the town residents. The roads were repaired by fixing the bumps and holes and introducing the new base, binder and surface courses. Afterwards, the eight building owners had initiated a lawsuit against road maintance company for negligence. They were seeking a compensation for building rehabilitation due to damage caused by vibrations due to intensive traffic and unmaintained road.

The task of the court specialist in this case was to provide evidence that the damage to buildings was caused by vibrations from increased traffic in the period of highway construction, to determine the damage level and its influence on the stability and serviceability of the buildings, and to provide recommendations on the possibilities of building rehabilitations or to suggest demolition. In order to complete the task the visual inspection of the buildings was conducted in order to determine the size of the damage and to grade the condition of the building. Conducted was the reconstruction of the events suspected to be the cause of the current building condition. The aim was to measure and to envisage vibrations caused by intensive traffic in the period of highway construction in order to relate them with negative effects on buildings and residents.

BUILDING INSPECTION AND VIBRATION MEASUREMENT

— Building condition inspection

The visual inspection is the first to be conducted in the process of determination of the building's condition. If by visual inspection no damage was discovered, there is no need to conduct the further examinations. By visual inspection determined are locations on the structure with damage which is usually manifested through small or large cracks on e.g. foundation walls, load- and non-load bearing elements, ceilings, walls, roof, staircases, near openings, chimneys, plaster, etc.

By spotting and recording the crack locations, measured was their size and the overall building condition was assessed i.e. safe or unsafe for residents. The assessment of structural and non-structural damage and building overall condition was conducted based on comparison of measured data with the by standard prescribed values.

The procedure of damage record was conducted by using the table forms for in-situ building damage and condition assessment after an earthquake. Based on the conclusion on overall building condition, given were recommendations for building rehabilitation in order to bring them to serviceable condition.

The total number of eight buildings were examined, located in two streets where the intensive traffic was present. In all buildings spotted was damage in the form of cracks of different size and shape spread over the entire building. Mostly affected were the walls, foundations, foundation walls, floors, ceilings, near openings, balcony and ceramic tiles. Additionally, observed were settlements, roof tile movements, rain lea page, even the wall buckling and ceiling collapse.

All observed building damage could have been a consequence of other irregularities such as from e.g. building construction, poor building maintenance, poor water drainage and soil settlement. Therefore, in order to relate the consequences of intensive heavy traffic-induced vibrations, it was necessary to determine the intensity of vibrations.

— Traffic-induced vibrations measurement

By intensive three year traffic of loaded and unloaded trucks over the road in poor condition, the higher vibrations of the surrounding ground were constantly present. They consequently propagated towards nearby buildings.

The traffic intensity was about 150 trucks on daily basis which can be qualified as long-term and intensive action. The intensity of excitation transmitted through the ground to the building is a function of: source excitation intensity, distance from the source to the building, ground type (radiation damping), ground water level, road condition, building structural system, building material characteristics, etc. Transmitted vibrations activated the inertia forces causing deformations of foundation and afterwards the rest of the building.

The task of the specialist was to provide the evidence that the traffic load caused higher dynamic excitation on buildings and consequently their damage. In order to provide such an evidence it was necessary to measure the intensity of vibrations caused by traffic. As measurement location points selected were the ground near building foundations and the 1st storey in multistorey buildings.

By vibration measurement the general dynamic response of a building is determined (resonant frequencies, damping). The most important parameter governing the dynamic response is the building resonant frequency since in the case of coincidence with dynamic excitation frequency becomes a cause of significant increase in response amplitudes. The influence of vibrations to the building is two-way, it causes damage to the building and annoyance to residents [10,11].

Based on vibration measurements, assessed was the relationship between the traffic load and the damage in the building. This was done in way that measured vibration level was compared with the values allowed for the buildings and residents as prescribed by the corresponding standards [5-9]. The hardest was to determine what and how much did it happen. In order to answer these questions, it was necessary to reconstruct the events that occurred several year ago having many characteristics changed within the period. The reconstruction was conducted by using heavy truck passage in front of the observed building.

The road condition in the period of intensive traffic was different then on the day of measurement. It was renewed thus not having bumps, holes, depressions, etc. In order to simulate the road irregularities the wooden board 24 mm thick was place on the road. The aim was to produce the effect of truck passage over the hole in the road. In the reconstruction of events used was one truck, having average speed of 30 km/h, and loaded with 77 % of nominal value, which was in compliance with the standards for cargo transports. The respondents claimed that the load in the trucks during the material transport was much higher than nominal one, and that they were passing in train formation, or by passing each other while having inappropriate speed. Therefore, much of the input parameters differs from original situation: road condition, truck weight, truck speed, traffic frequency, etc.

All of the named quantities imply that the dynamic excitation was many times higher than the measured one. This bias was tried to be overcomed by multiplying the measured quantities by the factor of 2. Vibration measurement was not conducted on all eight buildings. Only four were selected that represent the existing diversity in the building stock (age, condition, and distance to road). The selected buildings are marked in Figure. 2 by black dots. Measured was the intensity of horizontal vibrations (in x- and y-direction) and vertical vibrations (z- direction), caused by truck loaded with 26640 kg (of possible 35000 kg) of material. The total truck mass was 41240 kg. The truck passage was repeated several times.

For the purpose of vibration measurement used were instruments of "Syscom Instruments AG" company (see Figure 3 and 4). Instruments were specially devised for civil engineering purposes, and used in buildings, tunnels, construction sites, etc. Measuring system is recording the response velocities and the date are recorded to computer.

Veleocymeters are used to measure the response in the three different directions simultaneously (x-, y- and z-direction). Total measurement time was 5 h.

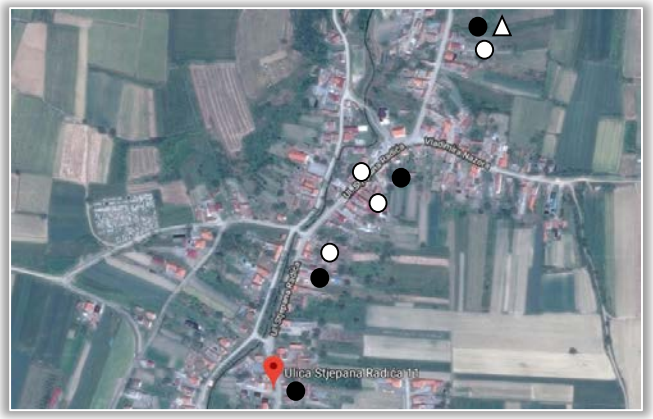

Figure 2. Map with supply truck routes and damaged buildings

Figure 3. View on the measuring equipment

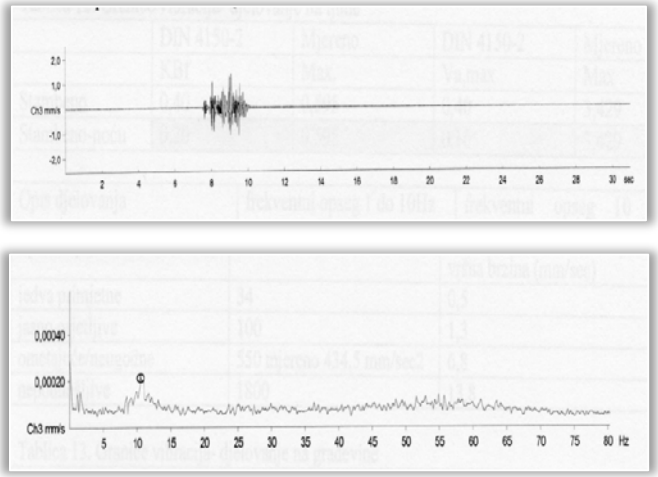

Figure 4. Time history record of vertical velocities (in mm/sec) at foundation (above) and acceleration data (in mm/sec^2) at various frequencies

VIBRATION MEASUREMENT RESULTS

Presented are results for single building that suffered the most of the damage (see Figure 5). The building is a house with basement of dimensions 80 m^2, built in two parts (50 and 30 m^2) with solid brick masonry without confining elements. The first, old part, was built 60 years ago, and second part was built several years ago. Due to age it is considered as sensitive building. The building is placed near road with 7 m distance to its closest point, and 19 m to its farthest. The foundation soil is rock. The building experienced both, the structural (collapse of storey slab in older part, cracks in outer and foundation wall) and the non-structural damage (cracking of windows, cracked ceramic tiles, displacement of roof tiles and rain water leakage).

Figure 5. Damage to the ceiling (left) and damage to the ceramic tiles (right)

To answer the question whether the traffic-induced vibrations caused the named building damage, measured quantities were compared to quantities prescribed by following standards: SN 64031a, DIN 4150 and ISO 2631 (see Tables 1 to 3).

The resonant frequencies of the building with structural masonry walls are usually similar for longitudinal and transversal direction, even when the ground plan aspect ratio is 3 to 4. The first vibration period of the structure can be estimated based on expression T_1=0.0165*H (f_1=1/T), which applied to the observed building comes to T_1=0,084 sec (f_1=11.9 Hz) in both directions.

Vibrations besides that they cause annoyance to residents, they disrupt working ability and long-term their health. In case observed, vibrations were disrupting the residents during the days, and were unbearable during night.

The increased traffic, and correspondingly the vibrations, including the initial condition of the road, its surroundings, could have led to heavy damage to buildings. In other buildings, the damage level was lower, due to different input parameters.

Table 1. Comparison of measured and prescribed limits for building sensitivity to vibrations

	SN	DIN 4150-3	Measured
$v_{a,max}$ (mm/sec) sensitive buildings	1.5-2.5	4	3.429

Table 2. Comparison of measured and prescribed limits for resident sensitivity to vibrations

	DIN 4150-2	mjereno	DIN 4150-2	mjereno
	f kB	max	$v_{a,max}$	max
Stambeno danju	0.4	0.595	0.4	3.429
Stambeno noću	0.2	0.595	0.16	3.429

Table 3. Comparison of measured and prescribed limits for resident sensitivity to working ability

Action description	Frequency range 1 do 10 Hz peak acceleration (mm/sec^2) prescribed vs measured	Frequency range 1 do 10 Hz peak velocity (mm/sec) prescribed vs measured
Barely noticeable	34	0.5
Clearly noticeable	100	1.3
Disrupting	550-434.5	6.8
Unbearable	1800	13.8

CONCLUSIONS

The roads of a small town were used for the crushed stone material transport to the highway construction site from a nearby quarry. The roads were already in poor condition even before the transport started. They were used in a period of three years. During that period, the buildings near the road and their residents experienced significant amount of traffic vibration increase.

Vibrations became constant and long-term annoyance to them. As a consequence, the damage appeared in many of the buildings placed near the road. The damage intensity was dependent upon the building workmanship, age and type. Usually, they were classified as sensitive due to their age and the lack of proper structural integrity. While some of the damage in buildings could be considered insignificant, the other however even lead to collapse of structural elements.

After some period of time, the residents of damaged buildings initiated a lawsuit on road maintenance company. It was needed to prove that the damage in their buildings was caused by traffic-induced vibrations, and not by other causes.

In that purpose the reconstruction of the events was conducted, in which the conditions leading to damage were simulated. This was not possible in total, since the road was meanwhile repaired completely. The road was without irregularities and didn't had such extreme traffic loading. This was overcome by introducing the wooden board to the road over which the heavy truck was passing several times. The weight of the truck and speed were in compliance with the standards for vibrations measurement.

Only on four of eight buildings vibrations were measured.

Based on the measured vibration intensity and by comparing them with by standards allowed values, conducted was assessment of the building condition. The effect of traffic-induced vibrations was higher on older buildings that had less structural stiffening elements and are considered as sensitive buildings.

The measurements confirmed the coincidence of building resonant frequency and dominant excitation frequency which can be served as a proof for the building damage. Additionally, the vibrations had disruptive and unbearable effect on residents.

Non-maintenance of town roads and non-planned usage with significant increase of heavy truck traffic caused the damage to many buildings near the road and annoyance to the residents. One of the most important things in planning a building construction is not to jeopardize the other buildings.

Note:

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APPLICABILITY OF MICROWAVE IRRADIATION FOR ENHANCED BIODEGRADABILITY OF TOBACCO BIOMASS

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Abstract: The aim of our research was to investigate the effects of microwave (MW) irradiation on the enzymatic degradation of the lignocellulose content of tobacco-originated biomass. Mixture of different parts of by-product tobacco plants in an aqueous suspension of 10 (m/m)% were used for the experiments, and MW-pretreatment was applied at two different levels of energy density. The effects of the chemical (acid/alkaline) conditions during the MW irradiation were also investigated. To evaluate the efficiency of the applied pre-treatment methods the concentration of produced reducing sugar was measured right after the treatment processes, and after the enzymatic hydrolysis stage, as well. In order to characterize the energy efficiency of pretreatments, the specific energy demand at each experimental setup was evaluated.
Keywords: microwave, pre-treatment, lignocellulose, biomass, hydrolysis

INTRODUCTION

Nowadays the decreasing of available and economically exploitable fossil energy sources presents a great global problem to be solved, regarding that the energy demand of the Earth has been increasing since the 90s. In order to support the sustainable development and the energy demand of the world, the utilization and use of alternative and renewable energy sources should be undoubtedly taken into consideration.

Recently, lignocellulosic biomass (LCB) has gained greater and greater attention as a promising source of energy due to its low cost and great availability, since it is presented in an excessive amount worldwide. Because of this, LCB, especially if produced as waste stream in agriculture or food industry, presents a good alternative for the energy sector and the food and chemical industry. Biomass-based energy production technically covers the direct utilization of solar energy after the transformation of biological systems. The energetic usage of biomass is „CO2 neutral", which means that during the utilization as fuel does not produce more CO2 than plants can utilize during photosynthesis (*Matthews, 2008*).

Commonly utilized bioethanol is produced from sugar or starch with fermentation by yeast or continuous distillation. There are several types of bioenergy plants for producing bioethanol like sugar-beet, wheat, corn in Europe, corn and wheat in North America and sugar-cane in South America. Besides these, raw materials with high cellulose or lignocellulose content, e.g. corn-stalk, waste of wood industry or sorghum have also been used frequently for this purpose recently (*Gnansounonou et al., 2005*). The method of bioethanol production can vary according to the type of the bioenergy plant: sugar extraction and fermentation, hydrolysis and fermentation of starch, and with the – possibly enzymatic – hydrolysis and fermentation of cellulose (*Grey et al., 2006*). In terms of bioethanol production, there is also a great potential in the cellulose-containing wastes of several different industries. On the other hand, the utilization of cellulose for energetic purposes faces difficulties, due to the rigid and resistant molecular structure of cellulose fibers, which makes biodegradation problematic. However, implementing a one or two-step pre-treatment process (e.g. chemical, physical or physicochemical) prior to the enzymatic digestion, might enhance the efficiency of the whole process, making cellulose-based materials easier utilizable for energetic purposes.

The electromagnetic radiation (EM) is divided into seven regions. One of them is the range of microwaves (MW), which falls in the interval of the EM spectrum between radiofrequency and infrared light. Its wavelength is from about 1 cm to 1 m, which corresponds to the frequency range of 30 GHz up to 300MHz *(Metaxas and Meredith, 1993).* Some of the doubtless advantages of microwave irradiation are the capability of more uniform heating in the penetration depth of the irradiated material compared to conventional heating methods, the ability of volumetric heating, and the high energy density – all of which shorten the time demand of operations. There are two main phenomena that contribute to the transformation of microwave energy into heat: ionic conduction, and dipole rotation. Ionic conduction is significant when the MW irradiated solution contains diluted and migratable ions, and dipole rotation is considerable when the material contains polarizable molecules.

Some preliminary publications have already mentioned in the early 1980s that non-thermic effects of microwave can affect biological systems in several various ways (*Taylor, 1981*). In some cases, enhanced activity of enzymes (e.g. cellulase) has occurred after the microwave treatment (*Neményi et al., 2008*), which indicates that microwave pre-treatment may enhance the biodegradability of lignocellulosic materials. But in high temperature material processing the existence of non-thermal, or microwave specific effect is unclear *(Géczi et al., 2013).*

Based on several studies, the hydrolysis of the main component of plant cell walls (cellulose) can be enhanced under alkaline and acidic conditions via microwave energy, which is attributed to its heating capability and "non-thermic" microwave-based

mechanisms. During acid/alkaline-combined microwave pre-treatments, the increasing energy absorption - that occurs due to the polar compounds - can enhance the efficiency of the process even further (*Gabriel et al., 1998*). The degradation of plant cell wall implies the releasing of intracellular liquid, and due to its dielectric properties, it can absorb the microwave energy. Thus, the increase of inner pressure induced by the fast increment of temperature can no longer be sustained by the cell wall, making it to disrupt. This phenomenon is considered to be the main reason why the enzymatic degradability can be enhanced with microwave irradiation-related processes (*Zhongdong et al., 2005*).

MATERIALS AND METHODS

Different parts of completely dried out and shredded by-product tobacco plants were used for the experiments with an average particle size of 0.2 ± 0.025 mm in 10 (m/m)% aqueous suspensions, i.e. 10 grams of dry material was suspended in 90 grams of distilled water, reaching 100 grams total mass per sample respectively.

For the microwave pre-treatments a Labotron 500 laboratory-scale microwave equipment (Figure 1) was being used, whose operational power can be adjusted in two levels (250 W and 500 W), and it is equipped with a 2,45 GHz frequency magnetron. To decrease the occurring heat inhomogeneity in the samples, the equipment is mounted with a turntable inside. The MW equipment was being operated with the following parameters (Table 1).

Table 1 – Operating conditions of microwave irradiation

level of power (P / MWP) [W]	operational time (t) [s]	total irradiated energy [J]
250	180	45000
	360	90000
500	90	45000
	180	90000

Figure 1 – Labotron 500 microwave equipment

For the simultaneous acidic treatment 72% H_2SO_4 was added to the samples to achieve pH=2. The alkaline treatment was carried out with using 5N NaOH solution, to reach pH=12. The pH of the chemical-control samples was not adjusted; the native pH of the suspensions was 7.2 ± 0,4.

For the 6-days-long enzymatic hydrolysis that followed the pre-treatments, a mixture of cellulose (*Trichoderma reesei*, Sigma Aldrich, nominal enzyme activity: 700 Ug^{-1}) and cellobiase (*Aspergillus niger*, Sigma Aldrich, nominal enzyme activity: 250 Ug^{-1}) was being added in a final volume of 300 – 300 µl, respectively. Based on data sheet provided by Sigma Aldrich, the pH during the hydrolysis was kept at a constant 4.8 ± 0.2, and the temperature was set at 45 ± 0.5 °C.

Cellulose degradation was characterized by measurement of produced reducing sugars (RS), right after the pre-treatments (as the degradation effect of pretreatment), and during the 6-days-long enzymatic hydrolysis as well. For the glucose assay, 3,5-dinitrosalicylic acid (DNSA)-based spectrophotometric method (Figure 2) was being used at λ=540 nm, and the concentrations was calculated by a glucose standard curve with an R^2 value of 0.9984.

Figure 2 – Spectrum of the DNSA-sugar complex

RESULTS AND DISCUSSION

— The effects of MW and chemical pre-treatments

In our study the effects of standalone and chemically-combined (acid/alkaline) microwave irradiation with different operational parameters (power level (*P*) and operational time (*t*)) on the efficiency of the subsequent enzymatic digestion were investigated. Furthermore, research aimed to identify whether the pre-treatment processes mentioned above have a degradation effect themselves on the cellulose fibers.

Figure 3 shows the results obtained for the standalone effects of microwave irradiation applied at two different power levels and operational time in acidic and alkaline medium, and without any chemical pre-treatment on the degradation of the cellulose of the tobacco biomass. Samples without MW pre-treatment (NMW) were used as controls. It can be seen that the MW irradiation itself - without any chemical dosage - could increase the amount of produced RS, however the difference between the four different operational setups is negligible. The maximum RS yield amount could be achieved when the operational time was set at 360 seconds with a power level of 250 W (17,1 mg/g_{rm}). Increasing the power level to 500 W but shorten the irradiation time to 180 seconds (which means the same energy irradiation as 250W power for 360s) shows a minor decrease in the RS-yield (cf. 17,1 mg/g_{rm} – 15,7 mg/g_{rm}).

Comparing the results obtained when applying alkaline condition during the MW treatment, the differences in the measured reducing sugar content are noticeable. The lowest RS-yield (33,83 mg/g_{rm}) was presented when the level of MW power was 500 W

with an operational time of 90 seconds, and the (overall) maximum amount of product could be measured when applying 250 W with 360 seconds of treatment time (51 mg/g_{rm}), hence the difference is more than 50%. It can be also noticed that the application of alkaline dosage (pH=12) could increase the RS yield for all of the different MW pre-treatment combinations. When analyzing the results of the control samples, it can be concluded that the standalone alkaline treatment seems more beneficial in terms of achievable reducing sugar concentration compared to acidic (cf. 14,5 mg/g_{rm} vs 10,1 mg/g_{rm}), furthermore, these results even exceed those obtained for the standalone 250W-180 seconds and 250W-360 seconds MW treatment as well. This might indicate that the combination of alkaline and microwave pre-treatment has the strongest effect on the degradation of the cellulose fibers, and these effects are considered to be additive. It can be stated that our major experimental results, that the chemically-combined MW irradiation can effectively degrade the cellulose polymer (without enzymatic hydrolysis) agreed the findings concluded in the study of *Marx et al. (2014)*.

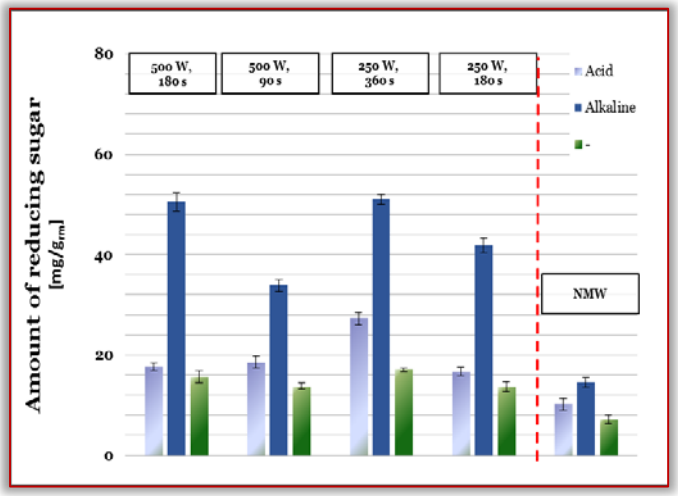

Figure 3 – The effects of MW and chemical pre-treatments, before hydrolysis

Besides investigating the standalone effects of physicochemical pre-treatments on the structure of the cellulose fibers, it is also an important aspect of research to find out how these treatments can affect the process of the enzymatic degradation. Figure 4 shows the results gained after the 6-days-long enzymatic hydrolysis that followed the same combination of pre-treatments discussed above. Our experimental results show that the highest concentration of end-product sugar could be achieved when the samples were subjected to MW irradiation in an alkaline medium. The maximum RS-yield (123.2 mg/g_{rm}) occurred if the operational parameters of the MW treatment were set as P=250 W and t=360 s. It should be noticed that at the power level of 250W shortening of irradiation time from 360 s to 180 s did not manifested in significant decrease of RS yield under alkaline condition (cf. 123,2 mg/g_{rm} vs 122,9 mg/g_{rm}). Therefore, it can be concluded that alkaline condition (pH=12) enable to reduce the energy demand of MW pretreatment process (9000 J/g_{rm} instead of 18000 J/g_{rm}).

Using acidic medium (pH=2) during the irradiation, the increase of the operational time resulted in noticeable change in the measured RS concentration, when the power level was set as 250 W (89,6 mg/g_{rm} – 102 mg/g_{rm}), however, these RS yields were than those obtained for the alkaline-MW pretreatments. Changing the level of MW power to 500 W a different tendency can be observed. Regardless to the chemical conditions during the MW irradiation, prolonging the operational time from 90 s to 180 s the achievable RS content has respectively increased. In combined MW-acidic pre-treatments increase of MW power has more significant effect on RS yield than was observed for microwave-alkaline method. Applying 500W MW power for 90 s resulted in RS yield of 108,2 mg/g_{rm}. Changing the irradiation time to 180 s, a slight increment in the yield could be observed (115 mg/g_{rm}). Acidic condition resulted in higher RS production than alkaline when chemical treatment was applied alone, without MW irradiation.

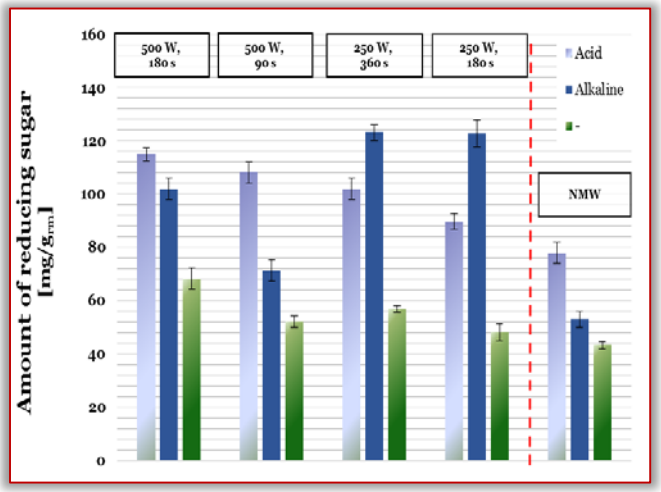

Figure 4 – The effects of pre-treatments on the enzymatic hydrolysis

Several studies have proven that combining acidic treatment with MW irradiation can intensify the enzymatic digestion of a lignocellulosic biomass, because both microwave and strong acids can weaken the chemical bond between the cellulose and lignin (*Lu et al., 2002*). The reason behind our results (that is, alkaline + MW combination is more beneficial than acid + MW) might be explained by that a strong acidic medium supplemented by a high investment of microwave energy may degrade more drastically the proteins presented in the tobacco plant than using alkaline. The exfoliated free amino acids or amino acid chains (especially those high in asparagine) then can be involved in a reaction with free reducing sugars (i.e. Maillard-reaction), forming Amadori-by-products or acrylamide, and indirectly lowering the measurable sugar content in the samples.

Since the alkaline combination with MW treatment revealed to be the most effective in terms of intensifying the efficiency of the enzymatic degradation, optimization of process parameters for maximum RS concentration was carried out by response surface methodology (RSM). Figure 5 shows the fitted response surface with the variables of irradiation time (seconds) and specific power intensity (*MWP*, W/mL) and response as RS concentration, specified as mg$_{RS}$/L. It can be concluded that increasing the MWP (at given irradiation time level) or increase the irradiation time at given MWP, the RS concentration increases, but after a breaking point, the too high power intensity/too long irradiation has decreased the

achievable RS concentration. Based on the results based on statistical analysis, in alkaline (pH=12) suspensions applying of irradiation time of 140 seconds and power intensity of 3.8 W/mL for MW pre-treatments resulted in the highest amount of reducing sugar produced in 6-days-long enzymatic hydrolysis (3657 mg/L).

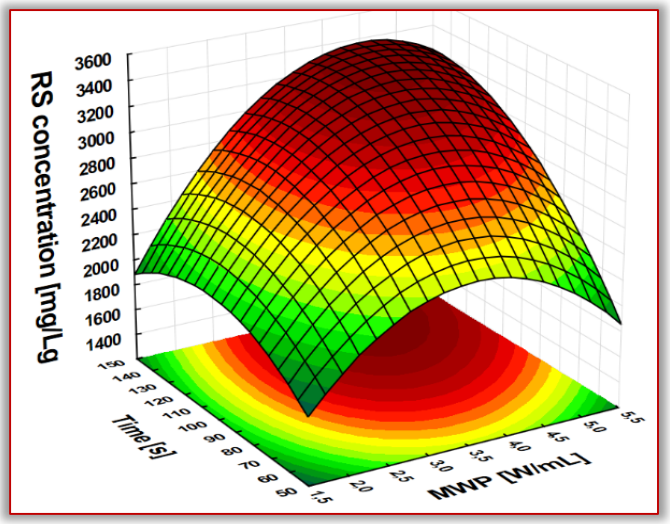

Figure 5 – Response surface for the effects of parameters of the MW pre-treatments on final RS yield

It is also needed to evaluate the ratio of reducing sugar concentrations obtained by different pretreatments to the theoretical maximum sugar yield calculated from the cellulose content of the tobacco biomass (Figure 6). Our results show that the maximum achievable RS yield applying MW-alkaline pretreatment (at pH=12 with 250 W-360 s MW treatment) is approximately 70% of the theoretical (calculated) maximum, while the control sample is less than 25%. Considering the ratio of obtained RS concentration to the theoretical maximum, it can be concluded that pretreatments enhanced the cellulose degradation degree; increment of RS yield was threefold.

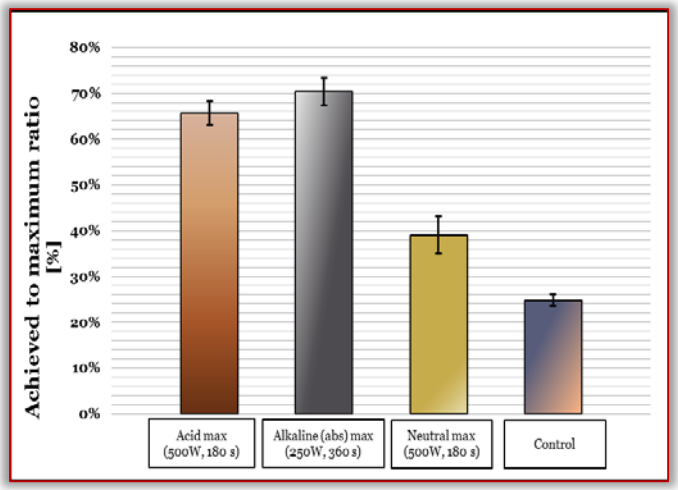

Figure 6 – Measured RS concentration compared to the maximum achievable

During an investigation of a microwave irradiation-based process, it should be always taken into account that the water content can greatly affect the efficiency. All through the mechanism of the microwave-originated heat generation, the mobile ionic and polar components play a great role in the transformation of the energy of the electromagnetic field with an alternating polarity with high frequency into heat. Therefore, increasing the dry matter fraction of an aqueous suspension over a certain extent would worsen the energetic efficiency of the pre-treatment process, even if the evaporation of the solvent is prevented.

The importance of these evaporation and water-replenishment phenomena during the application of MW irradiation to enhance the biodegradability of cellulose-containing suspensions were being investigated by *Lu et al. (2011)* as well. It should be noted that if the hydrolysate of the enzymatic digestion enhanced with MW-related pre-treatment processes is considered to be used for further fermentation into ethanol, solutions with low reducing sugar concentration can noticeably decrease the effectiveness of the whole process, since the oxidation of the ethanol may occur faster that way.

Therefore, MW irradiation as pretreatment stage could be beneficial from the aspects of overall efficiency of a complex (pretreatment-enzymatic hydrolysis-ethanol fermentation) cellulose based bioethanol production technology.

— Energetic characterization

As previously mentioned, selecting the operational parameters (i.e. level of power, time of exposure) of the microwave irradiation greatly affects the efficiency of the enzymatic hydrolysis. At the time same, in the perspective of availability, and especially of the economic aspects of pilot- and industrial scale applications it is also a major factor how much external energy investment is needed for a given microwave-based pre-treatment process. Furthermore, investigating how efficient the degradation of cellulose after the MW irradiation-included pre-treatments can also provide useful information about the energetic conditions.

Figure 7 shows the specific MW energy demand for each pre-treatment combination, given by the ratio of the overall external energy investment, and the amount of reducing sugar that produced from 1 gram of dry matter during the hydrolysis [Eq.1]:

$$\frac{MWP\ [W] \cdot t\ [s]}{(Y_{RS}\ [mg] \cdot DM_{1g}\ [g])^{-1}} \quad \left[\frac{J}{(mg_{RS} \cdot g_{DM})^{-1}}\right] \qquad (1)$$

This gives the opportunity to compare the energetic efficiency of each experimental setup, since it provides information about how much external energy is needed to obtain 1 mg of RS from 1 g of dry material.

Based on the equation shown above, the less the calculated value the more beneficial the process in terms of energy utilization for cellulose degradation. It can be observed that the lowest specific energy was needed when the MW irradiation parameters were P=250 W, t=180 s, combined with alkaline treatment (366 J/(mg_{RS}/g_{RM})). Even though the maximum RS yield occurred when the 250 W power level was applied with 360 s of irradiation time, it can be seen that from energetic aspects decreasing the process time to 180 s is significantly more favorable. At 250 W power level with 360 s and 180 s, which means external energy demand of 90 kJ and 45 kJ, calculated specific energy need was 730,5 J/(mg_{RS}/g_{RM}) and 366 J/(mg_{RS}/g_{RM}), respectively.

The same tendency can be observed when the applied power of MW is set to 500 W regardless the chemical co-treatments;

notwithstanding prolonging the time of irradiation from 90 s to 180 s inflicts an increment in the end-product yield, but the increment of RS yield was lower than the specific energy demand increases, indicating the diminution in energetic efficiency.

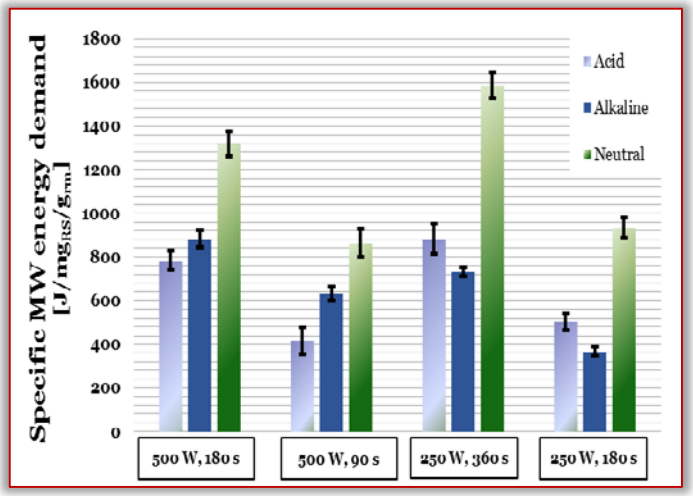

Figure 7 – Specific energy demand of the applied pretreatment combinations

SUMMARY

The aim of our research was to investigate the effects of microwave, chemical and combined type of pre-treatments on the enzymatic biodegradation of lignocellulose presented in tobacco waste-originated biomass. Mixture of different parts of by-product tobacco plants (those that are remained from tobacco-processing) were used for the experiments in 10 (m/m)% aqueous suspensions. The purpose of the standalone and chemically-combined (acid/alkaline) microwave pre-treatments was to enhance the efficiency of enzymatic hydrolysis of the cellulose-content of the processed biomass.

Table 2 – Summary of results

MWP [W]	MWE [Jg_{RM}^{-1}]	pH [-]	RS_{PreT} [mg g^{-1}]	Degradation rate [mg $g^{-1}day^{-1}$]	Y_{RSmax} [mg g^{-1}]	RS_{prod} / MWE [mg $g^{-1}J^{-1}$]
-	-	7	7.2	7.22	43.3	-
-	-	2	10.2	13.00	78.0	-
-	-	12	14.2	8.83	53.0	-
500	9000	7	13.8	8.68	52.1	0.005789
250	9000	7	13.7	8.03	48.2	0.005356
500	18000	7	15.7	11.38	68.3	0.003794
250	18000	7	17.1	9.47	56.8	0.003156
500	9000	2	18.6	18.03	108.2	0.012022
250	9000	2	16.7	14.93	89.6	0.009956
500	18000	2	17.7	19.17	115.0	0.006389
250	18000	2	27.3	17.00	102.0	0.005667
500	9000	12	33.8	11.87	71.2	0.007911
250	9000	12	41.8	20.48	122.9	0.013656
500	18000	12	50.5	17.00	102.0	0.005667
250	18000	12	51.0	20.53	123.2	0.006844

The degradation of cellulose was given by the reducing sugar yield determined right after the pre-treatments, and during the enzymatic hydrolysis stage. The specific energetic parameters were also evaluated, which give information about how much external energy investment is needed to achieve 1 mg of reducing sugar from 1 gram of raw material, during the hydrolysis with the applied pre-treatment methods.

Table 2 summarizes our experimental results regarding the effects of MW and chemically-combined pre-treatments on the structure of cellulose fibers and on the enzymatic hydrolysis, furthermore the energetic conditions of the MW irradiation-based pre-treatment processes.

Since the results of our work have successfully proven that MW irradiation combined with chemical co-treatments can enhance the enzymatic degradability, further experiments with other types of enzymes are planned to characterize whether other enzymatic processes can be enhanced with physicochemical treatments. Further experiments are needed to determine the biogas potential of remained fraction from enzymatic saccharification and ethanol fermentation to complex energetic evaluation of tobacco biomass utilization.

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WEED CONTROL METHODS FOR ORGANIC VEGETABLE CROPS

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Abstract: Organic vegetable crops are part of niche crops that can provide farmers with high incomes. Controling weeds in these crops is an extremely important work, constituting today a real challenge for vegetable growers because only non-chemical methods are accepted in the organic farming system for plant protection. Physical weed control is mostly used, which is based on the application of several techniques, the most used being mechanical and thermal control. The paper shows a short synthesis of current non-chemical methods and technical devices used in integrated weed management in organic vegetable crops.
Keywords: plant protection, non-chemical weeds control, integrated management of weeds, thermal control, mechanical control

INTRODUCTION

The organic farming system must be seen as an integral part of sustainable development strategies and as a viable alternative to conventional farming, as it can provide, in particular: less contaminated air, water and agrifood products, safe working conditions for farmers, biodiversity preservation, fertile and healthy soil, nutritional quality of organic products, food security, environmental protection, reduced use of non-renewable resources, economic benefits (*Brumă, 2015*).

With regard to organic farming, Romania is ranked 7th in the top led by Poland, of the 23 Eastern European countries analyzed by FIBL Switzerland. On the other hand, in recent years Poland and Romania registered a decline in certified surfaces ecologically (*Mediafax 2018*).

The so-called minor crops produce over € 60 billion a year, which represents more than 20% of the EU's total agricultural output (*Pannacci et al., 2017*). These include fruit and vegetable crops, plus seed, spice, medicinal and aromatic plant crops. Among these niche crops, organic vegetable crops are also found.

According to some authors, the physical combating methods for plant protection fall into two basic types: active and passive. Active methods consist of using a certain form of energy for destroying, injuring, inducing stress in crop pests or eliminating them from the environment, having immediate effect during application. Passive methods, on the other hand, cause changes in the environment and have a more sustainable effect. Depending on the energy used, the physical methods are classified as: mechanical control, thermal control, electromagnetic control, pneumatic control, etc. In the case of weed control in organic crops, they include: manual weeding, hand pulling, mowing, thermal and mechanical methods (*Panneton et al., 2001*).

Also, in organic agriculture, weed control is achieved by applying certain measures / practices which, depending on the moment and the manner of application, can be preventive and curative (*Roman et al., 2008*). Preventive practices are necessary for long-term effective management of weeds (*Gabe et al., 2014*), preventing them from emerging and multiplying. They consist of: crop rotation, application of fertilizers, use of competitive species and varieties, germination bed preparation methods, irrigation / drainage systems, as well as the harvesting method (*Walsh et al., 2013*).

The curative methods keep under control the weeds already in the crop, using mechanical and thermal weed control equipment, which constitute the traditional non-chemical physical means for organic crops (*Shaner and Beckie 2014*).

Thermal combat is achieved through heat transfer from the specific equipment to weeds, by foliar contact, aiming at the destruction of their vital parts after a short period of time (*Nadzeikienė et al., 2009*). In order to be effective, heat treatments should lead to an increase of the internal temperature in weeds, between 55 °C and 70 °C, for a period of approx. 0.1 s. Therefore, the amount of heat transferred between the thermal control equipment and the target organism, as well as the duration of exposure to the treatment are important parameters. (*Ascard et al 2007*). The effectiveness of the treatments also depends on the stage of weed development, the young ones being much easier to destroy. Heat exposure determines the expansion of intracellular water, followed by cell membrane rupture, the primary effect being plant drying together with other chemical decompositions (*Peerzeda & Chauhan 2018*).

Over the past few years, concerns about the worldwide growth of weed populations resistant to herbicides, the low availability of active ingredients for minor crops (vegetables), the multiplication and development of organic farms have stimulated the development of new non-chemical weed control methods (Harker & O'Donovan, 2013).

In this brief analysis, it is not possible to address the many aspects of weed management, so the focus will be on new developments in non-chemical (mechanical / thermal) and intelligent weed control technologies, especially in vegetable crops.

MATERIAL AND METHOD

Soil heating is a promising, preventative ecological method for controling weeds in niche crops that bring high incomes, such as vegetables and flowers.

Ecostar SC 600 selfpropelled machine (*Celli Spa.*) (Figure 1) is used for disinfecting the soil with steam and zeolite type (potassium hydroxide and carbon oxide) ecological substances, using the Bioflash system (Figure 2). The machine is destined to be used in greenhouses, solariums and on the field, being equipped with

rubber tracks for improving manoeuvrability and reducing soil compaction. It is fitted with horizontally placed steam generator, for reducing height. The disinfection section placed in the back can be displaced transversally, giving the possibility to conduct the treatment in the inferior and lateral parts of a tunnel greenhouse. The speed of a rotary cutter is of 40-60 rot min^{-1}. The machine is fitted with an automated and ergonomic command and control system, with a biaxial joystick controlling the movement and the speed. Due to the hydrostatic transmission, a continuous range of speeds between 60-6000 m h^{-1}.

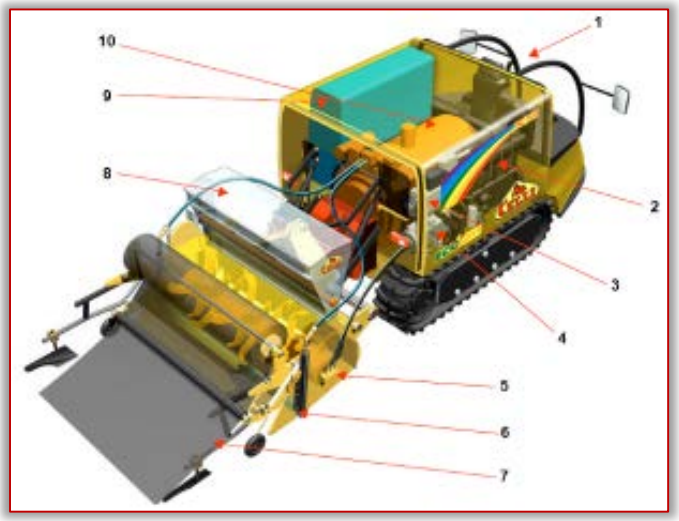

Figure 1 – Ecostar SC600 Equipment (Celli Spa)
1-drive joistick;2 –Diesel engine; 3- electric generator; 4-hydraulic transmission; 5- hydraulic rotating hoe; 6-steam injection bar; 7-plastic film mulch system;8-bunker for exothermal reactive;9-water tank; 10-boiler.

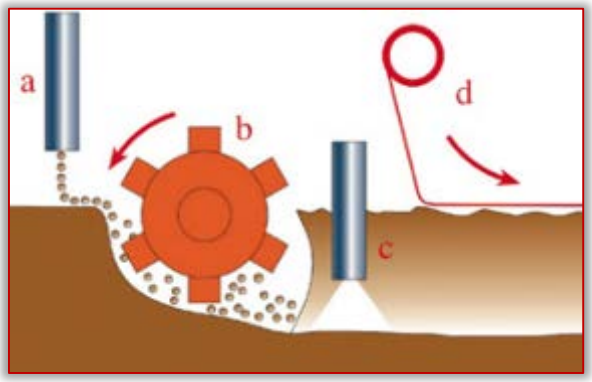

Figure2 –Bioflash system diagram (Celli Spa)
(a) substance distribution; (b) soil incorporation with a rotating hoe;(c) steam injection; (d) treated soil mulching.

The remote-control system allows driving without the operator on board. During the experiments, all the main components of the self-propelled machine (the rolling system, the rotary cutter hydraulic motors and the exothermic compound distribution system) were controlled electronically by a control card and its related software. (*Peruzzi et al., 2011*).

The technical characteristics of the machine are presented in table 1. (*Celoo, Peruzzi et a., 2011*).

The Ecostar SC600 machine (Figure 3) was tested using several types of steam injection bars to obtain different steam and heat distribution in the soil. Thus, it was equipped with: standard bar for Bioflash systems, which injected steam at a 200 mm depth; double bar, designed to have a more uniform distribution of steam in the treated soil and to reach deeper layers; carter bar, for surface treatments. During the experiments, a mix of the standard bar and the carter bar was used, with different ratios of steam distribution between the surface and the deep area. During the steam treatment, exothermic substances (CaO and KOH), applied in different doses (0, 1000, 2000, 4000 kg ha-1) were tested with or without plastic film mulching (*Peruzzi et al., 2011*).

Table 1. Technical characteristics of Ecostar 600

Characteristics	Measurement unit	Value
Equipment type	-	Self-proppeled
Power source	-	Thermal engine
Engine power	kW	44
Cubic capacity	cm^3	2.068
Fuel consumption	kg h^{-1}	11
Running system	-	Rubber tracks
Sleight dimensions (length x width x height)	m	1.9x0.32x0.52
Transmission type	-	Hidraulica
Speed	m h^{-1}	60-6000
Exothermal substances bunker capacity	m^3	0.23
Water tank capacity	m^3	0,6
Steam generator type	-	Electric
Electric motor power	kW	2.5
Steam flowrate	kg h^{-1}	600
Steam pressure	MPa	1.18
Working width	m	1.6
Overall dimensions (length x width x height)	m	3.8 x 1.6 x 1.5
Equipment weight	kg	3000

Following the experiments, soil temperature was measured using a dedicated system. The measured temperatures were divided into four "Classes" (T<40 °C; 40 °C < T < 60 °C; 60 °C <T < 80 °C; T > 80 °C). The amount of time each class persisted in the soil was recorded, along with the highest, average and final temperature (after 3 hours), in order to compare the effects of different treatments. A parameter - thermal addition (ΣT) was calculated as the sum of individual temperatures (measured every minute) for 3 hours after the treatment, including the temperature levels, duration and length of heating (*Peruzzi et al., 2011*).

The machine was also used to test the effect of five different systems of steam injection (surface or deep steam injection bar and three mixed systems at different steam distribution ratios between the surface and the deep bar: 1:2; 1:1 and 2:1) on an artificial infestation of Brassica juncea and on the natural weed seedbank. Treatments were performed using only steam or in combination with exothermic substances (CaO, KOH) applied at doses of 1000 and 4000 kg ha-1 (*Peruzzi et al., 2012*).

In order to evaluate both weed control and crop yield after applying different doses of steam in the soil strips together with exothermic substances, a prototype machine (Figure 4) using the Bioflash

system (Figure 2) was built, for applying strips. The machine, being towed, operated in aggregate with a 135 HP tractor, from which the hydraulic system and the electric generator were actuated. It was made of a two-wheeled pneumatic chassis that supports: the steam generation system, the steam application system and an exothermic compound (Bioflash system), the electrical system and the hydraulic system. The machine was coupled to the tractor via a drawbar. The application system for steam and exothermic compound was obtained by modifying a rotary cultivator with 12 units. Each unit acted on a width of 0.18m, being covered by a carter, on which the steam injection bar was placed.

The rotary cultivator (with 30-60 rpm min-^{1} speeds) was divided into three parts, each equipped with four units and a hopper for the exothermic compound. Each hopper was equipped with an adjustable metering unit, a measuring device and the four exhaust tubes, the system being driven by an electric motor. The steam obtained with a fast generator (Diesel type) was applied in 12 strips of 0.18 m, with 4 units grouped for each of the three ridges of 1.28 m width, resulting in a total working width of 4.58 m. In one day after using the machine, it was sown in the middle of the steam-treated strips. The tests were conducted in a carrot crop, organically grown under real field conditions, in order to study the effect of different doses of steam on the crop and on a natural weed seed bank over the entire growth cycle (*Raffaelli et al., 2016*).

Figure 3 –Ecostar SC600 Equipment (Celli Spa)

Figure 4 – Machine for soil disinfection in strips (prototype) (Raffaelli et al. 2016)

Hot water and steam are very effective in destroying annual weeds, some perennials ones, and permeable seeds close to the soil surface (*Banks & Sandral 2007*).

Hot water is effective in thermal combating when being used especially against young weeds. The water flows gravitationally, possessing other important properties (table 2) appropriate to this method (*Kristoffersen et al., 2008, Heatweed Technologies AB*). If the energy is correctly transferred to the weeds, their cellular structure is destroyed in a tenth of a second, then the roots are also dying. *Heatweed* equipment provides a stable water temperature of 98-99 °C, with the possibility of operating with vehicles, trailers, etc. They are intended to be used in areas with dense weeds: stadiums, parks, squares, etc., ensuring protection of surrounding plants due to low water pressure (*Heatweed Technologies AB*).

Table 2. Water characteristics

Thermal agent	Specific heat (kJ/kg^{0}K)	Thermal conductivity (W/m ^{0}K)	Energy density (kJ/kg)
Hot air (100^{0}C, 1 bar)	1,01	0,03	101
Hot water (100^{0}C, 1 bar)	4,18	0,682	418
Steam (100^{0}C, 1 bar)	2,08	0,025	2675

The main technical characteristics of the XL140 (*Heatweed Technologies SB*) destined for large surfaces (figure 5) are: 1.4 m working width; 34 l / min water consumption; 98-99.6 °C water temperature; 0.5-2.5 km / h working speed (depending on degree of weeding); 2 Diesel / BioDiesel burners; hydraulic transmission, 7x20cm application system with independent sections, 800 l tank volume, burner tank volume 105 l.

Because weeds and crop plants have similar biometric data, there is a problem of crop protection. Thus, the Hydra - Boom (*Weedtechnics*) system employs two heads of application of the Rowtech 55 (*Weedtecnics*) saturated steam and hot water mixture for organic horticultural farms. These conical heads follow the shape of the jet, retain the heat and protect the crops. Their main technical characteristics are: diameter 0.55 m, height 0.23 m, flow rate 4-19 l / min, weight 3.5 kg. The Hydra-Boom system is mounted in front of the tractor, with the position of the Rowtech 55 applicators being hydraulically controlled from the cabin. They also have the ability to easily follow the field (Figure6).

Figure 5 – Equipment XL140 (Heatweed Technologies)

Figure 6 –Hydra-Boom System (Weedtechnics)

The effect of controlling weeds with two types of steam (wet and overheated) obtained using electricity is studied. For this, an

innovative self-propelled chassis with the possibility of speed control, steam pressure and application width (*El-Sayed & El-Hameed 2017*) was used.

Mechanical control of weeds between rows without damaging the cultivated plants or their roots can be achieved with brush-type cultivators destined for use in vegetable growing, medicinal plants crops, etc. The technical characteristics of Fobro Hoe Brush are shown in Table 2. (*Baertschi Agrartecnic AG*).

Table 3. Technical characteristics Fobro Hoe Brush (AGB)

Tip Fobro Hoe Brush	Type 500	Type 760
Working width	1.5 m - 2,7 m	1.5 m - 2 m
Wheel track	adjustable	adjustable
Weight (according row on_iguration)	from 300 kg	from 600 kg
HP required	from 20 HP	from 50 HP
Diameter of Brush-Disc	500 mm	760 mm
Plant protector tunnel clearance	22 cm	33 cm
Tunnel width	6,10,14 cm	6 cm or 14 cm
Minimum row spacing	12 cm	12 cm
Power source	PTO 540 rpm or hydraulic	PTO 540 rpm or hydraulic

Fobro Hoe Brush equipment (Figure 7) consist of rotating brush units to which the fixed ones are added (Figure 8). The hairs of the brushes are made of durable and flexible materials that allow action near crops, protected by tunnels. The brushes do not move or scratch the ground like other devices, and the weeds dry quickly because the flexible wires pull them out of the root and affect the protective layer.

Figure 7 – Fobro Hoe Brush cultivator (*AGB*)

Figure 8 –Fobro Hoe Brush tunnel cultivator detail (*AGB*)

In general, mechanical methods for weed control between rows in vegetable crops are based on traditional spring harrows and cultivators, but new devices such as finger-weeders, torsion-weeders and intelligent weeders have emerged. (Peruzzi et al., 2017)

An automatic / intelligent weed control system has to achieve: guiding the mechanical devices, detecting and identifying weeds, eliminating them and eventually mapping. At this moment, only four companies sell automatic weed control machines: Robovator (Frank Poulsen Engineering ApS - Denmark); Robocrop (Garford Ltd. UK), IC Cultivator (Machinefabriek Steketee BV - The Netherlands) and Remoweed (Costruzioni Meccaniche Ferrari -Italia).

The Robocrop In Row cultivator is equipped with a hydraulic driven disc module for each crop row. As the cultivator advances on the row, the rotating disk controlled by a video image analysis system detects the location of the plants in the crop and rotates for correct alignment of the cut so as to remove the weeds between the rows and the plants one at a time (Garford Ltd). The Robocrop InRow cultivator has been tested to evaluate the effectiveness of weed control and soil loosening in salad, celery, radicchio, bok choy (obtained from seedlings), and in the cultivation of bok choy salad crops directly sown in the field. The cost of using the rotating cultivator in the two types of crops was also evaluated (Fennimore et al., 2014).

RESULTS

After testing the Ecostar EC 600, it was found that at a working speed of 150m h^{-1} the operating time was very high (20% was lost for auxiliary operations, eg: recharging). The advantage of Bioflash is that despite the relatively long working time, it has no toxic effects on crops. The tested system allowed to obtain higher temperatures compared to steam applications (in average + 17%), obtaining different results depending on the type of active compound and speed. Regarding thermal addition, CaO led to higher values compared to KOH (+ 7%) for the same rate of application. The higher dose for both active compounds led to a higher value for thermal addition (+ 10%) compared to lower doses. In terms of temperature classes, CaO applied at a dose of 4000 kg ha^{-1} led to temperatures above 60 °C for 50 minutes. In addition, for CaO applied at a dose of 1000 kg ha^{-1}, a temperature persistence time similar to the one KOH applied in high dose was obtained. The significant effect of soil heating due to the use of plastic mulch has been highlighted by the persistence time of the four different soil temperature classes. Mulching limited heat loss and allowed higher thermal addition (+ 30%) on treated parcels, compared to uncovered soil (*Peruzzi et al 2011*).

Also, the use of a single steam injection bar (surface or standard depth application) was more effective in achieving a high soil temperature and the holding time at a 100 mm depth, compared with mixed injection systems (*Peruzzi et al., 2011*).

For the machine prototype that applies the steam in strips using the Bioflash system, the best results for the temperature induced in the soil, over 60 °C at a depth of 25 mm, were obtained by applying a dose of CaO of 4000kg / ha and a maximum dose steam of 2.78 kg / m^2 (Figure 9). The authors recommended a steam dose of at least 2.3kg / m^2 at a working speed of 240m h^{-1} for a gradual satisfactory seed bank reduction in the soil, although economically it would have satisfied a dose of 1.9 kg / m^2 (*Raffaelli et al., 2016*).

Due to its thermal conductivity properties, hot water can transfer 23-27 times more energy than hot air or steam. A study conducted at the University of Copenhagen shows that after the hot water treatment of a weed infested surface, their least regeneration

occurs (Figure10), even at the lowest treatment frequency (*Heatweed Technologies*).

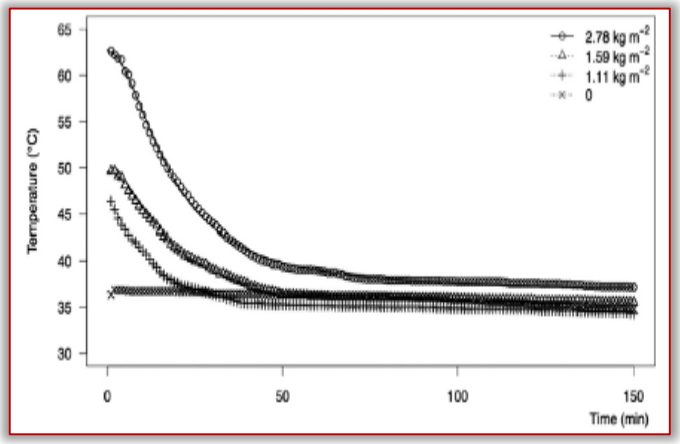

Figure 9 – Soil temperature variation in strips depending on the time and steam dose applied (*Raffaelli et al. 2016*)

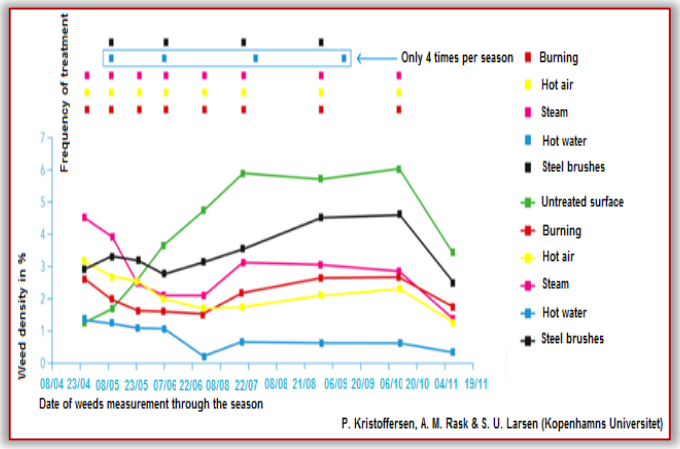

Figure10 – Weed density variation depending on the treatment applied (*Heatweed Technologies*)

Using the innovative chassis, for the same experimental conditions (working speed, pressure, application height), the results obtained in combating weeds using superheated steamed were superior to those obtained combating using wet steam. They were expressed through several indices, the most important of which was the weed extermination rate and their chlorophyll content, determined by: 2 and 3 days of treatment, as well as by weed regrowth determined after 1, 2, 3 weeks after treatment. (*El-Sayed & El-Hameed 2017*).

In general, for niche organic crops, treatments with traditional hoe with rigid shanks or brush-weeder for inter-row weed control, combined with finger-weeder for intrarow weed control, seems to be the better weed control strategy. For this type of crops obtained by sowing, characterized by small distances between the rows, is recommended to use high precision cultivators.

Robocrop rotating cultivator was in general more effective than the standard cultivator, concerning weed density as well as times consumed for removing weeds between the plants on the row, which is executed manually. It behaved well in the transplanted crops, especially in salad crop, where plants were bigger than weeds. In crop sowed using Robocrop achieved a thinningof 22-28%, compared with manual thinning and standard hoeing, therefore yield and net profits were lower.

CONCLUSIONS

In non-chemical weed management in organic vegetable crops, physical and mechanical weed control plays a fundamental role. The type of machine that can be used for this depends on the plant type, the cultivation technology, the size of weeds and the type of soil. For these methods of weed control, the development and adoption of efficient precision farming technologies can be a solution. Intelligent camera-based systems, capable of guiding mechanical and / or thermal devices contribute to increasing the working width and speed, which implies financial benefits.

The protection of vegetable plants against thermal destruction represents an important and seldom crucial factor in the technological process of chemical weed control, therefore different techniques need to be created and adpted, adequate for each type of crop. The study and development of weed control using hot water in organic vegetable crops, combined wih mechanical ones, in one pass, could constitute an important premise for achieving efficient equipment.

The preventive and curative control methods adopted, together with low tech, low cost or intelligent equipment, should be used within an integrated weed and pest control system in organic vegetable crops, in order to achieve an efficient weed management.

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EXPERIMENTAL METHOD FOR DEFINING THE STABILITY LOBE DIAGRAM IN MILLING Č4732 (42CrMo4) STEEL

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Abstract: Self-exciting vibration (chatter) is an unwanted phenomenon that can occur in metal cutting. Self-exciting vibration is a phenomenon that has a negative effect on productivity, leads to accelerated wear or breakage of the tool, and in some cases can lead to breakage of elements of jigs and fixtures or elements of the machine tools. In order to predict and control the process of creating self-excited vibration, different methods have been developed. One way of predicting self-excited vibration is defining stability lobe Diagram, which shows the boundary between stable, conditionally stable and unstable cutting process, whereby combinations of cutting depth, cutting speed, i.e. spindle speed and feed rate are observed. Methods for defining the stability lobe diagram can be analytical, and experimental. This paper shows the experimental method of defining the stability lobe diagram, on machining steel Č4732 (42CrMo4). Metal cutting is carried out on a vertical machining center. The methodology for defining the stability lobe diagram implies that a series of experiments were done, were workpiece surface to be milled is made with a slope of 3°. In this way, when moving the tool, the cutting depth gradually increases until the moment of self-excited vibration occurs. The occurrence of the vibration is registered by measuring the acceleration, where the accelerometer was being mounted on the main spindle carrier, as close as possible to the tool. After the self-excited vibration occurred, which is manifested by a sudden jump of acceleration amplitude, and by the change in the sound, the cutting process is stopped and then the axial depth of the cut at which the vibration occurs determined by the tangent method in Matlab. The obtained stability lobe diagram has two dimensions, which means that all measurements were performed for one, a constant value of feed rate per tooth.
Keywords: milling, self-excited vibration, stability lobe diagram

INTRODUCTION

The emergence of self-excited vibration during the cutting process has long been recognized. Despite, it is still a very current field of research both from the point of view of mathematical modeling and prediction, as well as from the point of view of experimental testing and management of the cutting process. By developing the CNC machine tools and increasing the application of high-speed machining, these problems have become even more pronounced, so the detection and prevention of the emergence of self-excited vibration have become essential for the exploitation of these production systems. This paper presents the method of determining the moment when self-excited vibration emerges during milling, as one of the indicators of dynamic instability of the processing system. The presence of vibration has been determined using modern diagnostic equipment National Instruments, as well as LabView and Matlab software. On the basis of experimentally obtained results, ie experimentally determined the depth of cut in which the self-extracted vibration emerge, the stability lobe diagram has been defined.

During the cutting process, due to insufficient dynamic stiffness of one or more elements of the machine tool system – cutting tool and holder - fixture - workpiece, three types of vibration can occur: free (natural), forced and self-excited vibration.

Free vibration emerges when a mechanical system derived from an equilibrium position is allowed to free oscillate without external influences.

Forced vibration emerge as a result the tendency of some object to force another one into vibrational movement. Free and forced vibration, if known, can be effectively avoided, reduced or removed from the processing process.

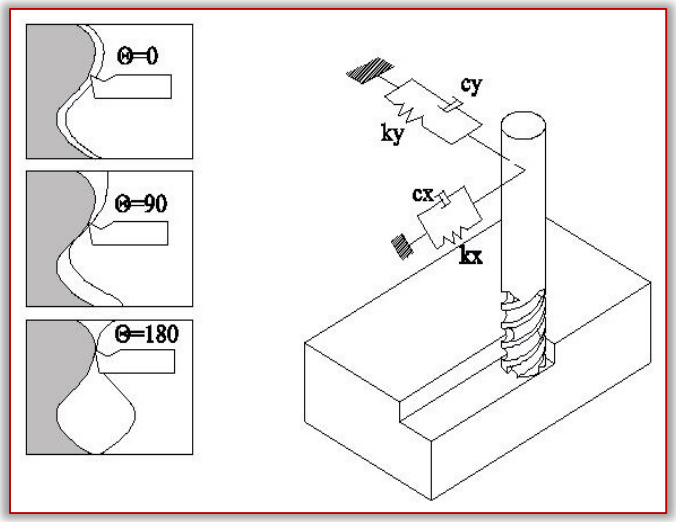

Figure 1. Regenerative chatter in milling. Initial tool deflection copied to workpiece surface is encountered in the next tool revolution

Self-excited vibration is the most unfavorable type of vibration because the energy for its occurrence and growth of the amplitude

receive from the cutting process itself. They can occur as a result of friction during the cutting process, due to thermomechanical effects, or as a consequence of the regenerative effect, i.e. variation the chip thickness during milling, Figure 1.

Self-excited vibration often leads to unstable machining, the so-called chatter. Chatter results in a reduction in the quality of the surface, the appearance of noise, the rapid wear of the cutting tool and in some case machine tool elements damage.

In order to avoid the consequences of self-excited vibration, it is often not possible to use certain cutting regimes during milling. Diagram showing the area of stable and unstable machining is called stability lobe diagrams. In this paper, a stability lobe diagram is formed on the basis of critical cutting depths in which self-excited vibration occur. Stability lobe diagram can be defined as analytically or experimentally.

The analytical model of the prediction of self-excited vibration requires the determination of the transfer function of the mechanical structure of the machine tool, while the experimental testing is reduced to determining the intervals of the individual cutting parameters in which the cutting process is stable.

Influence of self-excited vibration on cutting process stability was examined by Tlusty [1] and Tobias [2]. They provided their research almost simultaneously but in completely separate studies. Tlusty and Tobias proposed methods for analyzing the stability of the cutting process, the influence of the cutting regime, determining the limiting depth of cut and defining a stability lobe diagram.

Altintas [3] and Song [4] using the analytical and experimental approach, consider the influence of a different number of teeth on the appearance of self-excited vibration, cutting thereby the aluminum alloy 7075. They use tools with two angles of the coil. Zataraina [5] provide similar research, considering the influence of the tool coil angle, and cutting aluminum alloy 7075.

Quintana [6] defines the stability lobe diagram in milling experimentally, whereby he cuts the workpiece with an angled work surface. The emergence of self-extracted vibration is determined by recording and analyzing sound emissions, using modern signal processing techniques. Based on FFT sound analysis, the moment of self-excited vibration is detected, which excludes the possibility of an error due to the subjective feeling of the operator.

DESCRIPTION OF EXPERIMENTAL EXAMINATIONS

The experimental examination of the occurrence of self-excited vibration was carried out at the vertical milling center EMCO Concept Mill 450 within the Laboratory for Machine Tools and CIM Systems at the Faculty of Mechanical Engineering, East Sarajevo.

A series of experiments was conducted with a constant value of feed per tooth of 0.02 mm/tooth and variable cutting speed (rpm), ranging from 1000 to 3010 rpm, with an increase of 300 rpm at each subsequent test. The workpiece used in the experiment is made of steel Č4732 (42CrMo4), the shape, and dimensions given in Figure 2. The tool used in the processing is an end mill Φ10, with four teeth and an angle of coil 30°. During the cutting, no cooling agent and lubricating were used.

For each cutting speed, in combination with the calculated feed rate, the depth of cut is continuously increased, until self-excited vibration occurs. During the cutting, vibration amplitude is recorded by the accelerometer, mounted on a housing of the main spindle, as close to the spindle top as possible.

A continuous change in depth of cut is provided by the configuration of the workpiece, ie the inclination of the surface to be cut. Due to the aforementioned change in depth of cut, a very slight increase in the amplitude oscillation of the cutting tool occurs, and at a time when the depth of cut reaches the limit value, a sudden jump of amplitude occurs which indicates the emergence of self-excited vibration.

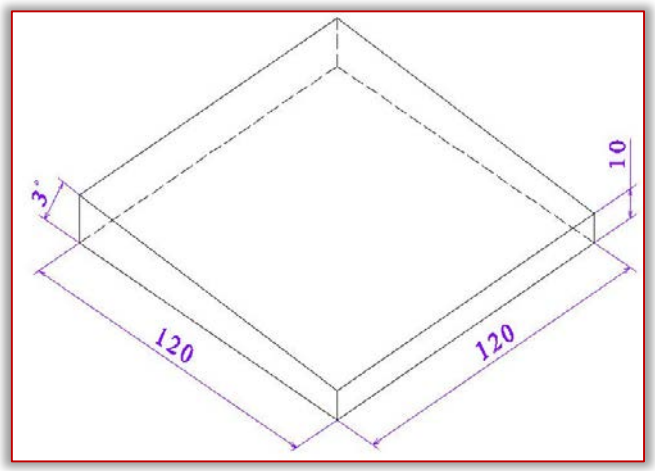

Figure 2. Shape and dimension of workpiece used for the experiment

The vibration parameter directly measured by the contact method is acceleration, using the National Instruments instrumentation. The instrumentation consists of the National Instruments cDAQ 9172 chassis (Figure 5a) and the NI 9233 analog card with four analog inputs of ± 5 V voltage range and a maximum channel selection speed of 50 kS / s (kilo samples per second). Accelerometer METRIX Instruments sensitivity 100mV / g with piezo-ceramics is placed on the main spindle carrier using a magnetic holder, as close as possible to the tool. For acquiring data, the graphical programming language LabVIEW was used, and for processing the results by the tangent method the Matlab software.

It should also be noted that when limiting value of depth of cut was determined using collected data, the absolute value of the vibration amplitude is not taken into account because it is not relevant for determining the moment when self-excited vibration occurs. This moment, in addition to the sudden vibration amplitude jump, is characterized by a change in surface quality, as well as the appearance of intensive sound, which is an indicator that the machine works with an unfavorable cutting regime.

REVIEW OF THE OBTAINED RESULTS

At the appearance of sound, the operator stops the feed movement of the tool. Dept of cut (axial) is subsequently determined using the tangent method, Figure 3.

Figure 4 shows the stability lobe diagram obtained by experiment. Table 1 shows the cutting regime, the cutting speed and the feed rate in mm / min. In the Y column path length of the tool in the Y-axis direction until the moment of self-excited vibration occurs was given.

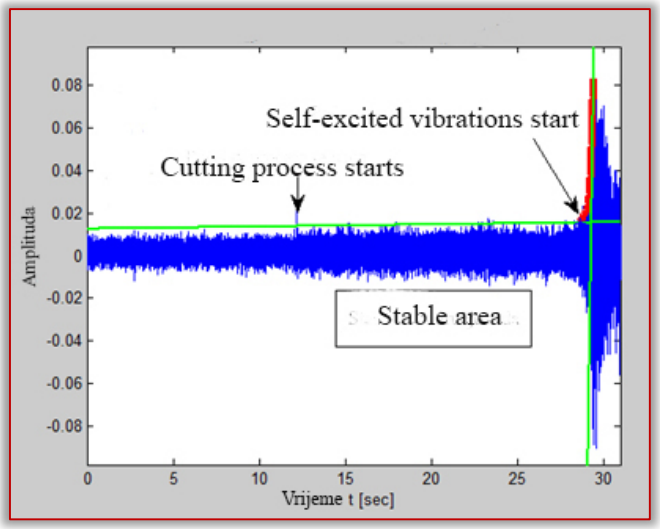

Figure 3. The amplitude of vibration in time domain and occurrence of self-excited vibration

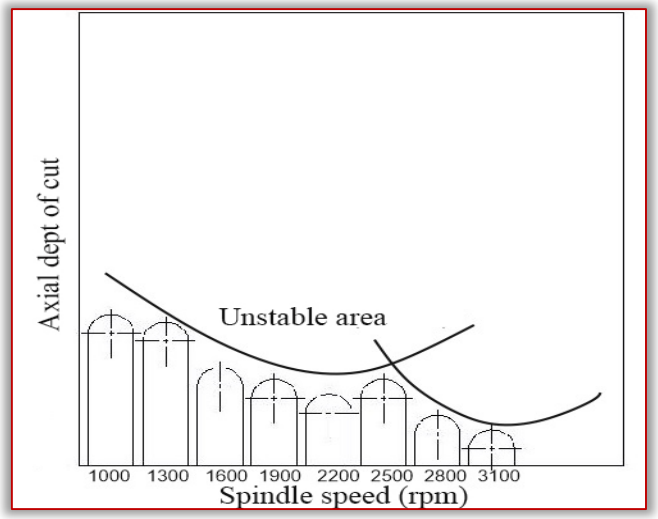

Figure 4. Experimentally defined stability lobe diagram

With each new passage of the tool, cutting speed increases, Figure 5. Accordingly, the velocity of the auxiliary movement is calculated, so that the feed rate per tooth has a constant value of 0.02 mm/tooth.

Table 1. Cutting regime and obtained results

No	Cutting speed (rpm)	Feed rate (mm/min)	Y (mm)	Limiting depth of cut (mm)
1	1000	80	40	2.1
2	1300	100	38	2
3	1600	130	26	1.4
4	1900	150	22.9	1.2
5	2200	180	19	1
6	2500	200	22.9	1.2
7	2800	224	13.3	0.7
8	3100	250	9.54	0.5

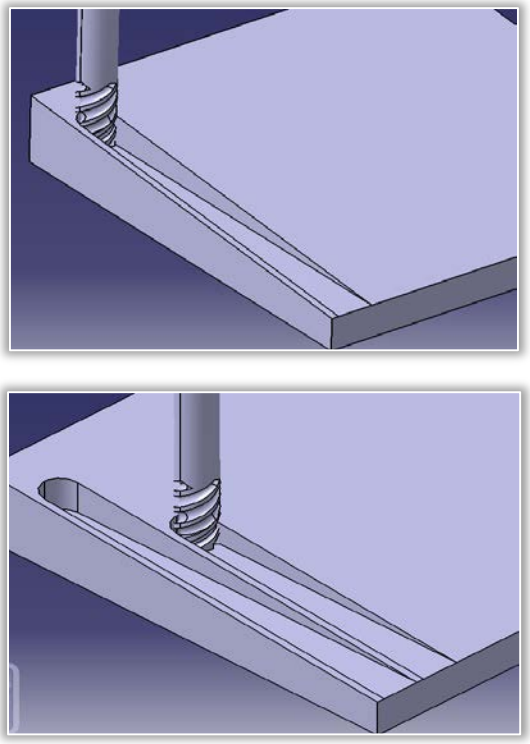

Figure 5. Schematic representation of the experiment

CONCLUSIONS

A stability lobe diagram, as a boundary between a stable and unstable cutting process, is a function of the cutting regimes, the cutting speed, feed rate, and the axial depth of cut. This paper shows a simple experimental method for defining the stability lobe diagram in milling. The boundary between a stable and unstable milling process can be experimentally determined by using data acquisition systems to measure the amplitude of vibration in the time domain, and then using the method of "tangents", to process obtained data, which is presented in this paper.

Also, the depth of cut at which self-excited vibration occurs can be determined by measuring the axial cutting depth on the workpiece itself. Due to the fact that results depend on the subjective feeling of the operator (as to the timing of stopping feed movement), this is considered to be the less favorable method.

The presented methodology is suitable for determining the stability lobe diagram for slot milling, where the width of the cut is equal to the tool diameter, and radial immersion is 100%.

Note:

This paper is based on the paper presented at COMETa 2018 – The 4th International Conference on Mechanical Engineering Technologies and Applications, organized by Faculty of Mechanical Engineering, University of East Sarajevo, in Jahorina, BOSNIA & HERZEGOVINA, between 27–30 November, 2018.

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ELECTRICAL UNITS FAULT ANALYSIS IN AUTOMOBILES

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Abstract: Safety of automobiles and its environmental protection is increasingly dependent on the correct functioning of its electrical and electronically controlled systems. Presently, there are insufficient data about the consistency of these systems and how their faults could be perfectly resolved in Nigeria. This study evaluated the frequent electrical faults of some automobile brands commonly used in Kwara State of Nigeria. Available data on the reliability of such systems was obtained from a number of sources across Kwara state. Analysis of data involved five brands of automobiles frequently used within Kwara state. Most electrical faults were observed to occur more frequently in older models of vehicles.

Keywords: Electronic Control Unit (ECU); Anti-lock Braking System (ABS); Satellite navigation unit (Sat/Nav); Engine Management System (EMS)

INTRODUCTION

Fault analysis is a method used to determine the various chains of effects that would cause a system to fail, compromising that systems safety or its stability. The automobile is one of the world-wide technologies which are in constant evolution.

Modern vehicles employ dozens of electronic systems. These systems are responsible for operational controls such as throttle, brakes and steering controls as well as many comfort and convenience systems such as the heating, ventilation and air conditioning, HVAC, info/entertainment, lighting systems etc. It would not be possible for automobiles to meet modern safety and fuel economy requirements without electronic controls. (Engineering Overview, 2014.)

BACKGROUND

Electronically controlled systems of increasing complexity are being fitted in growing numbers to new vehicles as vehicle safety and environmental protection is increasingly dependent on the correct function of these systems. Since the introduction of electronic systems in the 1960's there has been a rapid growth in their use on vehicles.

From the earliest examples such as cruise control and the replacement of dynamos with alternators, to the current Anti-Lock Braking System (ABS) and engine management systems (EMS), the market has been overwhelmed with technological developments. Presently, there are only but a few available data concerning these electrical faults and their hazardous evaluation in Nigeria (Eckermann, 2011). In recent times, mechatronics is applied in automobiles for outdoor locking, collision avoidance and in ignition and antiroll systems (Singh *et. al.*, 2006).

METHODOLOGY

— Study Area

Kwara state with the latitude: 8.5 and longitude: with latitude (DMS):8^0 30' 00^0N and longitude (DMS) 5° 00' 00'E N. Kwara state shares boundaries with the Republic of Benin at the west and the Niger River at her North. The capital city of Ilorin is situated 306km inland from the coastal city of Lagos and 500km from the Federal Capital Abuja. Major towns include Offa and Jebba, located on the Niger River.

— Data Acquisition

Electronic faults data was obtained and compiled from auto mechanic workshops across Offa and Ilorin in Kwara state through the use of questionnaire and public interviews. Five commonly used automobiles brands was considered in this study. These brands include Toyota, Volkswagen, Mercedes, Peugeot and Nissan. The faults of these brands were analyzed using their models ranging from the year 2000 to 2016.

— Data analysis

The descriptive statistical analysis was generated from the data and information obtained in the course of this study using SPSS and comparison of result obtained from this process.

Table 1(a): Common Electronic Related Faults

Brands	Common Electrical Failed Parts
Mercedes	Anti-lock brake system (ABS), airflow meter, airbags, body control module (BCM), central locking system, seat controllers, throttle bodies, transmission control and climate control (CCU).
Toyota	ABS, climate control unit, ECU, satellite navigation units (Sat/Nav), EPS, dash board/ instrument cluster, information display unit and throttle bodies.
Volkswagen	ABS, yaw sensor, anti-theft lock, airbag, body control unit, central lock system, ECUs and ECMs, EPS/EHPS, information display unit, instrument cluster, throttle bodies, transmission control module, radio, turbo actuator.

Table 1(b): Common Electronic Related Faults

Brands	Common Electrical Failed Parts
Peugeot	ABS, airbags, airflow meters, body control, climate control, display unit, ECUs/ Engine control module (ECM), EPS/EHPS, instrument clusters, radios, roof controllers and pumps, throttle body and stalk control.
Nissan	ABS, Body control unit, climate control unit, ECMs/ECUs, Electric power steering (EPS), Electric hydraulic power steering (EHPS), instrument clusters and throttle bodies.

Source: Jack (2007)

A bar chart for comparison of the percentage of electrical faults analyses between the five brands of automobiles was generated using an SPSS package. Table 1(a) and (b) shows the faults that frequently occur in brands of vehicles plying Nigerian roads.

RESULTS

— Fault Analysis on Toyota

The faults that commonly occur in Toyota Avensis include the engine sensor, horn, dashboard/instrument cluster and ABS pump. This study shows that ABS pump was estimated as 28.6, dashboard/ instrument cluster as 23.2, engine sensor as 21.4 and the horn as 26.8% as shown in Figure 1.

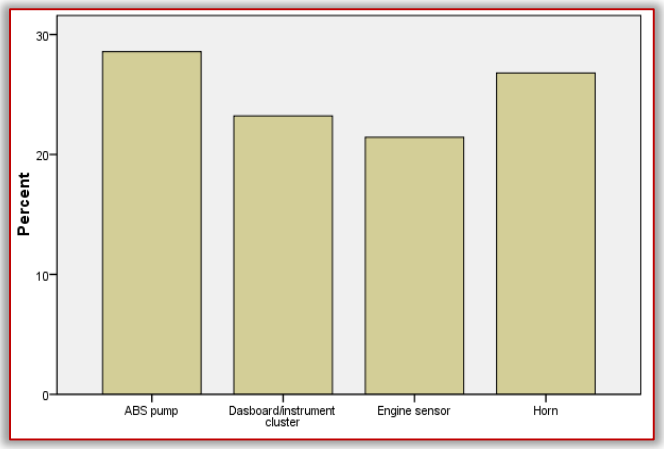

Figure 1: Comparative chart of electrical faults in Toyota Avensis

The faults that frequently occur in Toyota Camry include the dashboard/instrument cluster throttle body and alternator. Figure 2 shows the frequency of occurrence of these faults. The dashboard/ instrument cluster failure was estimated at 42.1, throttle body as 23.7 and the alternator as 34. 2%.

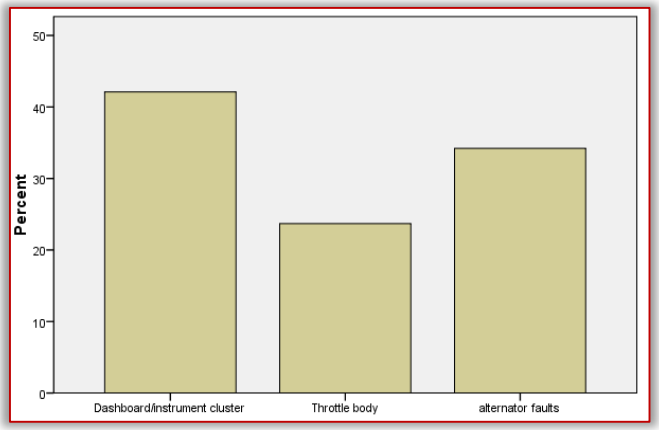

Figure 2: Comparative chart of electrical faults in Toyota Camry

The faults that commonly occur in Toyota Rav4 include the dashboard/instrument cluster ABS modulator, ABS pump, climate control unit, ECM ECU and SRS ECU. The dashboard/ instrument cluster failure was estimated at 26.2, ABS modulator as 16.4, ABS pump as 11.5, climate control unit as 6.6, ECM ECU as 21.3 and SRS ECU as 18.0% as shown in Figure 3.

The faults mostly experienced by users of Toyota highlander include the CCU and the information display unit. The CCU failure was estimated to be 31.6 while that of information display was estimated to be 68.4% as indicated in Figure 4.

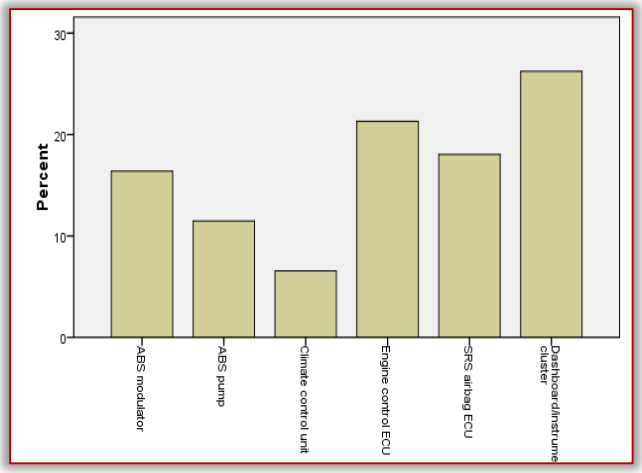

Figure 3: Comparative chart of electrical faults in Toyota RAV4

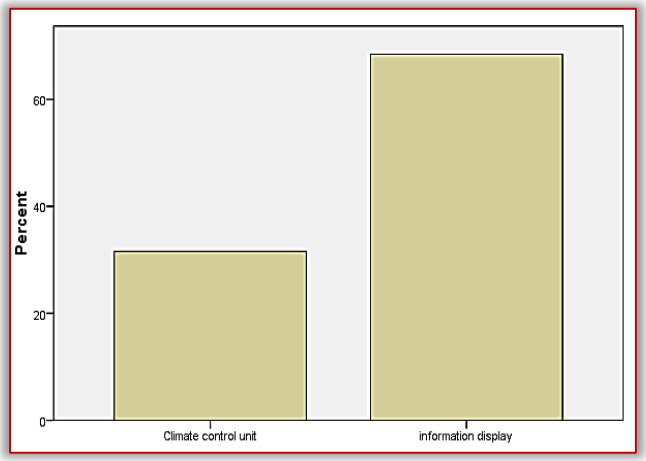

Figure 4: Comparative chart of electrical faults in Toyota Highlander

Faults commonly experienced by users of Toyota Corolla include the ABS pump, Sat/Nav display unit and the throttle body. Figure 5 shows how the faults varies. The ABS pump failure was estimated to be 39.4, Satelite navigation display unit as 30.3 and the throttle body as 30.3.

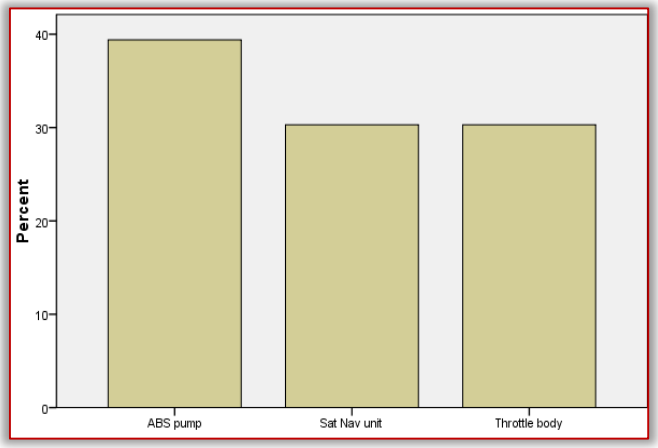

Figure 5: Comparative chart of electrical faults in Toyota Corolla

— Fault Analysis on Volkswagen

The faults commonly seen in Volkswagen Passat include the ABS pump, SRS airbag, BCM, ECU, multimedia control panel, dashboard/instrument cluster, throttle body and the hand potentiometer. The ABS pump failure was estimated to be 16.4, SRS airbag as 12.3, BCM as 9.6, ECU as 19.2, multimedia control panel as

8.2, dashboard/instrument cluster as 19.2, throttle body as 9.6 and the hand potentiometer as 5.5% as shown in Figure 6.

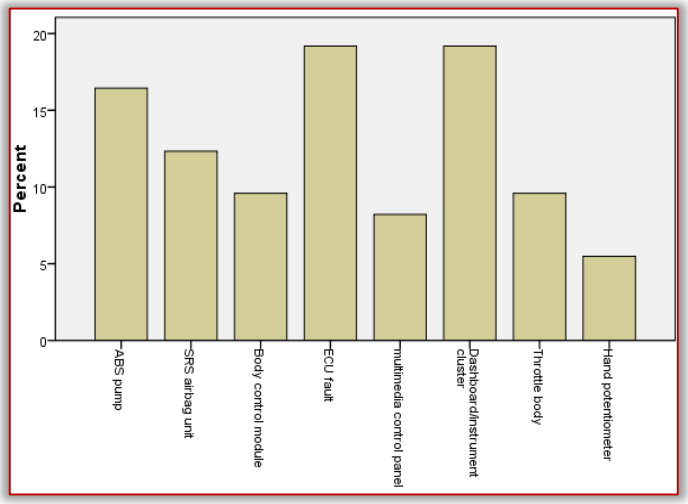

Figure 6: Comparative chart of electrical faults in Volkswagen Passat

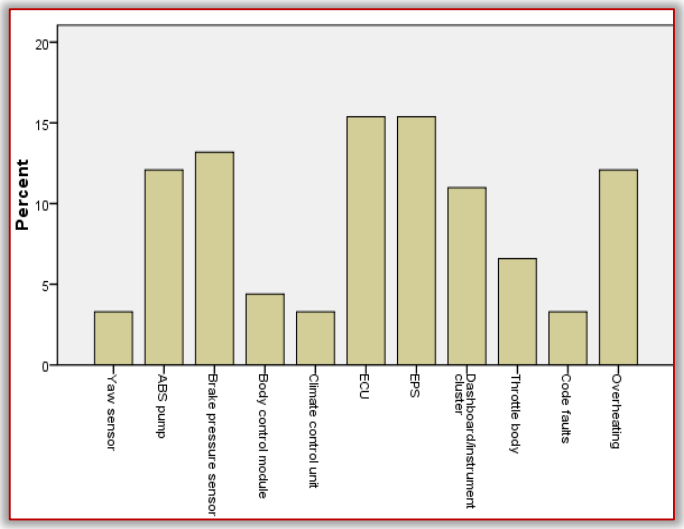

Figure 7: Comparative chart of electrical faults in Volkswagen Golf

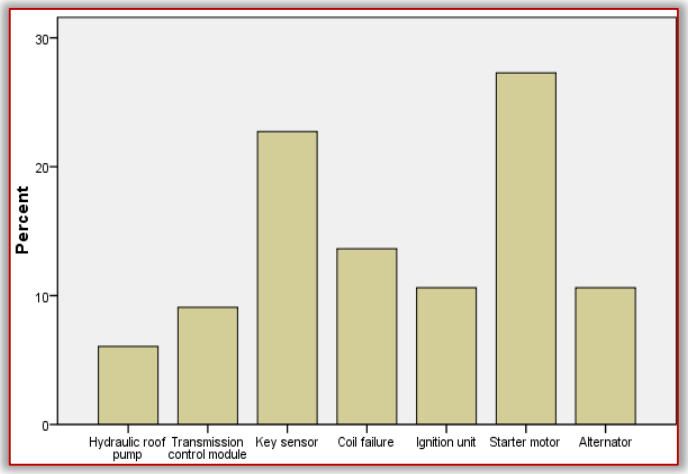

Figure 8: Comparative chart of electrical faults in Volkswagen Audi

Electronic faults common to Volkswagen Golf include the yaw sensor, ABS pump, brake pressure sensor, BCM, CCU, ECU, EPS, dashboard/instrument cluster, throttle body, code faults and overheating. The yaw sensor failure was estimated to be 3.3, ABS pump as 12.1, brake pressure sensor as 13.3, BCM as 4.4, CCU as 3.3, ECU as 15.4, EPS as 15.4, dashboard/instrument cluster as 11.0, throttle body as 6.6, code faults as 12.1 and overheating as 12.1. This detail is given by the chart in Figure 7.

Hydraulic roof pump, transmission control module, key sensor, coil failure, ignition unit, starter motor and the alternator are the faults common to Volkswagen Audi. The hydraulic roof pump failure rate was estimated to be 6.1, transmission control module as 9.1, key sensor as 22.7, coil failure as 10.6, ignition unit as 10.6, starter motor as 27.3 and the alternator as 10.6% as shown in Figure 8.

— Fault Analysis on Mercedes

Experimental results show that the ECU, airflow meter, immobilizer and key, actuator, EHPS, power steering rack, dashboard/instrument cluster, throttle body, gear control, transmission control and automatic clutch are the faults commonly associated with Mercedes A Class.

The chart in Figure 9 depicted that the ECU failure rate was estimated to be 21.0, airflow meter as 4.9, immobilizer and key as 4.9, actuator as 6.2, EHPS as 21.0, power steering rack as 4.9, dashboard/instrument cluster as 17.3, throttle body as 6.2, gear control as 4.9, transmission control as 6.2 and automatic clutch as 2.5%.

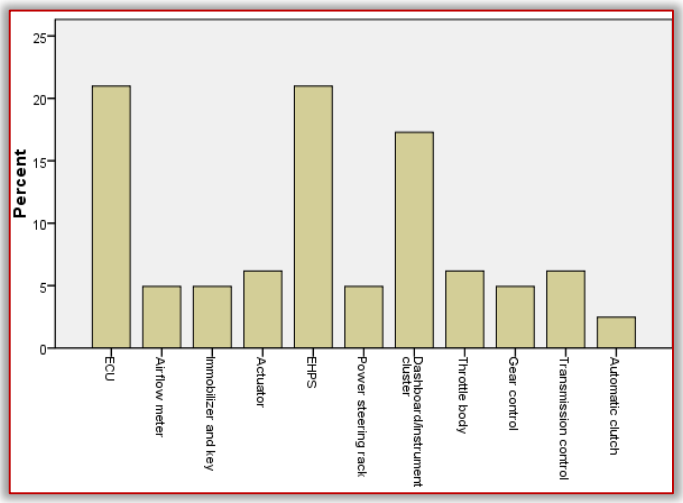

Figure 9: Comparative chart of electrical faults in Mercedes A Class

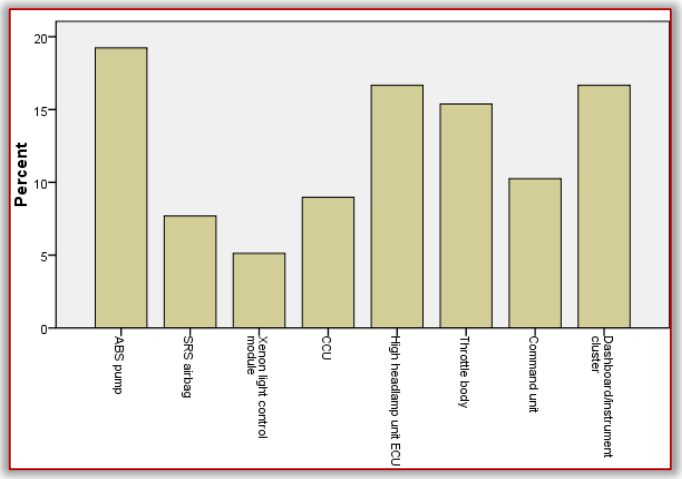

Figure 10: Comparative chart of electrical faults in Mercedes S Class

The faults commonly experienced in Mercedes S Class include the ABS pump, SRS airbag, xenon light control module, CCU, high head lamp unit ECU, throttle body, command unit and

dashboard/instrument cluster. The ABS pump failure was estimated to be 19.2, SRS airbag as 7.7, xenon light control module as 5.1, CCU as 9.0, high head lamp unit ECU as 16.7, throttle body as 15.4, command unit as 10.3 and dashboard/instrument cluster as 16.7% as indicated in Figure 10.

The faults associated with Mercedes C Class include wire expiration, fuel pump, injector nozzle, dashboard/instrument cluster and the throttle body. Figure 11 shows the wire expiration failure rate was estimated to be 5.6, fuel pump as 33.3, injector nozzle as 11.1, dashboard /instrument cluster as 35.2 and the throttle body as 14.8%.

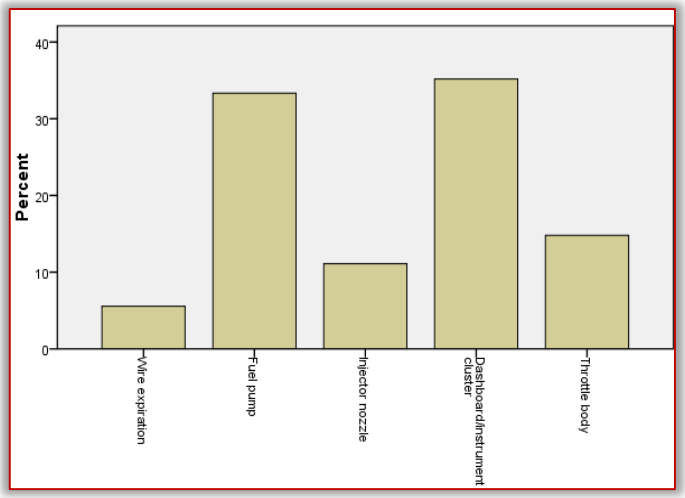

Figure 11: Comparative chart of electrical faults in Mercedes C Class

The faults common to Mercedes SL include the anti-theft security, central lock pump, BCM, climate control panel, heater control, cruise control, audio amplifier, Sat/Nav unit and dashboard/instrument cluster. According to the chart in Figure 12, anti-theft security failure rate stands at 11.4, central lock pump as 7.6, BCM as 11.4, climate control panel as 10.1, heater control as 5.1, cruise control as 5.1, audio amplifier as 15.2, Sat/Nav unit as 7.6 and dashboard/instrument cluster as 26.6%.

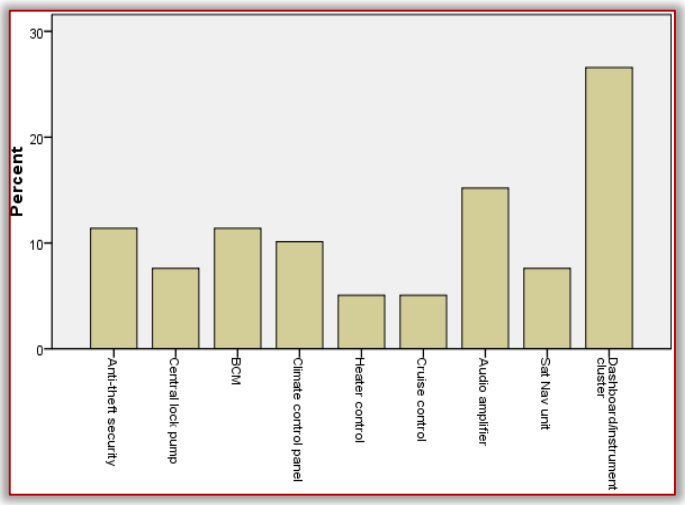

Figure 12: Comparative chart of electrical faults in Mercedes SL

— Fault Analysis on Nissan

The faults mostly experienced by users of Nissan Almera include the ABS ECU, ECU fault codes, BSI, Steering angle sensor, and EPS. The ABS ECU failure was estimated at 25, ECU fault codes as 29.7, BSI as 10.9, Steering angle sensor as 10.9 and EPS as 23.4% as shown in Figure 13.

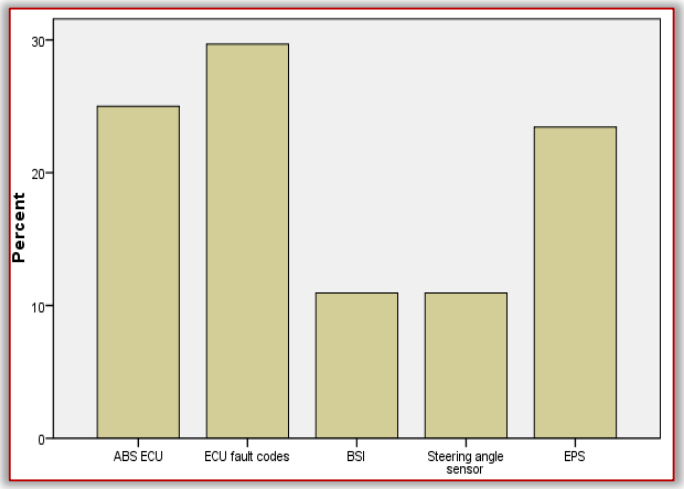

Figure 13: Comparative chart of electrical faults in Nissan Almera.

Common faults in Nissan Primera include the ECU fault codes, CCU, EPS ECU, Dashboard/instrument cluster, Sat/Nav reversing camera screen and throttle body. The chart in Figure 14 shows that ECU fault codes failure was estimated as 29.0, CCU as 9.7, EPS ECU as 14.5, Dashboard/instrument cluster as 24.2, Sat/Nav reversing camera screen as 8.1 and throttle body as 14.5%.

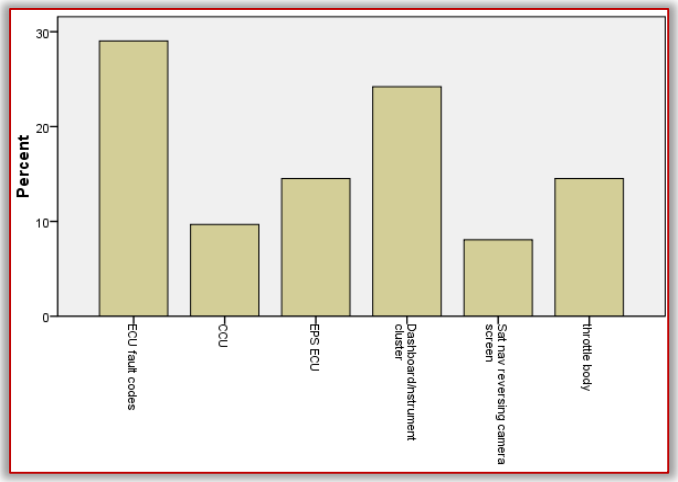

Figure 14: Comparative chart of electrical faults in Nissan Primera

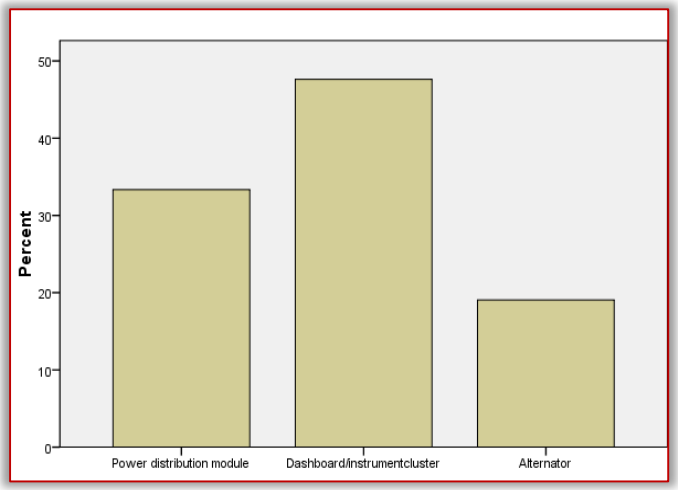

Figure 15: Comparative chart of electrical faults in Nissan Murano

Faults seen to frequently occur in Nissan Murano include the power distribution module, dashboard/instrument cluster and an alternator. The chart in Figure 15 shows that power distribution module failure was estimated to be 33.3, dashboard/instrument cluster as 47.6, and the alternator as 19.0%.

— Fault Analysis on Peugeot

Common faults in Peugeot 206 include the BSI fuse box, Heart control panel, SRS ECU, Radio, Sat/Nav unit, Roof controller, Dashboard, Display unit. Figure 16 shows the frequency of occurrence of these faults. The BSI fuse box failure rate was estimated to be 12.5, Heart control panel as 8.3, SRS ECU as 22.2, Radio as 18.1, Sat nav unit as 6.9, Roof controller as 4.2, Dashboard as 20.8, Display unit as 6.9%.

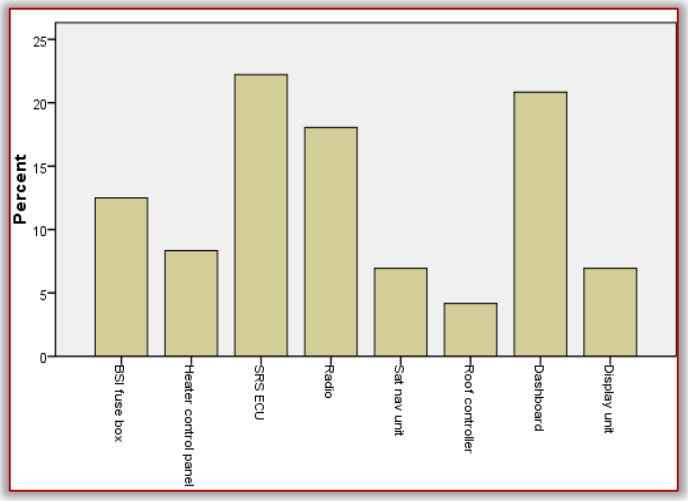

Figure 16: Comparative chart of electrical faults in Peugeot 206

The faults mostly seen in Peugeot 207 include the Roof controller, dashboard/instrument cluster, CCU, ABS unit, ABS ECU, SRS ECU. Figure 17 shows the manner in which these faults occur. Roof controller failure rate was estimated to be 9.6, dashboard/instrument cluster as 23.1, CCU as 7.7, ABS unit as 25.0, ABS ECU as 19.2 and SRS ECU as 15.4%.

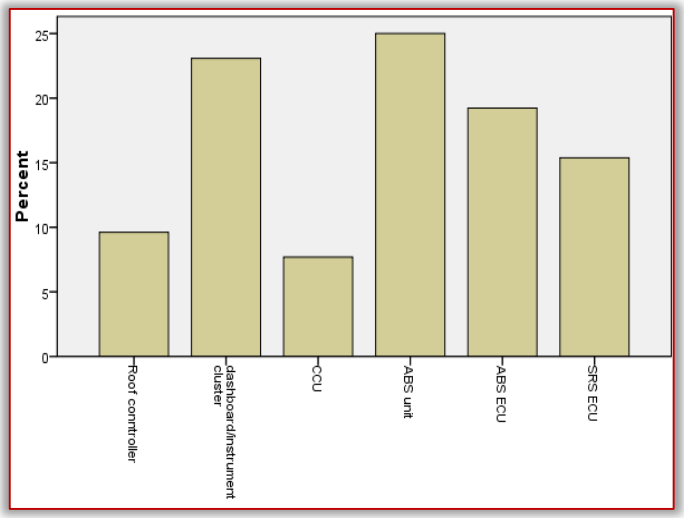

Figure 17: Comparative chart of electrical faults in Peugeot 207

In Peugeot 307, common faults are BSI, BCM unit, SRS ECU, Gear box ECU, Dashboard/instrument cluster, EHPS, Stalk control unit and Fuel pump. Figure 18 shows that BSI failure rate was estimated as 8.5, BCM unit as 9.9, SRS ECU as 9.9, Gear box ECU as 19.7, Dashboard/instrument cluster as 14.1, EHPS as 8.5, Stalk control unit as 12.7 and Fuel pump as 16.9%.

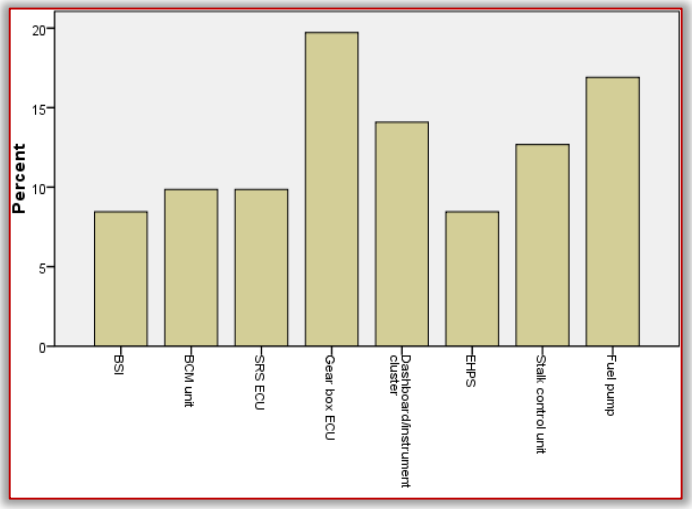

Figure 18: Comparative chart of electrical faults in Peugeot 307

CONCLUSION

This study shows the frequency of incidence of faults on electrical units in common automobile brands used in Nigeria. Electrical faults like Dashboard and instrument cluster occurs more frequently in all the five brands of automobiles considered in this study. While Yaw sensor and CCU related faults record lowest incident rate.

Dashboard and Instrument cluster have an average occurrence rate of 40%, alternator faults have an average occurrence of 40%, and yaw sensor and CCU faults as an average occurrence of 3.3%.

Besides, most of these faults have a least occurrence in Toyota brand and mostly occurs in the Nissan brand.

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RESEARCH ON THE IMPORTANCE OF THE QUANTITY OF AVAILABLE BIOMASS AND ITS USE

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Abstract: This research approaches a present topic in the field of energy production from energy renewable sources, evaluating the energetic potential of biomass, by increasing the caloric power and the efficiency of using the wood in combustion. Taking into consideration the fact that the biomass is a world wide spread source and presents a potential to produce solid, liquid and gaseous fuel, an experimental research is necessary. The present researches must start from the determination of caloric power, to continue with the determination of moisture influence, and finally to move forward to the assessment of the efficiency of using wooden biomass by increasing the caloric power, by dry thermal treatment in oxygenated environment.
Keywords: biomass, calorific value, moisture content, wood

INTRODUCTION

In 1870, at a world-wide level, the biomass was covering approximately 70% of the necessary of energy, which then let the floor for the hydro and photovoltaic fuels, and nowadays is still the main fuel for the production of energy in the countries in developing process (Cleveland 2009, Astbury 2008, Priddle 1998). The energetic sources present nowadays on the energetic market were classified on three categories: fossil fuels, nuclear resources and renewable energetic resources (Lunguleasa, 2007).

According to the descriptions of (Swithenbank, 2011), the first stage consisted on the decomposition of fossil fuels (1892) and the methods of obtaining energy from them, the second stage starts in the moment when the energetic crisis appeared in the 1970, which led the population towards new directions and visions of producing energy among which renewable energy sources. The third stage consists on exploiting and providing the necessary of energy.

There are known several methods to produce energy, respectively: water power, sun power, wind power, geothermal power, fossil fuels power and nuclear power. The development of the society depends on a great measure on the energy consumption. According to some researches it is considered that fossil fuel will be enough just until 2015 – 2020.

On a world-wide level there were implemented solutions to solve these problems with a tendency of using rationally the energy and discovering new sources of renewable energies.

Nowadays, energy is mainly produced from fossil fuels, which are non-uniformly spread on the Earth. In the world, fuels might be found in three different shapes, respectively fossil fuels, nuclear and renewable fuels. Fossil and nuclear fuels, according to the research conducted by European Union are seriously harmful to the environment.

The biomass is one of the renewable energy sources used from the oldest times by people.

Biomass is a renewable energetic source, because it increases from one year to another, it is widely spread world – wide and presents low costs in comparison to the fossil fuels, the biomass resources, from which fuel material is produced may include wood and wooden wastes, agricultural cereals and wastes resulted from their production, aquatic biomass and algae.

Biomass is one of the forms of renewable sources which may be converted in solid, liquid and gaseous energetic fuel and which may generate energy as heat by its burning, as well as electrical energy by conversion processes (Lunguleasa, 2007).

Biomass is environmentally friendly and a neutral energy against the emissions of carbon dioxide. The carbon dioxide is absorbed by the plants during the growing process and forms a closed circuit, because the quantity of carbon dioxide which was absorbed by the plants during the growing process will be equal to the one which was eliminated during the complete burning process (Eisentraut A, Brown A., 2012). The biomass may be used in the combustion process and mainly its does not require very high investments as hydro, solar, wind and geothermal energy do.

Currently, the biomass contributes with approximately 12% to the production of primary energy in the world, and in the countries in developing process it covers 40-50% of the necessary of energy. The Biomass is the alternative source that, according to (Berkesy, 2012) contributed with 7% from the energy produced in the world. Presently, the use of renewable fuel materials such as wooden wastes for producing biofuels increases the chances of biomass in the availability level on the energetic market.

The research of energetic market highlighted the following fuels materials which produce energy: fire wood, sawdust, woodchips, briquettes, pellets.

The sawdust resulted from the wood processing has an important role in many European countries. Normally, the wood bark and the sawdust are organic materials which usually do not pollute the environment.

The frame saw sawdust combined with the rain, snow or waste water easily enters the environment and pollute the underground water or the lake close by carrying along the dissolved material,

including substances used for treating the wood. According to the statistics, approximately 1600 tons of sawdust collected and processed yearly come from renewable resources, this thing means approximately 1600 tons of forest wood less or saving 9,2 hectares of forest, at an average of 218 m^3 of wood per hectare.

MATERIALS AND METHODS

— Determining the caloric power of the bark

The installation used for determining the caloric power of the wooden biomass was the explosive burning calorimeter type XRY-1C, produced by Shanghai Changji Geological Instrument Co from China.

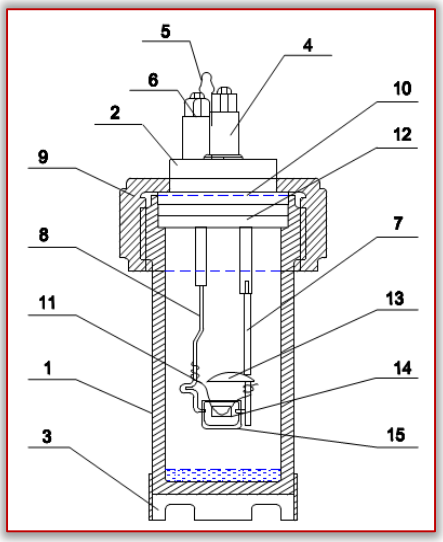

Figure1 - Section view through calorimetric bomb

Before proceeding to the attempting, the gauging of the calorimetric bomb is made with benzoic acid, using benzoic acid with a value of known caloric power (26463 kJ/kg).

The inferior caloric power of wood is determined based on the superior caloric power.

$$PCi = PCs - 6\,(U + 9h)\ [kJ/kg] \quad (1)$$

where:

PCs - superior caloric power, kJ/kg

U - wood sample moisture, kJ/kg

h - hydrogen content of wooden sample, 3,6%.

The method to determine the caloric power of the wooden material refers mainly to the preparation of the raw material and the installation, then to the proper determination and finally to the obtaining of the result.

The testing sample 1 is tied to the cotton thread 2 and is put in the bomb box 3. The copper nickel thread 4 is tied to the sample and the cotton thread, after which the protection covers 5 is put correctly. The box is connected to the calorimetric bomb cover 6 through two electrodes 7 and 8, which continue with the electrical threads for calorimetric bombs coupling 9 and 10. By threading the cover the bomb 11 is coupled to fitting 12 to the oxygen cylinder, introducing 30 atmospheres.

— Determining ash content

In order to determine the ash content of the grapes remains, the general method of standardized determination was used (ASTM D2866-11, 2012). According to this method, the milled and dried material until 0% humidity is baked at a temperature of 750°C in a lab oven, during 3 hours at least (Figure2). The advanced burning operation is made on a metallic melting pot resistant to high temperature, and the weighting was made on an analytical balance with a 3 decimal precision.

When determining the ash content it will be taken into consideration that the sample is completely dried and the cleaned and empty melting pot weight.

$$A_c = \frac{m_{a+c} - m_c}{m_{s+c} - m_c} \cdot 100\ [\%] \quad (2)$$

where:

m_{a+c} -mass of ash plus crucible;

m_{s+c}- mas of sample plus crucible;

m_c- crucible mass.

Figure 2 - Baking oven for determining the ash content

RESULTS

The description of the process to determine the caloric power is presented in figure 3.

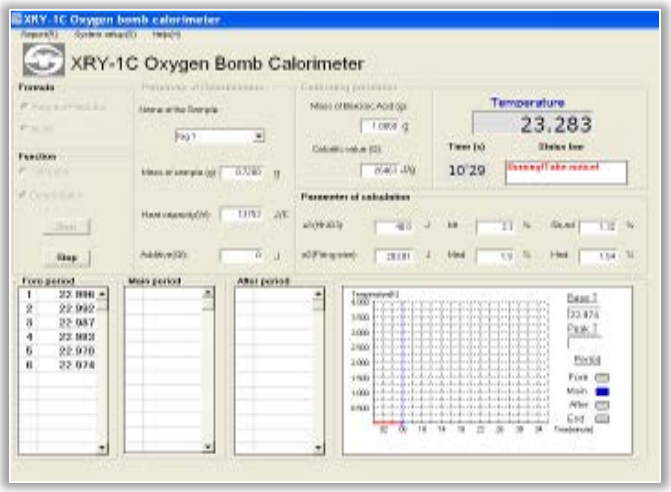

Figure 3 - Description of the process to determine the caloric power

The test consists in three different stages:

The initial stage ("fore") has as purpose the determination of temperature variations of water in the calorimetric recipient, due to the heat exchange with the exterior before burning. During this period, usually for 5 minutes, it is indicated and read at one minute periods the temperature with the precision thermocouple. The last reading of the temperature form the initial period represents in fact the first temperature in the main period. The values of the temperature registered in this period

are generally six. After registering the 6th value the lighting of the material takes place and its reading on the menu bar (Burning time).

The main period ("main") begins by burning the sample and has as consequence the increase of water temperature in the calorimetric recipient, due to the burning of wooden particles and heat delivery. To determine the final temperature the value of the temperature is indicated at one minute periods. The values registered during this period vary according to the burning time of the fuel material in the calorimetric bomb. The number of values may vary between 19–42 values of temperature registered during this period.

The final period ("after") has as purpose the determination of the average water temperature in the calorimetric recipient, due to the heat exchange with the exterior after burning. Identical to the first stage, the temperature is indicated at half minute periods, for 4-5 mutes, averagely there are registered 8 – 10 values of the temperature variation.

With measurement are performed values: for spruce of bark, mass sample 0.5100 g, net calorific value 19441 kJ/kg, gross calorific value 18943 kJ/kg, for U =0%, mass sample 0,4914 g, net calorific value 17372 kJ/kg, gross calorific value 16672 kJ/kg, for U =10%, mass sample 0.7100 g, net calorific value 15552 kJ/kg, gross calorific value 14153 kJ/kg, for 20%, mass sample 0.7890 g, net calorific value 10092 kJ/kg, gross calorific value 6594 kJ/kg, for U = 50% (Figure4).

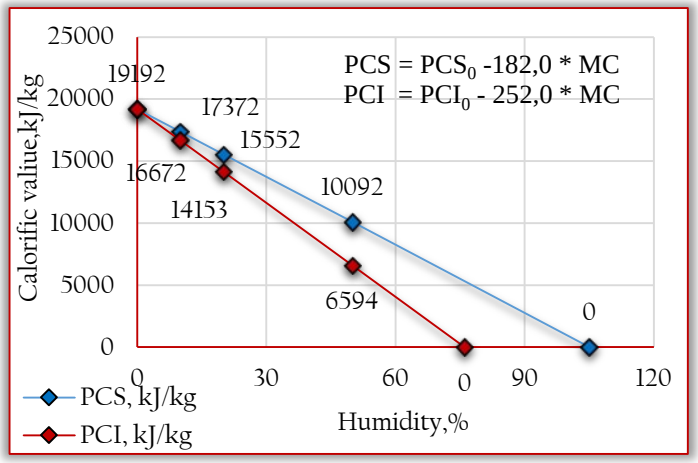

Figure 4 - Calorific value for spruce bark

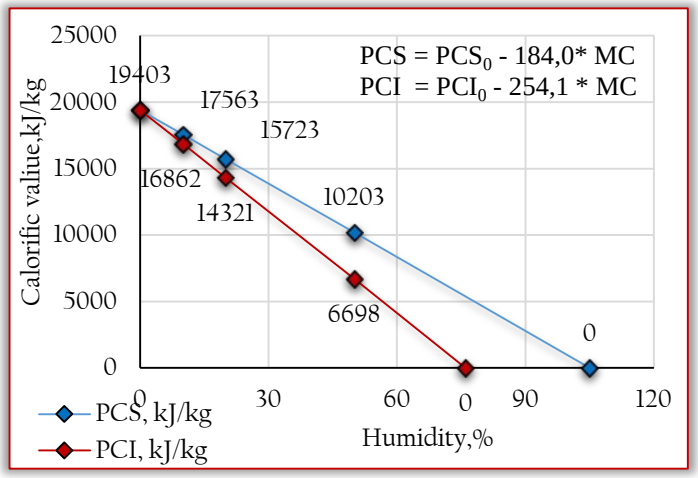

Figure 5 - Calorific value for populus of bark

The following values are obtained from measurements: for poplar bark, mass sample 0.7400 g, net calorific value 19665 kJ/kg, gross calorific value 19152 kJ/kg, for U =0%, mass sample 0.4964 g, net calorific value 17563 kJ/kg, gross calorific value 16862 kJ/kg, for U =10%, mass sample 0.3800 g, net calorific value 15723 kJ/kg, gross calorific value 14321 kJ/kg, for 20%, mass sample 0.8730 g, net calorific value 10203 kJ/kg, gross calorific value 6698 kJ/kg, for U = 50% (Figure5).

The following values are obtained from measurements: for beech of bark, mass sample 0.8900 g, net calorific value 19181 kJ/kg, gross calorific value 18681 kJ/kg, for U =0%, mass sample 0.6600 g, net calorific value 17137 kJ/kg, gross calorific value 16737 kJ/kg, for U =10%, mass sample 0.6371 g, net calorific value 15344 kJ/kg, gross calorific value 14544 kJ/kg, for 20%, mass sample 0.8790 g, net calorific value 9963 kJ/kg, gross calorific value 7963 kJ/kg, for U = 50% (Figure 6).

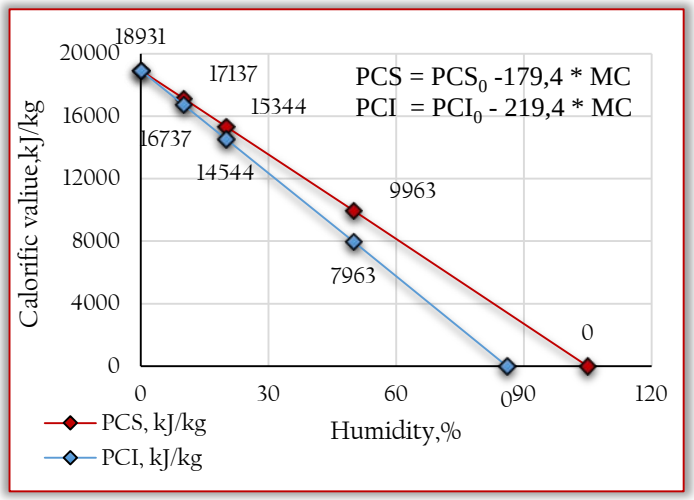

Figure 6 - Calorific value for beech of bark

CONCLUSIONS

The incomplete combustion has severe effects on the environment discharging in the atmosphere a large quantity of carbon dioxide.

Generally, the burning process of the bark develops in the same conditions as the massive wood biomass. The sole difference is the content of ashes which it presents and the difference of chemical composition. This thing contributes to the implementation in the field of bark burning of the technologies adapted to large contents of ash.

The ash content for spruce of bark is 2.6%, for populus of bark is 2.8%, for beech of bark is 2.9%.

Note:

This paper is based on the paper presented at ISB-INMA TEH' 2018 International Symposium (Agricultural and Mechanical Engineering), organized by Politehnica University of Bucharest – Faculty of Biotechnical Systems Engineering (ISB), National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry (INMA) Bucharest, The European Society of Agricultural Engineers (EurAgEng), Society of Agricultural Mechanical Engineers from Romania (SIMAR), National Research & Development Institute For Food Bioresources (IBA), University of Agronomic Sciences and Veterinary Medicine Of Bucharest

(UASVMB), Research-Development Institute for Plant Protection (ICDPP), Hydraulics and Pneumatics Research Institute (INOE 2000 IHP), National Institute for Research and Development in Environmental Protection (INCDPM), in Bucharest, ROMANIA, between 01–03 November, 2018.

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THE ANALYSIS OF THE IMPACT OF COMMUNICATORS ON THE HEALTH OF EMPLOYEES

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Abstract: Currently, there several contradictory epidemiological studies that address the issue of the impact of electromagnetic fields on the human health. It is problematic to prove that the exposure to the electromagnetic field causes health problems or direct health damage. The situation is all the more complicated because the effects of the electromagnetic field on human health are different for high and low frequencies. It is also necessary to note the Slovak legislation, which states that the limit and action values contained therein protect a person from the previously known effects of electromagnetic fields.
Keywords: electromagnetic field, long-term exposure, SAR, communicators

INTRODUCTION

The paper deals with the assessment of the effect of long-term exposure of humans to electromagnetic fields. The exposure is not even, as evidenced by the communicator's operating mode. The methods used have been designed with respect to technical standards, valid legislation and technical equipment available in the Slovak Republic.

ANALYSIS OF THE CURRENT STATE IN THE WORLD

The effects of electromagnetic fields are the subject of ongoing research and heated public debates. According to the World Health Organization, the electromagnetic fields of all frequencies are one of the most common and fastest growing sources of various environmental impacts. The issue also gives rise to concerns and speculations. At present, the whole population is exposed to electromagnetic fields, and the development of new technologies only increases the exposure.

The use of new technological procedures significantly improves working conditions, however, devices generating electromagnetic fields have created new problems and pose higher demands for protection of workers from their impact. The danger of electromagnetic fields and permanent magnetic and electrostatic fields is aggravated by the fact that they cannot be detected by the sensory organs of humans.

This issue is addressed by several authors in their research. T. Wessapan, in his publication "Temperature induced in human organs due to near-field and far-field electromagnetic exposure effects" deals with the biological effects of electromagnetic radiation on the human organism and its sensitive organs which are the result of absorption of the electromagnetic field.

The author also considers SAR and heat transfer in a heterogeneous human body model. In the paper "The role of electromagnetic fields in neurological disorders" M. Terzi attempted to point out the link between electromagnetic fields and human neurological disorders. Transmissions in electromagnetic channels are analyzed in a paper "Capacity of Continuous-Space Electromagnetic Channels with Lossy Transceivers" by W. Jeon. The study on SAR distribution using the modified FDTD method was performed by Wang, J. in "Study on SAR Distribution of Human Body on the Vehicle Platform Using a Modified FDTD Method".

In the paper, the author addresses the characteristics of the SAR in a human body while in the vehicle in the presence of a high-intensity intensive electromagnetic pulse (IEMP) using finite-difference time-domain method (FDTD).

Another author, who researched the impact of the electromagnetic field on the health of the population, was L. Diez in "Electromagnetic Field Assessment as a Smart City Service: The SmartSantander Use Case", where he proposed a completely new approach to monitoring the effects of wireless communication. Reducing exposure of electromagnetic radiation from WSN through transmission planning is addressed by D. Dragomir in the publication « Reducing EMF exposure from WSNs using transmission scheduling».

DESCRIPTION OF ELECTROMAGNETIC FIELD SOURCES

The subject of the research was the Quail Digital Pro7 Headset System Communicator. It is designed to improve team productivity in retail, restaurants and other work processes that require ongoing communication. Headsets enable employees to handle customers with better flexibility, make troubleshooting and search for help easier, enable fast location of inventory, expert advice, and faster service.

Figure 1. Headset communicator Quail Digital Pro 7 Headset System

The system includes wireless lightweight digital headset for up to 30 users with the option of integrating headphones with cash registers, POS systems, customer help, and passive alarm systems

and a base station. The communication is limited to 6 participants at the time. Figure 1 shows the headset.

The sources of the electromagnetic field and its parameters are as follows:

1. Base station Pro7 typ Q-P7BS,
   - # operating frequency for Europe 1.88 - 1.90 GHz,
   - # DECT transmission power for Europe 250 mW,
   - # dimensions 250 x 160 x 40mm,
   - # power 100 – 240 V AC,
   - # weight 310 g.
2. Cordless headphones with microphone Pro7 typ Q-P7HS,
   - # operating frequency for Europe 1.88 - 1.90 GHz,
   - # standard Talk Lock and PTT,
   - # Lithium-ion battery 3.7 V,
   - # weight 23 g

The base station is a wireless transmitter with a DECT receiver without the need for a license. The external power supply operates at a voltage of 48 V DC. The system can be expanded to multiple bases up to a maximum of 20. In a closed communication, the network is connected by the Cat5 cable.

The typical reach of the base station is 50 meters indoors and up to 100 meters outdoors. Internal walls, staircases, partitions, especially concrete with metal fittings, building fabrics and room height may affect the range.

MEASUREMENT METHOD

We made use of methods that are based on current technical standards and relevant legislation. Measurements must be carried out in such a way as to eliminate the impact of any other sources. The operating mode of the device and its actual radiated intensity must also be assessed with regard to the time mode.

We identified two EMP sources.

- » the headset - subject to our research - due to its location directly on the head
- » the base station that allows the transfer of information between the headset.

The measurement was performed with a probe with a frequency range from 420 MHz to 6 GHz. The instrument has an automatic measuring range, RBW - 1 MHz, minimum display frequency Fmin - 1800 MHz, maximum display frequency Fmax - 2000 MHz. The measurements took place in close proximity to the auditory organ and in close proximity to the Q-P7BS base station. The measurements were performed in an electromagnetic compatibility laboratory in the EMC chamber at the Department of Electrical Power Engineering of the Technical University in Košice, see Figure 2.

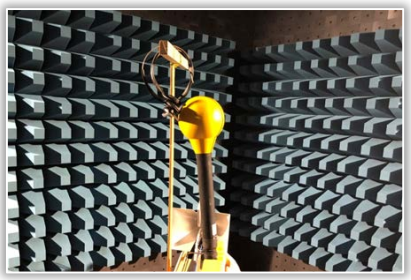

Figure 2. Measurement in EMC chamber

HEALTH PROTECTION REQUIREMENTS

Thermal effects are the most frequent manifestation of high frequency electromagnetic fields. Heat is one of the forms of energy and is given by the overall kinetic energy of the disordered movement of molecules. The higher the kinetic energy of the molecules, the more heat the substance radiates.

The absorption of electromagnetic radiation in the human body is manifested by an acceleration in the movement of the molecules of the tissue and thereby the increase in its temperature. The total amount of energy absorbed in the tissue depends on the water content of the tissue. Values of intensity and power density of electromagnetic fields which cause an overall or local rise in temperature that exceeds the thermoregulatory capabilities of the organism are perceived negatively as they have a negative effect on the human organism. Typically, the power density is 10 mW.cm-2 which is also a limit for the occurrence of the thermal effect called hyperthermia. Heat effects increase significantly with rising frequency.

Higher-frequency electromagnetic radiation penetrates into the body and causes attenuation in the tissues. The most endangered organs include eyes, the brain and the male sex organs. Warming of the eyes is associated with a high risk of their damage, as the eye lens can get rid of heat only with difficulties. Very high intensity of high frequency fields can also cause death from overheating.

For people working in the electromagnetic field (e.g. radar staff), the effect of the electromagnetic field on the eyes is manifested by eye fatigue, vision changes, reduced color sensitivity, and reduced sensitivity to the light stimulus. There is a cumulative effect (repeated irradiation and EMP below acceptable levels). The impulse array is more effective than the uninterrupted field in terms of negative effects.

EFFECTS OF HIGH FREQUENCY ELECTROMAGNETIC FIELDS

In Slovak legislation, only thermal effects of high frequency electromagnetic fields are addressed. Nevertheless, the results of recent research have shown high frequency electromagnetic fields have various effects on humans, although the results obtained by monitoring people exposed to the radio frequency electromagnetic field are often contradictory. Non-thermal effects often occur only under certain, precisely defined field parameters.

The course of the disease usually has three stages:

- » At the onset of the disease comes the neurasthenic syndrome.
- » The next stage is characterized by increased, sometimes decreased blood pressure and vascular problems.
- » Next appears hypothalamic syndrome, cardiovascular disorders with changes in ECG, blood disorders and changes in the endocrine system.

Based on these effects, some scientists regard the electromagnetic field as a non-specific biological stressor that is detected by the nervous system. Stress of this type can be a risk factor influencing the emergence of certain stress-related diseases.

The exposure action values with regard to the electromagnetic field were set based on the frequency range used by the communication units specified in Government Order no. 209/2016 Coll., see Table 1.

Table 1. Exposure action values

Frequency band	Exposure action values	
	Intensity of the electric field $\frac{E}{V.m^{-1}}$	Flow rate of equivalent plane wave $\frac{S_{eq}}{W.m^{-2}}$
2 GHz - 6 GHz	140	-

The SAR_L limit values for health effects at frequencies ranging from 100 kHz to 6 GHz are shown in Table 2.

Table 2. SARL limit values for health effects at frequencies ranging from 100 kHz to 6 GHz

Health effects	SAR_L
The body's thermal load expressed as the mean SAR absorbed by the entire body of a person	0,4 W/kg
Localized heat stress in the head and torso of a person expressed as localized SAR in body	10 W/kg
Localized heat load in the limbs of a person expressed as a localized SAR in person's limbs	20 W/kg

MEASUREMENT METHODOLOGY AND RESULTS

Given the nature of the source under consideration (headset), the ideal device for assessing EMP parameters would be a phantom head intended for specialized measurements. However, such a head is not available in the SR, so we used other available methods. We used two types of measurements with corresponding probes of different shapes and different technical parameters. All measurements were made in the shielding chamber that prevented any interference.

The analyzers used the frequencies of 1800 MHz to 2 GHz. The results of the frequency-selective measurement of the electric field (E) intensity with the assessment of its impact on the employees are shown in Table 3. The measurement made use of an RMS detector that measures the intensity of Eef field. In the case of frequency-selective measurements, the following shall apply: Σ (EefP / Ea) 2 - all signals whose level is greater than 30 dB below the maximum measured level must be less than 1.

The maximum electric field intensity values were recorded for addressing impulses (recorded duration was milliseconds), these, however, did not have a significant impact on the outlined values. Nevertheless, these impulses are included in the calculated values.

Table 3 Results of the measurement of the electric field intensity - impact on employees

Measurement place	Frequency band	Measured effective value of electric field intensity	Estimated effective intensity value of the electric field	Action values according to the Decree of the Ministry of Health of the SR no. 534/2007 Coll.	$(EefP / E_a)^2$
	f / V/m	Eef / V/m	EefP / V/m	Ea / V/m	
M1	1800 ÷ 1900	1,54	2,00	140	$2,00\ E^{-03}$

Measurements were performed in different modes and with different number of communicators in operation. The results of the measurements of the electric field intensity as well as the frequency spectrum of the electromagnetic field are shown in Figures 3 - 8.

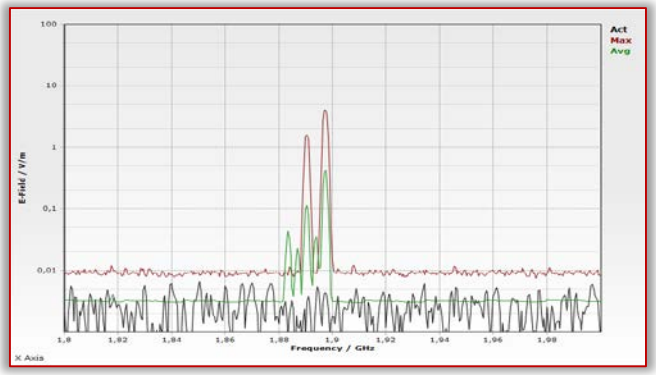

Figure 2. The communicator in the operating mode placed directly on the desk

Average value 0.47 V / m, maximum value 5.46 V / m.

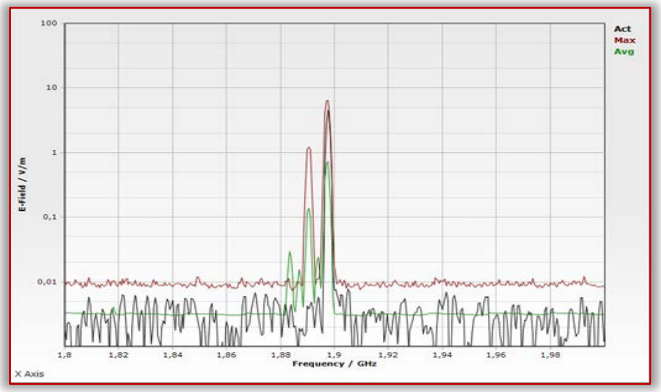

Figure 4. Communicators in standby mode hanging next to each other

Average value 0.76 V / m, maximum value 8.01V / m.

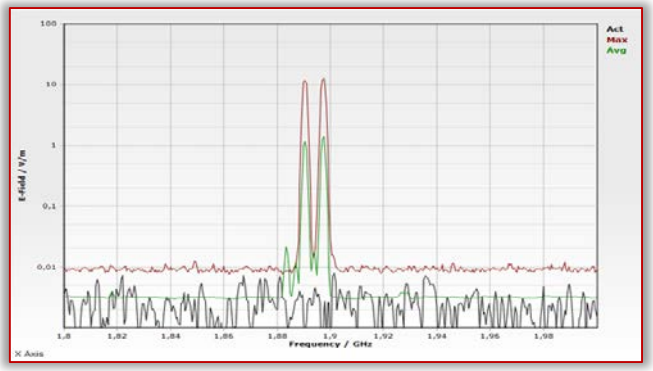

Figure 5. Measured base station in close proximity when three communicators were being used

Average value 1,53 V/m, maximum value 22,14 V/m.

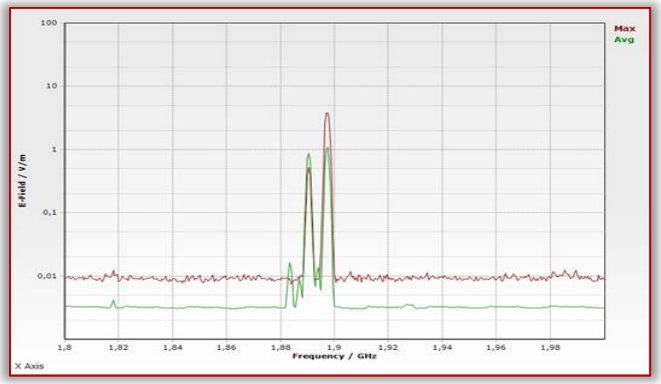

Figure 6. The communicator in operation on the head of the participant

Average value 1.54 V / m, maximum value 4.84 V / m.

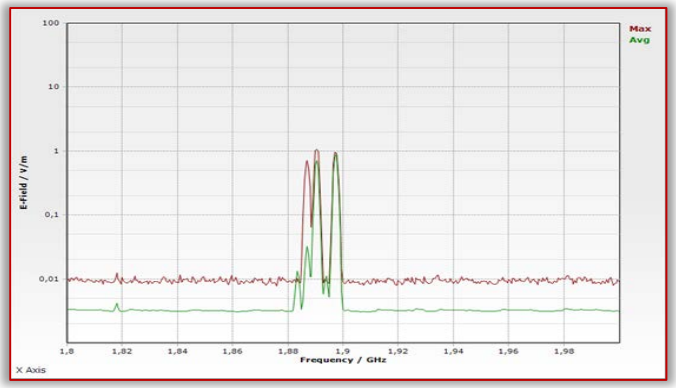

Figure 7. Measurement of 3 switched off communicators hanging next to each other

Average value 1,25 V/m, maximum value 1,94 V/m.

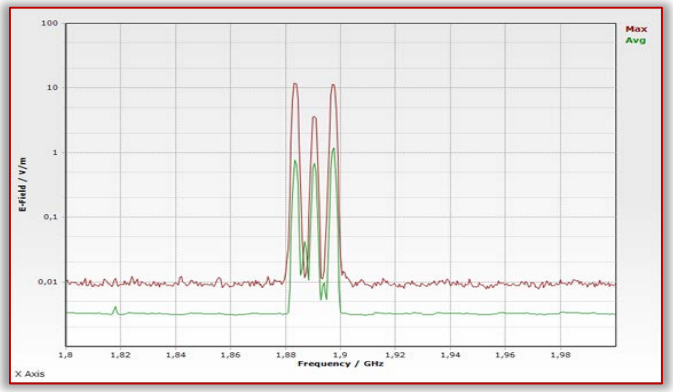

Figure 8 Measured router in close proximity of switched off communicators

Average value 1,25 V/m, maximum value 1,94 V/m.

SAR CALCULATION

In order to assess the impact of the communicator on the employee, an important value is the Specific Absorption Rate (SAR). It expresses the extent to which the body absorbs energy emitted by the high-frequency electromagnetic field. It can also be defined as the absorbed power of the weight unit of the biological organism. The SAR is usually calculated for the whole body or for a small sample of body volume, usually 1g or 10g of tissue as follows:

$$SAR = \frac{d}{dt}\frac{(\Delta W)}{(\Delta m)} = \frac{d}{dt}\frac{(\Delta W)}{(\rho \Delta V)} = \frac{\sigma E^2}{\rho}$$

where: ΔW – energy gain

Δm – weight gain in volume elements ΔV, whose specific weight is ρ,

E – the effective value of the electric field strength in the tissue

σ – electrical conductivity of the tissue

The localized heat load in the head, expressed as the localized absorbed SAR calculated based on:

» of the measured field strength E, see. tab. 3,

» the relative conductivity of human body tissues for frequencies 1800 – 1900 GHz v [Sm-1]:

Brain: σ = 0,35 Sm-1,

Skin: σ = 0,8 Sm-1,

Muscle: σ = 6,0 Sm-1,

Bone marrow: σ = 1,0 Sm-1.

in our calculations, we took into account the most unfavorable value (muscle = 6.0 Sm-1). The average weight of the human body is ρ = 1,025 kg / dm3. On the basis of the above values we calculated SAR. The results are shown in Table 4. It is obvious that the effective value of the intensity of the electric field in the tissue is smaller than at the measured point - between the communicator and the head of the participant.

Table 4. Calculated SAR

Calculated SAR	Assessed value	Limit value	Exceeding
0,014 W/kg	0,18 W/kg	10 W/kg	-

In the technical regulations the manufacturer outlines the following value: SAR = 0,056 W/kg.

CONCLUSION

Based on the results of the examination of the parameters of the electromagnetic field emitted by the communication system, we can state that the values are in accordance with the Slovak legislation. When compared to the action values, measured values are so low that the question arises whether there is a need to deal with such sources of electromagnetic field and their impact on a human beings.

Other research shows, however, that the long-term effects of EMF on humans are evident. The results are often contradictory, though. The aim of the paper is to extend knowledge on the topic of the effects of EMF on humans.

Acknowledgement

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MATERIAL FORMABILITY AT BULK METAL FORMING, CRITERIA, METHOD OF DETERMINATION AND APPLICATION

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Abstract: Material formability it is material ability to deform permanently in different stress condition without structure damage. The fracture limit of material in bulk metal forming is based on fracture and formability criteria. In metal forming, two formability criteria and two workability diagrams are being used: a) the strain based and b) stress based formability diagram. Strain based formability diagram represents the dependence of the principal strains on the free surface of specimen at the moment of the fracture occurrence. The stress based formability diagram represents the relation between limit strain and stress triaxiality ratio in the zone of fracture. In this paper, methodology of formability diagrams determination is presented and application of formability diagram for the limit strain prediction in multi-stage upsetting of prismatic specimen by V-shape dies is performed.

Keywords: Material formability, Triaxiality stress ratio, Multy stage upsetting

INTRODUCTION

Material formability (or material workability) is material ability to deform permanently in different stress condition without structure damage. It is convenient to distinguish two groups of formability criteria, theoretical and empirical. Empirical criteria are based on experimental investigation of real forming processes and they can be presented by two variants of the formability diagram (FLD): a) the strain-based and b) the stress-based formability limit diagram.

Formability diagram based on strain criterion represents relationship between two principal strains in the moment of fracture appearance [5-14, 16-19]. Usually this diagram is used in conjuction with upsetting test with different initial geometry. The strain based formability diagram and, therefore, the corresponding fracture criterion are path-independent [19].

According to the stress criteria, limit strain mainly depends on the stress state in the critical zone of the specimen, i.e., in the zone of material damage. Generally, the material formability depends on two groups of factors:

- # type of material, and
- # process conditions.

Quantitative measure of formability limit is effective strain, (φ_e^l), i.e., strain at the moment of material structure damage, strain localization or can be defined by any other criteria. For the given material, with the defined initial microstructure and in cold forming conditions by quasistatic deformation, material formability is a function of stress state only [5]:

$$\varphi_e^l = F(T_\sigma) = F(\beta) \tag{1}$$

where: T_σ – stress tensor

β – triaxiality stress ratio at the critical point of specimen, i.e., at the point of structure damage. Stress indicator is defined as:

$$\beta = \frac{\sigma_x + \sigma_y + \sigma_z}{\sigma_e} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{\sigma_e} \tag{2}$$

where: σ_e – effective stress.

σ_x, σ_y, σ_z– normal stress components in three orthogonal directions (x, y, z)

Graphical interpretation of the relationship (1) is the stress-based formability limit diagram [5]. This diagram shows that in bulk metal forming processes in which compressive stresses prevail ($\beta < 0$), values of limit strains achieved are higher than in the processes in which tensile stresses are predominant ($\beta > 0$).

Values of stresses in expression (2) are determined from the stress-strain relation and the Misses yield criterion.

In the upsetting process (Figure 1) crack occurs at the free surface of the cylinder and at that point plain stress state exists, because $\sigma_r = 0$.

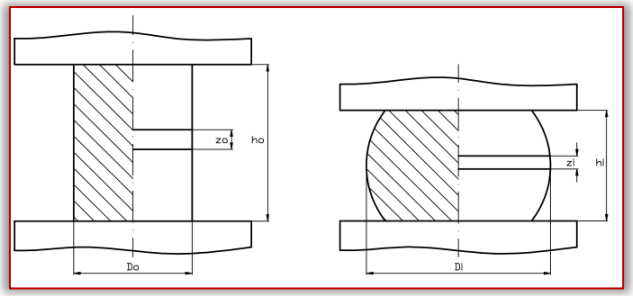


Figure 1. Upsetting of cylinder

Axial and tangential stress components could be determined by following expressions.

$$\sigma_z = \pm K[1 + \frac{(1+2\alpha)}{2+\alpha} + (\frac{1+2\alpha}{2+\alpha})^2]^{(-1/2)} \tag{3}$$

$$\sigma_\theta = \sigma_z \left(\frac{1+2\alpha}{2+\alpha} \right) \tag{4}$$

where α is the strains ratio:

$$\alpha = \frac{d\varphi_\theta}{d\varphi_z} \tag{5}$$

φ_θ and φ_z are logarithmic strain components in z and θ direction, experimentally determined by measuring specimen

$$\varphi_{\theta i} = \ln(\frac{d_i}{d_{i-1}}) \quad \varphi_{zi} = \ln(\frac{z_i}{z_{i-1}}) \tag{6}$$

It is also necessary to find relationship between these strain components. This function represents strain path in the area of crack appearance.

$$\varphi_\theta = B \cdot \varphi_z^2 + A \cdot \varphi_z \tag{7}$$

Stress factor β is determined by:

$$\beta = \frac{\sigma_r + \sigma_\theta + \sigma_z}{K} = \frac{\sigma_\theta + \sigma_z}{K} = \pm \frac{1 + \frac{1+2\alpha}{2+\alpha}}{\sqrt{1 + \frac{1+2\alpha}{2+\alpha} + \left(\frac{1+2\alpha}{2+\alpha}\right)^2}} \tag{8}$$

Stress-based formability limit diagram could be determined experimentally, by employing basic deformation models:

uni-axial tensile test, $\beta = +1$

torsion test, $\beta = 0$

uni-axial compression test, $\beta = -1$

At β=+1, the limit strain is experimentally determined by tension test at the stage of uniform deformation. It has also been shown that the uniaxial tension test can be replaced with the collar cylinder test for obtaining a point on the formability diagram where the fracture criterion based on an average value of the triaxiality ratio is adopted [12]. It is also shown that the collar test provides a more accurate prediction of the strain to fracture.

A more detailed determination of the formability limit diagram demands application of more sophisticated methods.

In the case of non-monotonous processes, stress indicator (β) changes during deformation and its mean value is inserted in the FLD diagram. The mean value of stress indicator is defined as [6,7,10,11]:

$$\beta_{av} = \frac{1}{\varphi_e^l} \int_0^{\varphi_e^l} \beta(\varphi_e) \cdot d\varphi_e \tag{9}$$

where: $\beta(\varphi_e)$ – history of triaxiality stress ratio which indicates change of stress-state as a function of effective strain.

It has been shown in [17] that the average value of the triaxiality ratio is expressed through the in-surface principal strains φl_1 and φ_2^l as:

$$\beta_{av} = \frac{2}{\varphi_e^l}\left(\varphi_1^l + \varphi_2^l\right) \tag{10}$$

In this paper the experimental methodology for determination of formability limit diagrams (strain-based and stress-based) in bulk metal forming is presented. The material used in the experiments was steel C45E (Č.1531).

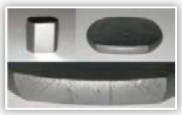
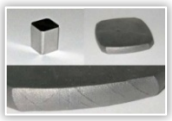
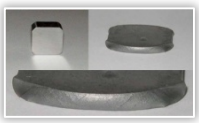
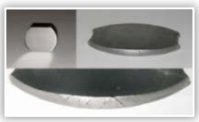
EXPERIMENTAL DETERMINATION OF FORMABILITY DIAGRAMS

The remaining part of this work shows the results of experimental determination of formability diagrams for two variants. The diagram was determined based on the results of basic tests: RT – Rastegaev test (cylinder upsetting without friction influence), BC – cylinder upsetting, T – torsion test, CC – collar cylinder test [7,12,13]. Additional tests (Type 1–5) were performed by die upsetting of five types of non-axisymmetric specimens [18].

Table 1. Basic formability tests [7,12,13]

Test specimens		
Type of tests	Rastegev	Basic cylinder
Test specimens		
Type of tests	Collar cylinder	Torsion

Table 2. Additional formability tests [18]

		
Type 1	Type 2	Type 3
		
Type 4	Type 5	

— Strain based formability limit diagram

Based on the strain path for the different experimental processes (standard and additional test, mentioned before) the strain based formability diagram is determined.

Strain path curves for different specimens are shown in Figure 2. The limit line was derived by approximation of final values for the strains (on the strain path curve) of particular tests – Figure 2.

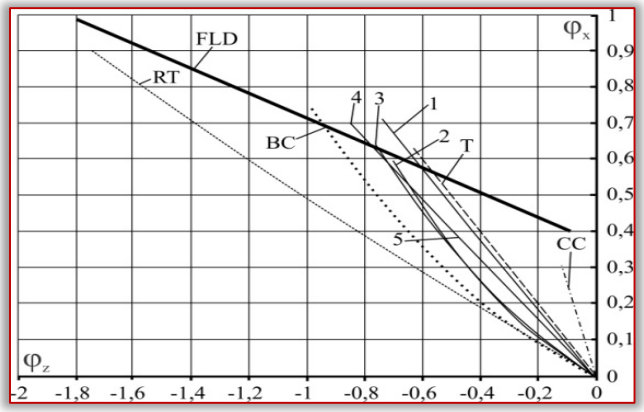


Figure 2. Strain-based formability diagram for steel C45E [18]
Basic tests: 1; RT–Rastegev test, BC–basic cylinder test, T–torsion test
CC–collar upsetting test, 1–5 additional tests [18]

— Stress-based formability limit diagram

The stress-based formability diagram (Figure 4) was generated applying the methodology described in the introductory section, based on the experimental data for the basic and additional forming methods. Essentially, the methodology used for constructing this diagram is based on the strain path diagram for the particular forming process shown in Figure 2, which allowed determination the history of triaxiality stress factor (β) using formula

(8). The history of triaxiality stress ratio for the standard and additional tests is presented in Figure 3.

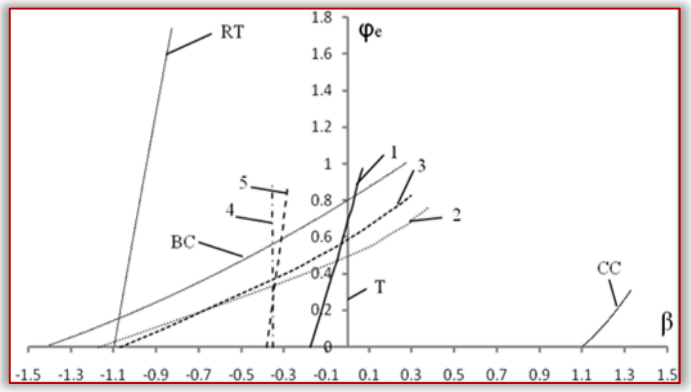


Figure 3. History of triaxiality stress ratio for different specimens: RT – Rastegaev test, BC – cylinder upsetting, T – torsion test, CC – collar cylinder test, 1–5 additional tests [18]

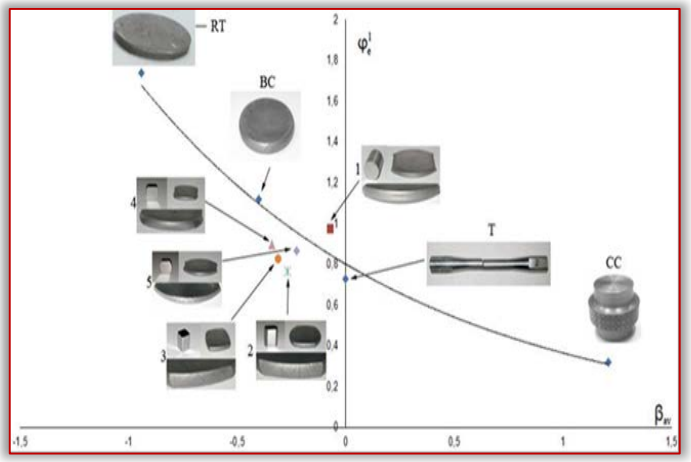


Figure 4. Stress-based formability limit diagram of steel C45E: RT–Rastegaev test, BC–cylinder upsetting, T–torsion test, CC–collar cylinder test, 1–5 additional tests [18]

Based on the history of triaxiality stress ratio and using formula (9), mean value of factor β_{av} was calculated.

Stress based formability diagram represents relationship between limit strain (φ_e^l) and average values of triaxiality stress ratio (β_{av}) – Figure 4.

APPLICATION OF FORMABILITY LIMIT DIAGRAM

In metal forming process forming limit diagram is used for fracture prediction, i.e. for the design and optimization of the number of forming phases. Same procedure may be used in metal structure load analysis. At first, it is necessary to create formability limit diagram for specified material and then to analyse the stress state and the triaxiality stress factor at sample bulk. For stress-strain state analysis in bulk specimen finite element method is recommended, i.e. application of proper software (SimufactForming, Abaqus, and Deform, etc.).

Presented below are the results of material formability analysis for multistage upsetting by V-shape dies of the prismatic billets made of Č.1221 [20]. The purpose of the analysis is to examine potential limit strain in this process, at upsetting with 17 stages, with sample rotation for 90° after each phase. Limit strain prediction is carried out by numerical analysis of upsetting by V shape dies of samples made of Č.1221. For this analysis, SimufactForming V10 software was used.

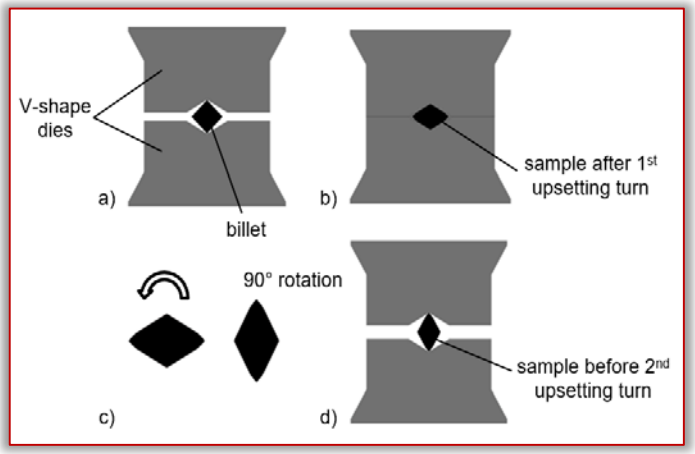
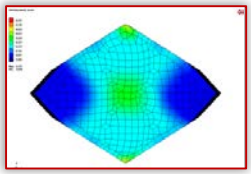
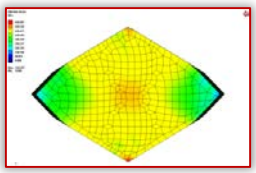
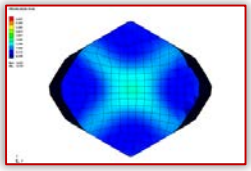
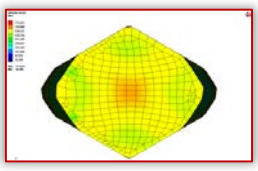
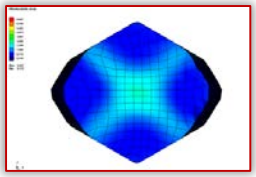
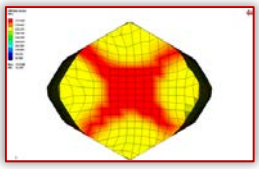
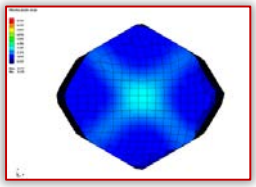
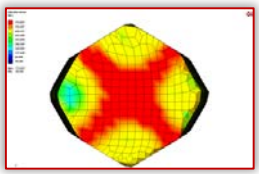
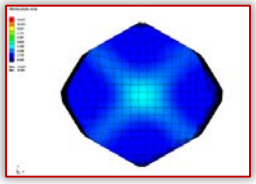
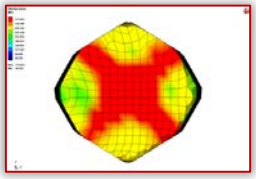
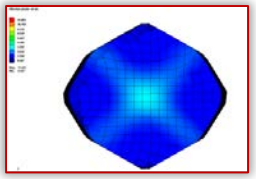
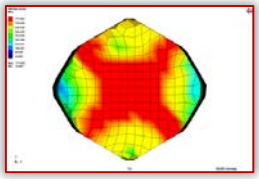


Figure 4. Multi stage upsetting of prismatic specimen by V-shape dies [20]

Table 3. Numerical simulation of multistage upsetting by V shape die [20]

No.	Effective strain	Effective stress
1		
3		
7		
11		
15		
17		

Triaxiality stress ratio analysis was carried out for the critical point on the specimen that is located at the centre of free (forehead) surface. The triaxiality stress factor is determined from the hydrostatic stress and the effective stress at the centre of the sample surface obtained by numerical simulations. The change of the triaxiality stress factor for different upsetting stages and corresponding effective strain values, at the centre of the sample forehead, is presented in table 4.

Table 4. Triaxialiti stress factor in correlation with effective strain

Upsetting stage	1	3	5	7	9
φ_e	0.39	1.58	2.29	2.61	2.83
β	- 2.88	- 2.38	- 1.95	- 1.95	- 1.91
Upsetting stage	11	13	15	17	
φ_e	2.98	3.14	3.28	3.34	
β	- 1.68	- 1.56	- 1.44	- 1.17	

FLD for Č.1221 (annealed) determined experimentally by the cylinder upsetting with flat plates, the torsion test and the tensile test [15]. Based on the data from Table 4, history of triaxiality stress ratio was identified and approximated by following equation:

$$\beta = 0,09 \cdot \varphi_e^2 + 0,156 \cdot \varphi_e - 2,925 \quad (11)$$

Average value of triaxiality factor was determined by formula (9):

$$\beta_{av} = \frac{1}{3,34} \int_0^{3,34} (0,09 \cdot \varphi_e^2 + 0,156 \cdot \varphi_e - 2,925)\, d\varphi_e = -2,32 \quad (12)$$

By using numerical analysis, average value of triaxiality factor β=–2,32 with corresponding value of limit strain $\varphi_e^l = 3,34$ was calculated. The illustration of fracture incidence at multistage upsetting of prismatic sample is presented at Figure 5.

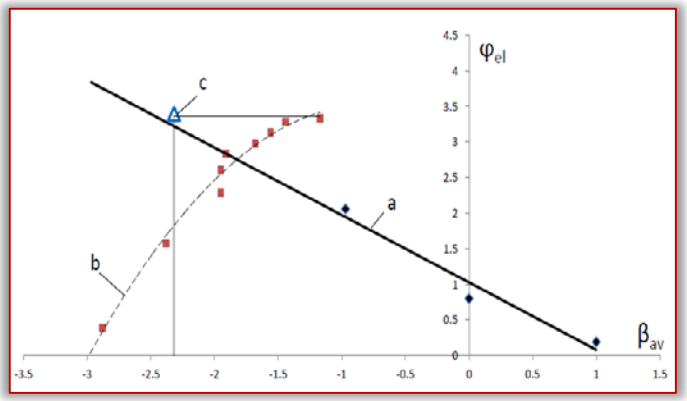


Figure 5. FLD for Č.1221 and the position of multi stage upsetting by V shape dies after 17 stages: a–FLD, b–history of β factor, c– estimated limit strain

DISCUSSION OF RESULTS AND CONCLUSION

- In the metal forming technology two formability criteria can be applied strain-based and stress-based criterion.
- Strain-based formability criterion is simple for application because it is based on strain determination in the material fracture zone. Due this feature, its application is limited to processes where fracture occurs on the free surface of workpiece.
- Stress-based formability criterion represents limit strain dependence from a stress state in the zone where material fracture occurs. This criterion can also be applied in the case of fractures occurring inside the specimen. In this paper is presented how stress based formability diagram can be determined based on data obtained from the strain-based formability diagram.
- Stress-based formability diagram is more important since its shows a significant impact of stress state on the magnitude of the limit strain (Figure 4).
- This study showed that strain-based formability diagram can be transformed into a stress-based one.
- The reverse transformation of stress-based formability diagram into a strain-based formability diagram is also possible, as demonstrated in [19].
- The application of FLD enables the prediction of limit strain in real forming processes and the optimization of the number of stages.
- Results of multi stage upsetting of prismatic specimen by V shape die proves the existance of a small reserve of material formability after 17 stages.

Note:

This paper is based on the paper presented at COMETa 2018 – The 4th International Conference on Mechanical Engineering Technologies and Applications, organized by Faculty of Mechanical Engineering, University of East Sarajevo, in Jahorina, BOSNIA & HERZEGOVINA, between 27–30 November, 2018.

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SYNTHESIS OF SILVER NANOPARTICLES FROM SELECTED PLANTS EXTRACT

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Abstract: Plants extract from Chromolaena odorata (C. odorata), Jatropha curcas (J. curcas) were used for the synthesis of nanomaterials from silver nitrate solution. The synthesized nanoparticles were characterized by UV, XRD and FTIR technique. The average particle sizes were found to be 3.58 nm, 3.64 nm corresponding to C. odorata, J. curcas, respectively. The plant extracts were also found to be good reducing agents for production of silver nanoparticles.

Keywords: nanoparticles; synthesis; FTIR; XRD; extracts

INTRODUCTION

Research on new materials technology is attracting the attention of researchers all over the world with the view to improving the properties of the materials [1]. Nanotechnology is a broad interdisciplinary area of research, development and industrial activity which has grown very rapidly all over the world for the past decade [2]. Nanotechnology is emerging as a rapidly growing field with its application in science and technology for the purpose of manufacturing new materials at the nanoscale level [3]. Different physical and chemical approaches are known for the synthesis of nanomaterials. Most of the methods reported in the literature are extremely expensive and also involve the use of toxic, hazardous chemicals such as stabilizers which may pose potential environmental and biological risks.

Recently, plants have been gaining importance due to their unique constituents and their diverse applicability in various fields of research and development [4]. The green synthesis of metallic nanoparticles and their applications is one of the most important area of research.[5,6] Plant extracts comprise of a wide range of naturally occurring chemical compounds, which are generally recognized as natural products .These natural products possess varieties of biological activities due to their exceptional variety in their chemical structures. The phytomolecules present in plant extracts enable the synthesis of the nanoparticles by acting as reducing agents. Also, it encourages the synthesis to be carried out under a control pressure and temperature. This advantage coupled with its environmentally-friendly nature and the fact that it does not require sophisticated laboratory facilities or costly instruments succeeds it as the best approach for synthesizing the nanoparticles directly accessible to be applied in several applications, particularly biological and catalytic applications [7]. In the present study, we have explored the synthesis of silver nanoparticles from the leaves extract of Chlomolaena odorata, Jatropha curcas.

MATERIALS AND METHODS

— Plants Extract Preparation

Each of Chromolaena and Jatropha, in Figure 1 and 2 were obtained in Akure, Ondo State, Nigeria, sundried and pulverized separately with a pulveriser with model number ES-1731F, power of 300W, frequency of 50Hz and an AC voltage of 220V. About 10g of each of the pulverised leaves were weighed and soaked separately in 200ml distilled water and refluxed in a water bath. The mixture was then filtered to obtain the extracts [8].

Figure 1. Chromolaena odorata

Figure 2. Jatropha curcas

— Biosynthesis of silver nanoparticles

The stocks of extracts obtained were used for preparing the nanomaterials by the addition of 0.1M of $AgNO_3$. The mixture containing the $AgNO_3$ was then placed in a microwave oven for complete bioreduction at a power of 300W for 10minutes [4] while the colour change was being monitored with the naked eye.

— Characterization of silver nanoparticles

To characterize the silver nanoparticles, the following tests were conducted;

— UV–Vis spectra analysis

The reduction of pure silver ions was monitored by measuring the UV–Vis spectrum of the reaction medium at 5 h after diluting. A

small aliquot analysis was done using UV–Vis spectrophotometer UV-2450 (Shimadzu).

— X-ray diffraction (XRD) analysis

The AgNP solution was repeatedly centrifuged at 5000 rpm for 20 min, re-dispersed with distilled water and lyophilized to obtain pure AgNPs pellets. The dried mixture of AgNPs was collected to determine the formation of AgNPs. This was carried out using Shimadzu XRD-6000/6100 model with 30 kV, 30 mA with Cukα radians at angle 2θ.

— FTIR

The AgNPs obtained were centrifuged and redispersed and subsequently, the dried powder was obtained by lyophilizing the purified suspension. The resulting lyophilized powder was examined by Infrared (IR) spectra, recorded on a Bruker Vector-22 Infrared spectrophotometer using KBr pellets.

RESULTS AND DISCUSSIONS

— Visual Examination

The leaf extract had a pale yellow colour and appeared thick and muddy soon after adding $AgNO_3$. After the solution was kept in the microwave oven, the intensity of the colour increased gradually from pale yellow to dark brown at the end of the experiment. The appearance of dark reddish brown colour is an indication that the aqueous silver ions in the reaction mixture were reduced to silver nanoparticles [9]. A steady state was achieved where there was no significant change after some time, therefore indicating the completion of the reduction reaction process. The appearance of the brownish colour was due to the excitation of Surface Plasmon Resonance of the AgNPs [10]. The free electrons of AgNPs give rise to a surface plasmon resonance absorbance due to the combined vibration of electrons of the metal NPs in resonance with the light waves [8]. Thus, indicating the reduction of Ag+ to Ag^0 of the AgNPs.

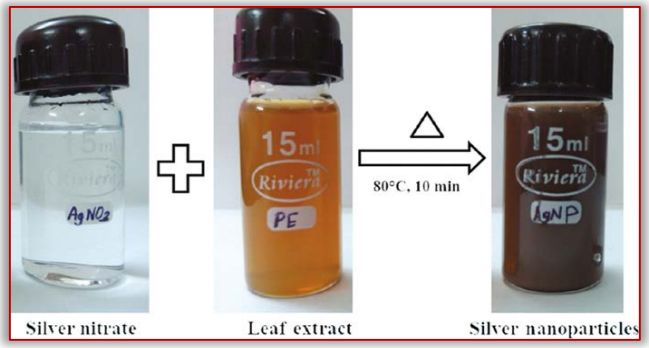

Figure 3: Pictorial Representation of the Synthesis of the Nanomaterials Showing the Colors of the Reactants and the Product

— UV-Vis Analysis

The formation and stability of silver nanoparticle in aqueous colloidal solution were confirmed using UV–Vis spectral analysis. Figures 4 and 5 show the UV-Vis absorption spectra of the leaf extract and synthesized silver nanoparticles solution of C. odorata, J. curcas respectively. Numerous intense absorption peak are observed in the range of 200 to 260 nm for the leaves extract while for the AgNPs, the peaks are in the range of 250 to 400 nm corresponding to the surface plasmon resonance of silver nanoparticles. This peak pattern is similar to the result of Narender et al. 2013 [11].

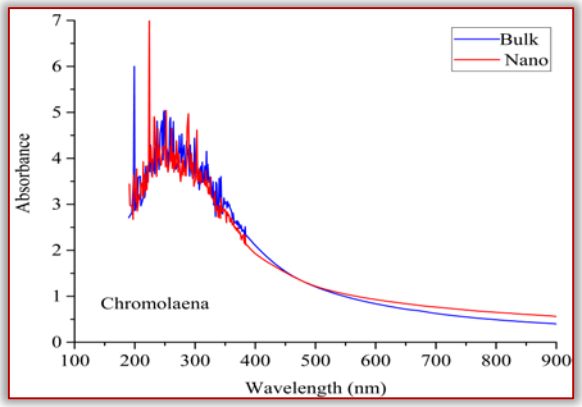

Figure 4: UV-Vis Absorption Spectra of C. odorata Leaf extract and C. odorata Synthesized Silver Nanoparticles Solution

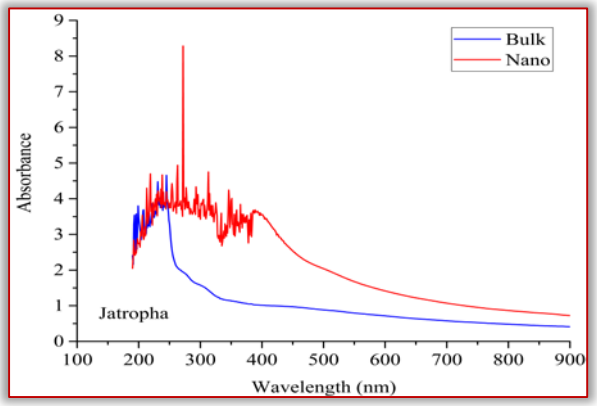

Figure 5: UV-Vis Absorption Spectra of J. curcas Leaf extract and J. curcas Synthesized Silver Nanoparticles Solution

— X-Ray Diffraction Studies

In order to verify the results of the UV–vis spectral analysis and to determine the nature of the silver nanoparticles, the samples of silver nanoparticle in aqueous colloidal solution were examined by XRD. Figure 6 and 7 show the XRD pattern for silver nanoparticles synthesized using natural plants extract. The particle size of silver nanoparticles was calculated from the XRD pattern according to the line width of the plane [4]. The equation uses the reference peak width at angle θ, where λ is the X-ray wavelength (0.154060 nm), β is the width of the XRD peak at half height and κ is a shape factor. The calculated particle size of the biosynthesized AgNPs were found to be 3.58 nm and 3.64 nm corresponding to C. odorata, J. curcas respectively.

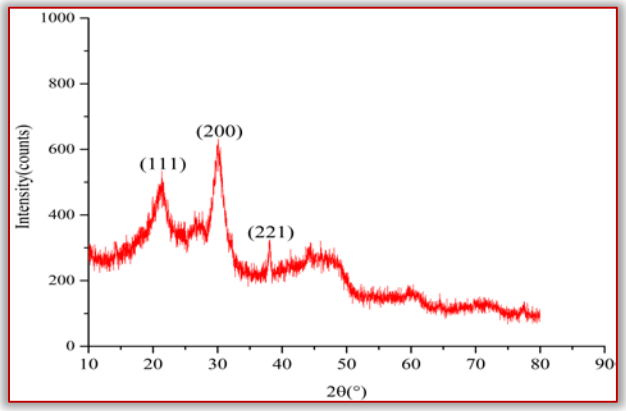

Figure 6: XRD Pattern of the Silver Nanoparticles of C. odorata Extract

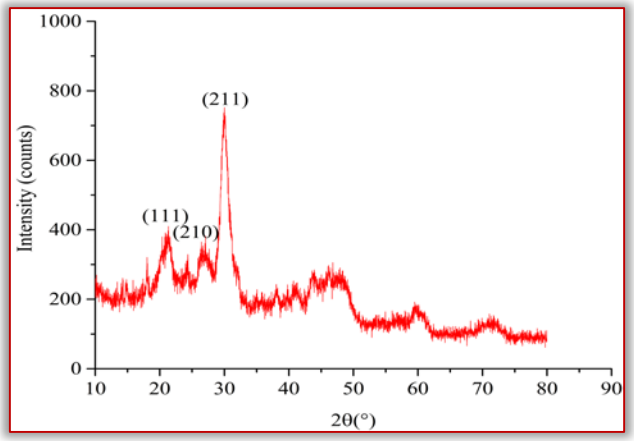

Figure 7: XRD Pattern of the Silver Nanoparticles of J. curcas Extract

FTIR Analysis

FTIR spectroscopy was employed to characterize and identify the biomolecules of leaves extract of C.odorata, J. curcas. FTIR spectra of C. odorata leaf extract and synthesized C. odorata AgNPs solution are shown in Figure 8. The spectrum of the C.odorata extract contains an absorption peak at 3428 cm^{-1} indicating the presence of hydroxyl groups, which points to the existence of several oxygen comprising functional groups, such as carboxylic, epoxy, carbonyl, and hydroxyl groups.

Other absorption peaks were observed at 2939, 2830, 1984, 1550, 1185 and 1006 cm^{-1}, due to vibration and deformation bands of C-H stretch, C=C and C-O stretch respectively. Most of the absorption bands of the C.odorata also exist in the FTIR spectrum of C.odorata AgNPs, either at identical positions or with minor shifts, for instance the band at 3388, 2931, 2838, 1542, 1263 and 1077 cm^{-1}. The presence of these IR bands in the spectrum of C.odorata AgNPs evidently recommends that the organic compounds of C.odorata extract not only act as a bioreductant, but also act as capping ligands on the surface of the C.odorata AgNPs. Shaik et al., 2017 [12] reported similar observation on Origanum vulgare leave extract.

FTIR absorption spectra of Jatropha leaf extract before and after bioreduction, are shown in figure 9. The major absorbance bands present in the spectrum of the Jatropha extract were at 3419, 2915, 2846, 1557 and 1433 cm^{-1} .The broadband observed at 3419 cm^{-1} could be assigned to stretching vibrations of O–H groups in the leaf extract. The bands at 2915 and 2846 cm^{-1} correspond to stretching vibrations of CH group. The sharp peak at 1557 and 1433 cm^{-1} could be assigned to carbonyl group. While the spectrum of the reduced Jatropha L.extract showed characteristic absorbance bands at 3404, 2923, 2861, 2349, 2015, 1550 and 1426 cm^{-1}, respectively. In the IR spectrum of nanoparticles, shifts in the band peaks from 3419 to 3404, 2915 to 2923 and 1557 to 1550 cm^{-1} corresponding to OH, CH and carbonyl group respectively with decreased band intensity were observed. Based on these band shifts, it can be inferred that both hydroxyl and carbonyl groups of Jatropha L. extract are involved in the synthesis of silver nanoparticles [13].

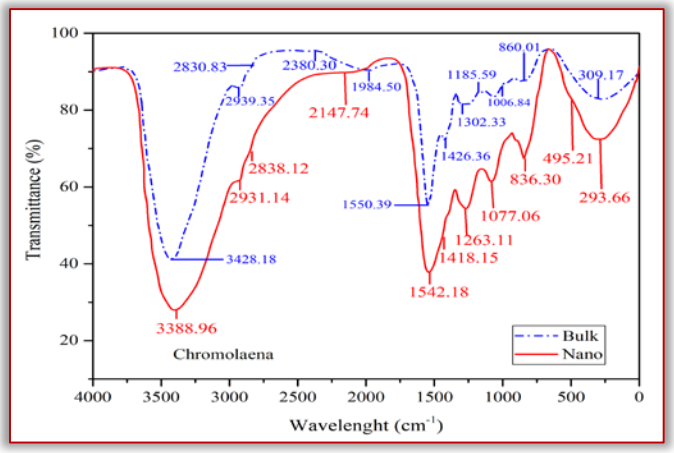

Figure 8: Fourier Transform Infrared Spectroscopy Spectra of C. odorata Extract

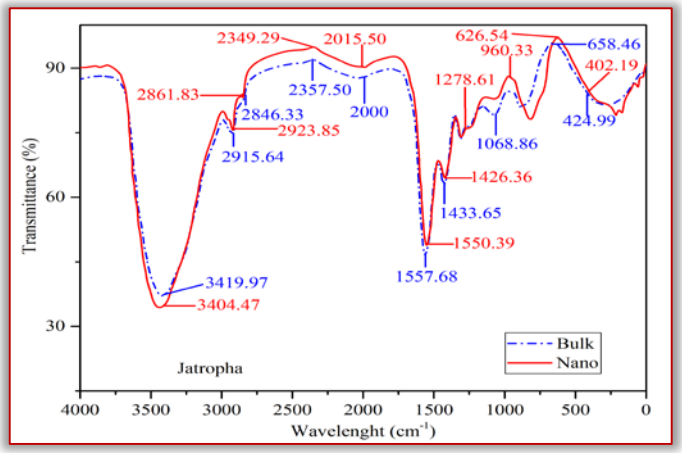

Figure 9: Fourier Transform Infrared Spectroscopy Spectra of J. curcas Extract

CONCLUSIONS

Synthesized nanomaterials from plants extract were investigated. From the results of the analyses, the following conclusions were drawn;

- C. odorata, J. curcas were good reducing agents for silver metal. This is evident from the appearance of reddish brown colour on the addition of $AgNO_3$ to the plants extract.
- The UV spectra of extract after the addition of $AgNO_3$ showed maximum absorbance at around 250 to 400 nm confirming the formation of AgNPs while the extract without the addition of $AgNO_3$ show low peak between 200 to 260 nm indicating that the plant extract is free from Ag^+ ions.
- The particle size of silver nanoparticles as calculated from the XRD pattern were found to be 3.58 nm, 3.64 nm corresponding to C. odorata, J. curcas respectively.

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STATIC PRESSURE DISTRIBUTION IN THE SOIL UNDER THE WHEEL OF A SPRAYING MACHINE

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Abstract: Current farming practices using heavy machinery are associated with soil compaction. The paper presents the results of tests aiming to determine in field the contact area and pressure distribution in the contact area between MSL machinery (for the precise application of the phytosanitary treatments in orchards) and the agricultural soil, respectively the determination in laboratory, on Hidropuls, of pressure distribution at 0 - 45 cm deep into the soil under the wheel of the MSL machine. The tank of the machine was loaded with 750 litres of water (wheel load 9.81 kN) and tire inflation pressures were 100, 150 and 200 kN.
Keywords: soil, compaction, pressure, mesh sensor, Hidropuls

INTRODUCTION

Several years ago, compaction would have been relatively shallow because farm equipment weighed less and many cover crops were grown in rotation (Sivarajan et al, 2018). Nowadays, the risk of soil compaction increases with the growth of farm operations and the drive for greater productivity causing farmers to use heavier machinery, with repeated passes, most often on soils with high moisture content. The heavier equipment used today for different agricultural practices increases the negative effects of artificial compaction both on agriculture and the environment. Preventive measures should be taken to avoid soil compaction because targeted amelioration of this type of degradation of soil is complex, costly and rarely long- lasting (Rücknagel et al, 2015).

Surface soil compaction takes place until a depth of 0.3 m or in the topsoil (soil tillage layer) and subsoil compaction takes place to depth under soil tillage layer. Soil compaction in cropping systems affects mostly the upper layer of soil (topsoil compaction) but it is also observed at certain depth (subsoil compaction) (Nawaz et al, 2013). The increase in the size and weight of agricultural machinery calls for accurate measurements of stresses applied by machinery in the tire-soil interface and in the soil profile (Lamande et al, 2014). During compaction, stress distribution is influenced by factors such as tire inflation pressure, wheel load, tire–soil contact area, lug, tire stiffness (bias or ply), single or dual tire and soil conditions, e.g. soil type, soil texture and soil strength (Schjonning et al, 2008). In order to predict the stress in soil due to wheel pressure, the stress has to be determined on the soil and on the contact area. The shape and area of the tire footprint and the magnitude and distribution of stresses distributions have practical implications on the topsoil compaction. These factors are also decisive for the pressures reaching the subsoil, as well as the potential of improving our understanding of contact pressures propagation to the soil (Cueto et al, 2016).

The effect of surface stress distribution on soil stress decreases with increasing depth. The vertical stress in the upper subsoil (down to 1 m depth) depends on both soil contact stress and wheel load (Nankali et al, 2012). Arvidsson and Keller (2007) found that tire inflation pressure has a great influence on contact pressure at the depth of 100 mm, but has a very low influence on the subsoil stresses (at 300 mm and deeper). When doubling the wheel load, the contact area increases by 30-40%, while at the doubling of the tire inflation pressure, the contact area drops by 70-80% (Ekinci and Çarman, 2011). Way and Kishimoto (2004) have shown that the stress in the contact area is not uniformly distributed and the maximum stress may be many times greater than tire inflation pressure. Most of the contact pressures researches were done in experimental conditions, because in field conditions, is difficult to measure and maintain the experimental parameters during testing. During agricultural works, using higher tire inflation pressure results in smaller footprint area, soil deformation increases and the pressure is distributed deeper into the soil (in this case, deep loosening is needed to alleviate the compaction). Using lower tire inflation pressure, tire deformation increases, footprint area increases, contact pressure decreases, soil deformation are smaller and the pressure is transmitted to shallower depths (Ungureanu et al, 2018; Kenarsari et al, 2017).

Quantitative understanding of stress transmission and deformation processes in arable soils remains limited. Yet such knowledge is essential for better predictions of effects of soil management practices such as agricultural field traffic on soil functioning (Keller et al, 2013). Strategies for prevention of soil compaction often rely on simulation models that are able to calculate stress propagation in soil profile for certain mechanical loading (agricultural machinery) and soil conditions (e.g. soil moisture), and may help farmers and advisors in planning and making decisions about specific traffic situations in the field (Keller and Lamande, 2010).

MATERIAL AND METHOD

A. In the first set of tests, carried out in the field, were determined the size of contact area and the distribution of contact pressure under the wheel of MSL spraying machine for precise application of the phytosanitary treatments in orchards. The tire is Danubiana Superfront Tractor, size 6.00-16, profile F-2. The total weight of the

machinery with empty tank is 4.90 kN (2.45 kN wheel load). The tank was filled at with 750 litres of tap water litres (maximum capacity is 1000 litres) and then the load on each wheel was measured, resulting in a total of 9.81 kN wheel load. Tire inflation pressure varied to 100, 150 and 200 kPa. Contact pressure and the size of contact area were measured by mesh-type pressure sensor Tekscan Industrial Sensing coupled to the VersaTek Handle electronic data acquisition system (Figure 1) and to a laptop.

Figure 1 – Field testing of the MSL spraying machine

B. The second set of tests was conducted in laboratory conditions, using a complex testing system that works in simulated and accelerated regime, Hidropuls type (Figure 2), which can simulate the static pressure at compression of the tires on the soil (stationary machinery). A container made of reinforced sheet with thickness of 3 mm was filled with soil (Figure 3).

Figure 2 - Installation for testing in simulated and accelerated regime, Hidropuls type

Figure 3 - Container filled with soil

Eight sensors for force measurement, Flexi Force Tekscan type W-B201-L (Figure 4) with the maximum domain of 10 N / 50.24 mm^2 and the diameter of contact button of 0.8 cm, were mounted in the container at depths of 5, 10, 15, 20, 30, 35, 40 and 45 cm. The connection between the laptop and force measurement sensors was achieved through an adaptation module, formed by amplifiers and analog-to-digital converter, coupled to a serial interface 4RS232 to coupling view (USB), an adaptation module (acquisition system) and laptop. A hydraulic cylinder with a force of 10 kN, close to the wheel load determined in field testing and some intermediate devices in the Hidropuls (Figure 5) were used to simulate the static compression pressure of the MSL wheel on the soil.

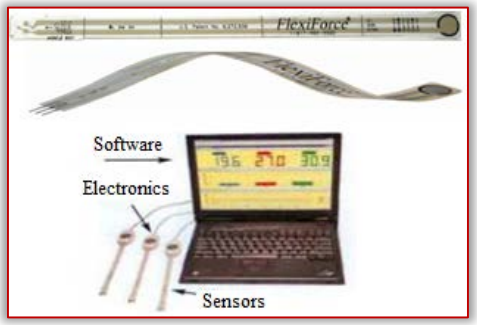

Figure 4 – Flexi Force Tekscan type W-B201-L sensor

Figure 5 – Stand for static compression pressure

RESULTS

The experimental data obtained from field testing of the MSL spraying machine are given in Table 1.

Table 1. Compaction characteristics under the wheel of MSL machinery in field testing

Wheel load Q [kN]	Tire inflation pressure p_i [kPa]	Size of contact area A [m^2]	Contact pressure p_c [kPa]
9.81	100	0.0619	159
	150	0.0546	180
	200	0.0539	182

Figure 6 shows the mapping of pressure distribution in the footprints obtained in field testing. It can be seen that at soil surface, for 9.81 kN wheel load and tire pressure ranging from 100 - 200 kPa, were obtained contact areas between 0.0539 - 0.0619 m^2 and the contact pressure ranged between 159 - 182 kPa.

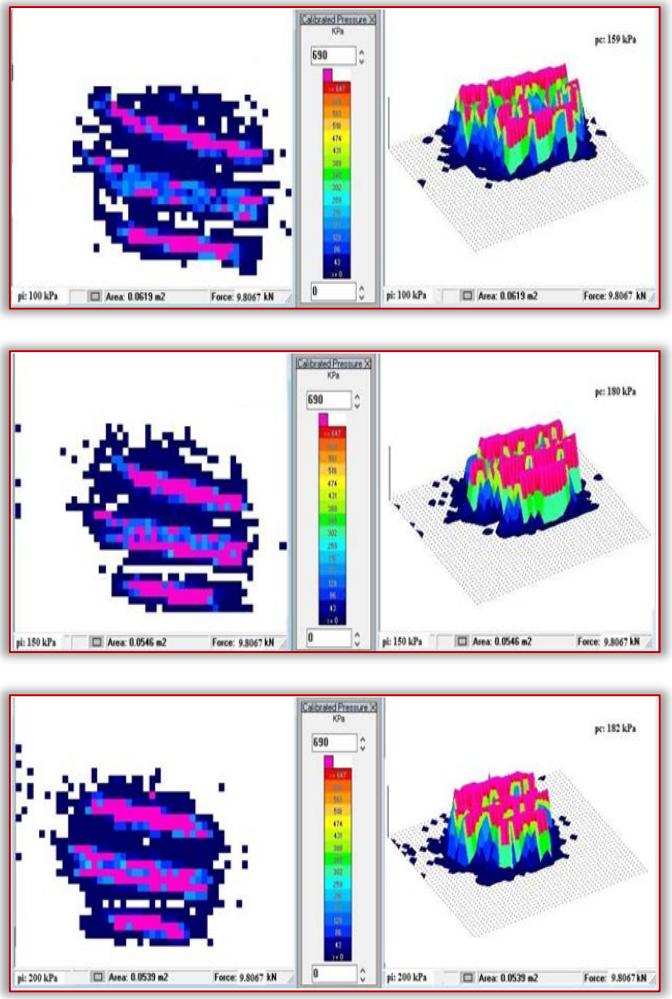

Figure 6 – Field mapping of pressure distribution in the footprint between tire and soil

The shape of footprint tends to be rectangular at 100 kPa wheel load, but with increasing tire inflation pressure, it changes into an elliptical shape. Also, the maximum contact pressure values are recorded close to the tire's edges.

Referring to the results obtained in the second set of tests, pressure distribution was determined at eight soil depths where the force sensors were applied, in the direction of action of the compressing force (vertical direction). At each tire inflation pressure, three replication tests were made. Vertical stresses measured at each tire inflation pressure for one of the replicate measurements are presented next. In Table 2, the size of contact area at soil surface was recorded during field testing, using the mesh-type pressure sensor Flexi Force Tekscan. For depths between 5 – 45 cm, the size of contact area reffers to the surface of FlexiForce sensor in contact with the soil, which was computed as: $S = \pi \cdot R^2 = 3.14 \cdot 0.16 = 0.5024$ cm^2.

To simulate the pressure applied by the wheel of the MSL machine, for each tire inflation pressure, a compressive force was progressively applied to the wheel by a hydraulic cylinder until it reached the value determined in real conditions (by weighing the machine after filling the tank with 750 litres of water) and determining the distribution on axles and on the wheels), when the forces were measured at each of the 8 depths using the Flexi Force Tekscan W-B201-L sensors. Thus, at tire inflation pressure of 100 kPa, the duration of load was 33.5 seconds, until the compressive force of 9842 N was reached; at tire inflation pressure of 150 kPa, the duration of load was 33.3 seconds, until the compressive force of 9828 N was reached, respectively at tire inflation pressure of 200 kPa, the duration of load was 39.7 seconds, until the compressive force of 9810 N was reached.

Table 2. Laboratory testing of static compression for the MSL spraying machine

Sensor no.	Depth of sensor [cm]	Compressing force [N]	Size of contact area [cm^2]	Presssure in the soil [N/cm^2]
Tire inflation pressure 100 kPa				
-	0	9842	619	15.9
1	5	19.3633	0.5024	38.5416
2	10	13.8288	0.5024	27.5255
3	15	19.7474	0.5024	39.3031
4	20	5.7194	0.5024	11.3842
5	30	10.3005	0.5024	20.5026
6	35	10.1156	0.5024	20.1346
7	40	10.8269	0.5024	21.5504
8	45	11.7232	0.5024	23.3344
Tire inflation pressure 150 kPa				
-	0	9828	546	18
1	5	23.2473	0.5024	46.2725
2	10	15.1613	0.5024	30.1777
3	15	22.0238	0.5024	43.8372
4	20	5.6389	0.5024	11.2240
5	30	10.1873	0.5024	20.2773
6	35	9.8149	0.5024	19.5360
7	40	10.9587	0.5024	21.8127
8	45	11.4109	0.5024	22.7128
Tire inflation pressure 200 kPa				
-	0	9810	539	18.2
1	5	23.7458	0.5024	47.2647
2	10	15.5888	0.5024	31.0287
3	15	22.9301	0.5024	45.6411
4	20	5.7703	0.5024	11.4855
5	30	10.4681	0.5024	20.8362
6	35	10.0451	0.5024	19.9942
7	40	10.7853	0.5024	21.4676
8	45	10.8004	0.5024	21.4976

Variation of pressure with soil depth under the wheel of MSL spraying machine, obtained in laboratory testing, is presented in Figure 7.

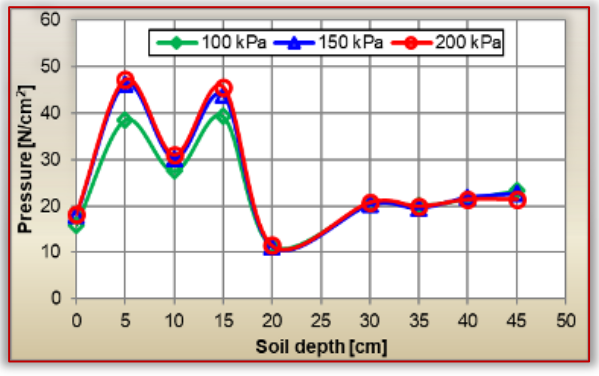

Figure 7 - Variation of pressure with soil depth, under the wheel of the MSL machine, in laboratory conditions

It can be seen that for the tested tire inflation pressures, the variation curves follow a similar trend. The pressure applied to the soil tends to decrease suddenly as soil depth increases to 10 cm, and then rises to a depth of 15 cm, after which they follow a sharp downward curve to a depth of 30 cm, and then there is a slight increase at the maximum tested depth of 45 cm.

CONCLUSIONS

Soil compaction mainly depends on the compression applied on the soil surface by agricultural machines. Hence, contact pressure at the soil-machine interface can be measured as a good indicator of the potential compaction on agricultural soils.

We conclude that a traffic event in the tested conditions is likely to induce serious impacts on soil properties and functions to a depth of least 45 cm. Our results show that at 45 cm soil depth, wheel loads of 9.81 kN may induce vertical stresses around 233, 227 and 215 kPa, for tire inflation pressures of 100, 150 respectively 200 kPa. Maximum stresses in the tire-soil contact area were as high as 182 kPa.

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AN OVERVIEW OF HAZELNUT HARVESTING MACHINES WITH DIFFERENT DESIGNS

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Abstract: Many factors (Topography, soil characteristics, planting technique etc.) affecting the applicability of mechanical harvest in hazelnut. Today, many of these factors have been developed to overcome the adverse effects. As a result, there are differences in mechanical harvesting techniques applied to different production regions around the world. Information was given about hazelnut harvesting machines which have different collecting units designed and manufactured in order to reduce harvest expenses and labor force requirement which are important in hazelnut production cost with this study.
Keywords: hazelnut harvesting machines, mechanical harvesting, pneumatic harvesting, hazelnut mechanization

INTRODUCTION

The hazelnut (Corylus avellana L.), one of the World's major nut crops is one of the most important agricultural products in Turkey (Yıldız T., 2016; .Selvi K.Ç. 2017), since as agricultural products have relevant nutritional and economic value (Zambon et al, 2017). The traditional harvesting method consists in collecting hazelnuts from ground and a preliminary accurate selection is then needed to avoid stones, ground, brunches, leaves, etc. (Delprete and Sesana, 2014). In recent decades, advanced technology and the latest results of scientific research have been largely applied in agriculture in order to improve the quality of products and to increase productivity (Bachche S., 2015). This situation has increased the use of mechanization in hazelnut harvest rapidly instead of traditional harvesting methods.

Mechanical harvest of nuts include such as, ground preparation, dropping of fruits, stacking of dropped fruits, collecting and cleaning process. In Italy, Spain and USA, which produce hazelnuts economically, the mechanical harvest has been widespread by the amount of planting technique and land topography allowed. In Italy, Spain and USA, which produce hazelnuts economically, the mechanical harvest has been widespread by the amount of planting technique and land topography allowed. For this purpose, machines with pneumatic (vacuum), pneumatic + mechanical and mechanical effective sweeping units are used. As a basic principle in the first harvesting machines developed for this purpose, aspiration of the fruits dropped to the garden floor was taken into account (Parks and Fairbank, 1948), followed by mechanical and aspiration + mechanical collector combination methods (Fridley and Adrian, 1959; Whitney et al, 1966).

MATERIAL AND METHOD

In working with these machines, a good preparation of the ground (levelling and compacting) and a spreading product with lateral sweepers are required. The fact that the hazelnuts cultivated in the countries are short-husked as a kind of characteristic, causes the hazelnuts to be poured as grains during the harvesting period.

For this reason, no husk separation machines are used. Due to the definable geometric shape of the hazelnuts, it is possible to effectively clean them with known separation methods. Uncleaned stone and other elements are separated in water pools and cleaned nuts are dried in desiccants.

In the production of nuts in our country, the harvesting process is the way of pouring the fruits by shaking and then collecting them by hand from the floor or the branches. Harvesting with this method constitutes approximately 74% of the total labor requirement. This situation increases the production cost of hazelnut significantly and causes labor force based on heavy labor during the harvesting period.

The fact that the Turkish hazelnut varieties have a long husk and that the fruit is tightly wrapped and does not have an identifiable geometric shape makes the separation systems of such machines ineffective. In addition, the effectiveness of the sweeping units is also diminishing due to the differences in the planting technique and the characteristics of the garden grounds. Also, the large size of the machines creates problems due to the sowing technique. Despite the Italian machinery manufacturers have worked to enter the market for decades Turkey (demonstrative trials by farmers in bringing the machine to the garden Turkey) have not been successful due to the lack of appropriate equipment.

In this study, hazelnut harvesting machines having different collecting units designed and manufactured in order to reduce the harvest expenses and labor force requirement, which have an important place in hazelnut production cost, were examined.

RESULTS

— Trailer type pneumatic nuts collection machines

Trailer type pneumatic nuts collection machine consists of 5 main units as aspirator, separator, unloader, suction mouth and transmission hose. This type of machine takes the movement of a diesel engine mounted on the tail shaft by a shaft or on a belt-pulley system. The general view of the pneumatic nuts harvesting machines is given in Figure 1.

As can be seen from Figure 1, the nuts, leaves, small branches, stones and powders collected by the suction pipe from the ground come to passive separators. As the mixture discharged from the separator passes through the air stream created by the

fan, leaves and other light materials are removed. The remaining hazelnut is separated from the foreign material by the large-hole rotary sieve and the small-hole sieve. The cleaned nuts pass through the air conveyor fed by the radial ventilator and are bagged in here.

Figure1 - General view of trailer type pneumatic nuts collection machines

It is reported that in the previous studies, the product work performance changed according to the yield of the garden, and as the garden productivity increased, the work performance of the machine increased. In addition, it has been determined that the production of fruit gatherers improves the product performance significantly and reduces the labor requirement (Biondi et al, 1992). According to the productivity of the garden, the product work performance was between 14.95-38.21 kg/Ewh (Ewh=Employee working hour), the harvesting efficiency was between 92.43 % and 95.13 % and the field work success was between 0.428-0.352 ha/MLh (MLh=Machines labor hour) non-collecting the hazelnuts by hand and moving the delivery hose by hand has been reported (Beyhan M., 1992). Again, Sauk (2016) reported that under naturel spillage and in five different garden yield conditions, the product work success, collecting efficiency and the area of work success were between 18.90-67.18 kg/h, 97.68% and 99.36% and (in the case of harvesting the hand- from floor) 0.014 to 0.009 ha/MLh respectively.

— Movable type pneumatic nuts collection machines

The movable type pneumatic picking machines are pulled by the tractor according to the movement transmission system (Figure 2) and are divided into two groups as a self-propelled and trailer type (Figure 3).

Figure 2 - General view of trailer type pneumatic nuts collection machines

As seen in Figure 2, this type of machine takes its movement from the pto shaft of the tractor. Unlike non movable trailer type pneumatic hazelnut collection machines, sweeping units are added to the suction mouths of these machines. This unit is sweeping into the pre-barrel nipple suction tube.

Figure 3 - General view of self-propelled type pneumatic nuts collection machines

As can be seen in Figure 3, the nuts that are naturally poured into the garden floor are turned into barrels by the sweeping unit and delivered to the machine by suction hose. Monarca et al. (2009) obtained product work performance, work force requirement and field work performance values of different types of hazelnut harvesters in different gardening conditions as in Table 2.

This type of machine is absorbed into the leaf, small stone, soil and coarse dust machine with the grain + ground nut from the ground of the garden, spreading a lot of dust which can be harmful to workers' health and environment. For this purpose, dust emission is

reduced by using filters made of cyclone and napkin in type machines.

Table 1. Some work parameters of hazelnut harvesters in different gardening conditions (Monarca et al, 2009)

Garden yield (t/ha)		Unit	Trailer type	Self-propelled
3.7	Product work performance	(kg/h)	880	985
	Labor requirement	(h/ha)	4.21	3.76
	Field work performance	(ha/h)	0.24	0.27
1.8	Product work performance	(kg/h)	627	980
	Labor requirement	(h/ha)	3.03	2.04
	Field work performance	(ha/h)	0.33	0.49

— Mechanical Hazelnut Picking Machine

These types of machines with mechanical collection system consist of four main units: collection unit, separation system, and storage and power supply-hiking system. The general appearance of mechanically effective nuts harvesting machines is given in figure 4.

Figure 4. - The general appearance of mechanically effective hazelnuts machines

As can be seen from Figure 4, these machines are generally large in size and are widely used in modern gardens in the USA and France. Collecting machines which can be used in small gardens and can be mounted on garden tractors at 10-16 HP have also been developed

First, the machine's collection unit, developed by Peterson and Monroe (1977), consists of a drum with spirally placed rubber fingers. With this machine, 91% collection efficiency was achieved at 1.21 km/h speed and 70.2 min-1 rotation speed of collection drum, and field work performance was between 0.1-0.14 ha/h.

Later on, Ghiotti (1989) developed a prototype system based on the principle that the chains of chains attached to a drum rotating in the opposite direction of motion hit the fruit. In previous studies, Yıldız (2000) has designed a prototype nuts collection machine with a tractor-driven mechanical pick-up, and said that this machine consists of four main units: picking, spiral conveyor, launcher and conveying channel. The prototype nuts harvesters were taken in the experiment under different garden yields, feed speeds and number of different picking cycles. It determined that the collection efficiency was 91.66% and the product work performance was 100.29 kg/h when garden yield at 225 kg/da, 3.2 km/h feed speed and 430 min^{-1} rotation speed.

Fanigliulo and Tomasone (2009) have worked on different garden floors with a mechanically effective nuts collection machine that is mounted on trailers. In the study, the product work performance of the machine and the field work performance in the grassy field were determined as 2.5 t/h and 0.35 ha/h respectively. In the case of non-grass conditions same variables were measured as a 2.6 t/h and 0.38 ha/h respectively

Pagano et al. (2010) have determined that the machine has a field work performance of 0.64 ha/h, a product work performance of 1.25 t/h and a collection efficiency of 71% in order to determine the performance values of a mechanically effective hazelnut harvester developed for flat terrain

Sauk (2016) examined the possibilities of mechanical harvesting nuts grown in Turkey close to flat and flat land. Sauk tried a mechanically effective prototype nut harvesting machine under different gardening conditions. As a result of the work, the field work performance was found to be 0.158-0.102 ha/h and the product work performance was 124.83-1322.08 kg/h.

CONCLUSIONS

In countries that produce hazelnuts economically in international markets, mechanical harvesting methods have been developed according to the land topography, planting technique and the nature of the hazelnut variety. However, to meet a large part of world hazelnut production to be manually gather the nuts in Turkey is thought-provoking. In our country, the development of suitable mechanical harvesting methods for the planting technique and hazelnut planting where land topography is appropriate will be important in terms of cost reduction. Thus, the reduction in the cost of harvest due to the degree of mechanization of the hazelnut harvest will increase our competitive power in international markets.

A hazelnut harvester should be designed with high efficiency and sweeping efficiency in an ergonomic principles direction that takes into consideration the user comfort and safety of work, with a mechanically effective sweeping system that can make hazelnut harvesting in plain and sloping terrains taking into account the conditions of our country.

Depending on factors such as distance between branches, branch height, branch angle etc. in existing hazelnut gardens, the basic

dimensions of the machine should be determined and these systems should be placed within this dimension. When such a hazelnut harvester is manufactured, the cost of harvesting and demand for hazelnut labor cost will be reduced, and on the other hand it will be economically and ergonomically beneficial, as the harvesting of hazelnuts will not damage the branches.

Thus, with the realization of gardening and manufacturing of a machine suitable for our hazelnut varieties, an important step will be taken to mechanize the hazelnut which is one of the most important problems in our country.

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USING SCADA SYSTEM FOR PROCESS CONTROL IN WATER INDUSTRY

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Abstract: In this paper, we explained the concepts of industrial engineering, the ecological aspect of water treatment and the systems for wastewater purification. The goal of introducing the automation of the process of processing and purifying water is to make as many functions of the technical process as possible in an economically acceptable manner. SCADA is a system for measuring, monitoring and controlling industrial systems in different fields. This paper presents the SCADA application in the control of technological processes in water treatment. The advantages of using the described SCADA application represented in this paper showed increasing the safety of employees, the accuracy of the water treatment process within the given parameters and the economy of the automated industrial water process.
Keywords: industrial engineering, water treatment process, SCADA, ecology

INTRODUCTION

The rapid increase in human activities and the industrial revolution have led to an increase in energy production and consumption of natural resources [13], [16]. At the same time, the increase in production levels and increased energy consumption significantly disturbs the ecological factor and the natural balance [1], [2]. Consumption of large quantities of natural resources creates enormous amounts of waste and pollution. New technologies often result in greater consumption of natural resources [2].

Industrial engineering explores the principles of design, organization and management of production processes and systems [13]. Industrial engineering finds a way to conduct analysis and to improve the segments of production activities or the production system as a whole, especially from the aspect of technical efficiency [16]. Industrial engineering finds application of modern methods and approaches for the purpose of planning and optimizing the process already at the stage of designing production systems [13], [16].

Environmental technology envirotech or greentech or cleantech is the application of environmental science and green chemistry to preserve the natural environment and resources [8], [14], [15], [16]. Sustainable engineering is a process of using energy and resources at a rate that does not endanger the natural environment [16]. Water is a necessary raw material in industrial production, energy, food industry, utility needs and all other production processes. The most demand for cleanliness of water is set by the food industry as well as utility systems for supplying citizens with drinking water [8], [16]. All of the raw water treatment processes are of great importance, solid suspended, organic and inorganic chemical components, bacteria and chemicals that give a bad taste and smell [8], [11], [14], [15]. Due to high raw water treatment costs, suitable technologies must be combined in the best way to strike a balance between price and water quality obtained.

SCADA (Supervisory Control And Data Acquisition) applications in industrial systems is the highest quality, but a costly solution. SCADA systems have wide application in the management and monitoring of the operation of industrial plants and equipment in telecommunications, energy, wastwater systems and other fields [3], [4]. SCADA represents a system for monitoring, monitoring, archiving and control of industrial systems with parameter display, with the availability and reliability of such a system at a high level [6], [7]. These systems include a wide range of equipment, subsystems and technical solutions that enable the collection and processing of process data, and responding in an adequate optimal way.

Process management can be automated or initiated by the operator. In the field of treatment, water can be used from simple monitoring of flow, pressure, residuals, to complex monitoring and control of technological processes of water disinfection [1], [2], [3].

MATERIAL AND METHODS

The paper presents an example of the application of the SCADA system used in water supply systems [3], [4], [6], [7]. For this purpose, the Wonderware InTouch software package can be used [18]. The most common relay system is built up through two SCADA configurations [10], [12]. The first application is introduced by PLCs (Programmable Logic Controllers), with a proposed TCP/IP (Transmission Control Protocol/Internet Protocol) protocol based communication connection [5], [9], [17]. This application uses a simple signaling and alarm system and simplifies process management through increased functionality and productivity.

On this application it is necessary to perform a clear signalization of the condition of the equipment as well as an alarm signal indicating when the process does not meet the nominal working conditions. The three components of the SCADA system are: multiple remote terminal units PLC master station and HMI (Human-Machine Interface) computer and communications infrastructure.

Master station refers to servers, to software for communicating with equipment, and to HMI software running on one or more computers in the control room. In smaller SCADA systems, the main station can be only one PC, while in larger SCADA systems, the main station can consist of multiple servers and distributed software applications. Depending on the chosen configuration, the communication infrastructure is selected. This involves the choice of signal levels for transmitting data from the encoder to PLCs as

well as linking the PLCs to the computer on which the SCADA is installed [9]. The signal communication link is based on the TCP/IP protocol [5], [17]. The application of SCADA system offers a number of advantages:

the existing installed equipment can be used to expand the production capacity,
the realized relay management scheme is retained, the security is increased because the centralization is reduced (one computer runs the entire process, and
in the event of a failure it stops completely all parts of the process) there is a group of users of the system trained to work with the Wonderware InTouch software package for SCADA system [6], [10], [12], [18].

The simplest configuration of the SCADA system is reduced to a system that consists of one-way switches, encoders, relays, etc. on the other hand, a PC that receives data through its acquisition card, processes them, forms information about the controlled process, and determines management actions. Simple structures include the configuration that is formed from one PLCs and PC with SCADA system.

With this SCADA system configuration, the introduction of a PLCs means the ability to monitor / manage one other process from one computer. PLC device is placed in the control room, in order to provide optimum operating conditions and receive information on the pressure, level and position of the valve on the input module. It is also possible to use PLCs with digital input and output module. InTouch is a software package that creates applications for SCADA systems.

For the purposes of this work, version 10.0 was used. Wonderware InTouch allows two trends to display the values of the defined variables: real-time and history data [10].

SCADA SYSTEM IN PLUMBING SYSTEMS

In cases where the water treatment plant is separated from the control center, it is possible that all signals related to the basic process parameters will be brought from the automation to the master PLCs with the touch screen operator panel and the control system connection. In this way, the user is enabled to inspect the status of water treatment and chlorination systems and there is the possibility of changing certain process parameters.

The remote touch screen panel are particularly practical in geographically diluted water systems is shown in Figure 1. The touch screen control panel is located on the front and has a sound indication of touch. Over a dozen screen displays provide an optimal view of all the information necessary for quality monitoring of the water treatment process, as well as a detailed system management procedure.

The control touch screen panels can be installed in the front door of the control electrical cabinets are shown in Figure 2. The characteristics of the touch screen panels are: remote control of all process parameters, remote control of the process of chlorination from the control room, data storage in the cloud or other way of storing and storing process parameters (flow, residual, valve position, amount of chlorine to be dosed, etc.), adjusting system parameters for process automation.

Figure 1. Remote control panel for process automation

Figure 2. PLC with electrical cabinet

Figure 3. Electrical cabinet with touch screen panels

The Figure 4 shows the workflow automatically monitored to control the operation of the filter fields. The flow meter signal reaches the PLCs at the command of the PLCs and the pump pumps and opens the electromagnetic valve. The picture shows whether the pump is working, whether the valve is open and how open is it, the flow rate on the flowmeter, the valve opening on the drain.

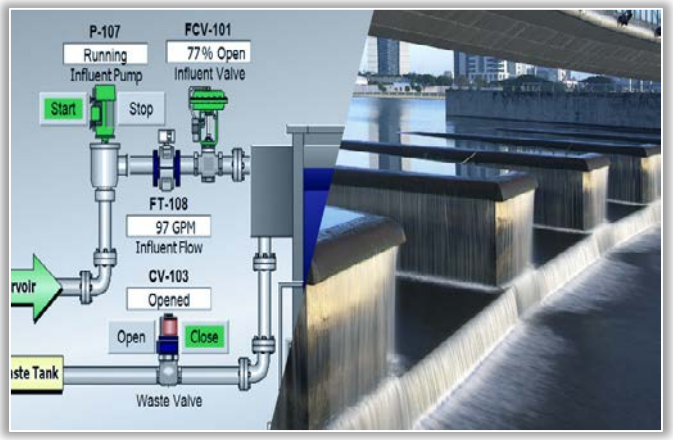

Figure 4. Monitoring the operation of the filter fields via the SCADA

The SCADA system involves a higher degree of automation of industrial processes used to collect data from sensors and instruments located at remote stations, to transmit and display data at a central station for the purpose of controlling or managing the process.

The collected data is viewed on one or more SCADA computers in the central control station. Analog signals that the SCADA system monitors are levels, temperatures, pressures, flux or gas flows and engine speeds. Digital signals controlled by the SCADA system are level switches, pressure switches, generator status, contact relay status, etc.

Data collection begins at PLCs level and includes reading of values and status of controlled parameters. Data that is stored and monitored can be stored in the history to show trends. The SCADA system implements a distributed database, called the tag database. Tag represents one input or output value that is monitored or controlled by the system. HMI is a device that processes process data to an operator and through which the operator controls the process.

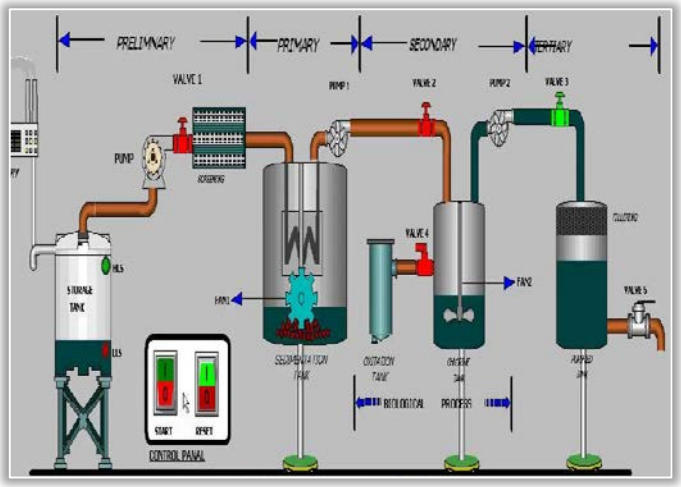

Figure 5. Water processing technology using SCADA

The graphical interface of the operator is a set of graphic displays that represent the representation of the equipment being watched. The Figure 5 shows the technological process of the primary, secondary and tertiary water treatment system with the equipment that the operator sees at the touch screens panel.

Bottles with chlorine and dosing device must be placed in a separate room (chlorine station) with forced ventilation, shower and drainage with sewage connection. On the outside of the chlorine station there is a cabinet and a switch to turn on the fan. In the room, a free chlorine indicator is connected to the alarm device (chlorine detector), which activates the neutralization system in the event of a chlorine expiration.

The floor in the chlorine station must be carried out with the fall towards the drainage in the drain. As sensors for signaling the leakage of gas chlorine from the bottle, special electrochemical probes that react to elevated chlorine concentration in the air are used, and the electronic device includes a chlorine neutralization plant from the air. Chlorine neutralization is done in two degrees. For smaller quantities of detected chlorine in the air, a chlorine bleeding fan is started.

The second phase involves the initial firing of the chlorine neutralization device from the air. The ejector within the device compulsorily inserts contaminated air through a filler that discharges with the neutralization fluid that is driven by the recirculation pump. In this forced circulation of polluted air and neutralizing fluid, the neutralization of chlorine from the air is carried out. This process lasts until the concentration of chlorine in the air drops below the given level.

All activities record the PLCs device and send it to the database server and auto-record. The PLCs enables data downloading and data storage in addition to data transfer. Water entering the city water supply network should be chlorinated continuously, in order to prevent secondary infections. The adjusted concentration is independent of the amount of water flow, because the system automatically maintains a constant concentration of active chlorine. Raw water is collected in wells. Well pumps water into the precipitator. In the precipitator, physical impurities are deposited and aeration is performed. Water meters are installed in the precipitator.

Measurement level meters are level ultrasonic or float system. When water is precipitated and reaches a certain level of water, the water is transferred to the filtration. From the filter fields, water is pumped into the reservoirs via filter pumps. Disinfection of water is carried out in the reservoirs and sent via the water supply system to consumers. Operation of well and filter pumps, water level measurement and automatic process control is performed by the PLCs controller. Everything is controlled and monitored by the operator in the control room of the water supply system. Special attention is paid if the parameters that deviate from the given parameters, then the system reports an error and sends the alarm signals.

In the plant and control room, signal lights and sirens have come down. All employees who have the authorization to monitor and control the value of SMS messages on mobile devices. A part of the automatic system for controlling water parameters is a PLCs device with a touch screen where the parameters of operation are

monitored. The most important parameters whose measurement is monitored in the on-line mode are: chlorine in water, humidity, temperature, pH value, flow, chlorine in the air, pump operation and chlorine neutralization system as shown in the Figure 6.

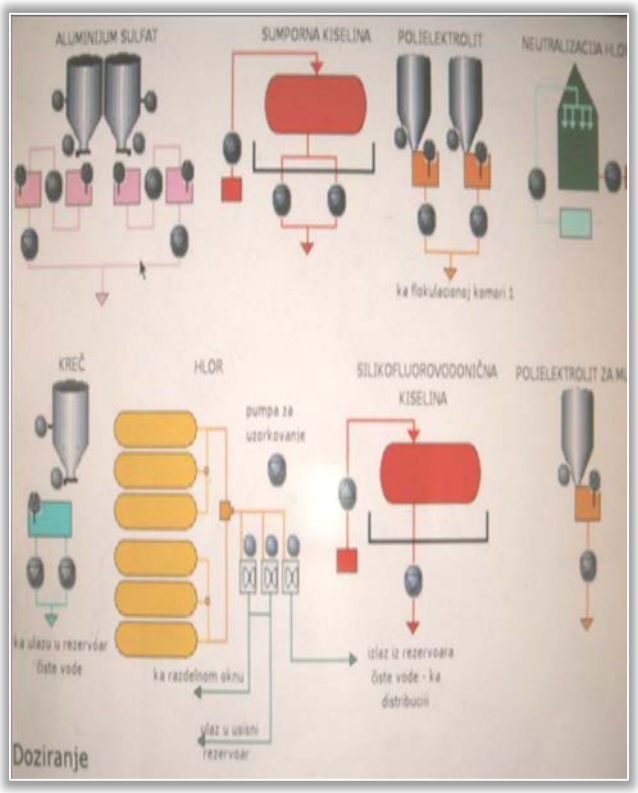

Figure 6. Technological process of water treatment using SCADA

Chlorine is dosed with a vacuum system in the reservoir [8]. In the reservoir, after dosing and disinfection of the chlorine volume measurement probe in the residual value, it sends the signal to a 4-20mA PLCs controller that opens /closes the electromotor valve on the chlorine bottles. The dosing is done by the flow of water by programming the chlorine dosing to the PLCs by the openness of the electromotor valve. According to the standards it is desirable for water to go to consumers with a concentration of chlorine in the residual 0,5 g / m3. Without the pump, the system could not function. Two pumps are always installed. One working and one spare. One of the screens of the PLC device provides information about their work. Which pump works, the number of hours of operation, the number of turns.

In the context of increasing efficiency and safety, a chlorine-producing device is produced and it is brought into the water network, by the process of chlorine production by electrolysis of salt. The device consists of several components (electrode materials, relays, programmable logic controllers, power supplies, sensor elements, converters, cooling systems, heat exchangers, dosing devices, etc.). The production process is conditioned by the electrolysis of the saline solution as shown in Figure 7. The resulting sodium hypochlorite is subsequently dosed into the water network by the dosing system of the pump.

The advantages of using devices for obtaining active chlorine are: safe work for people and environment during production, reduced production costs, easy maintenance, improvement of water quality, reduced quantities of side products during disinfection, operation of the device does not depend on the purchase of special chemicals, the cheapest disinfectant.

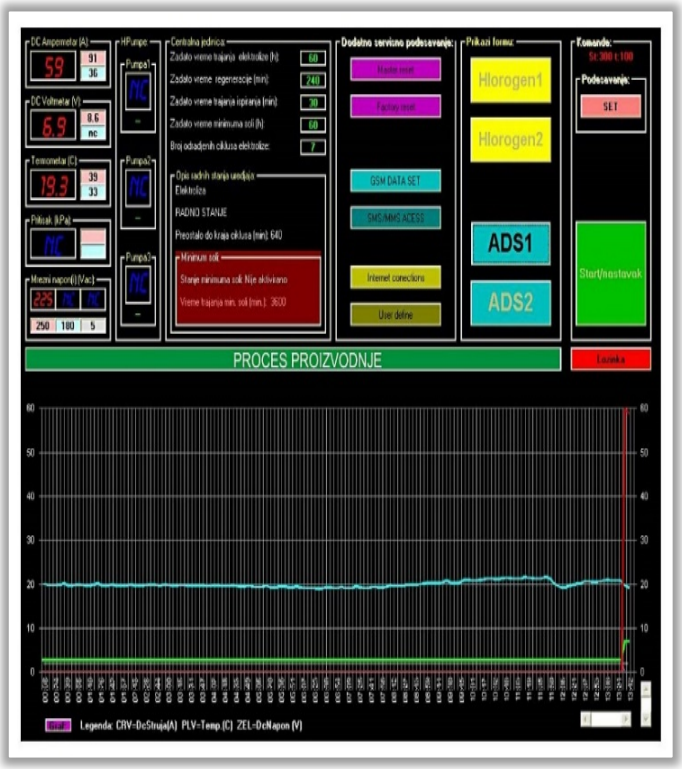

Figure 7. Process of chlorine production by electrolysis of salt

The communication system provides the transmission of information between remote stations and the dispatch center [5]. Distant stations are independent microprocessor devices that provide communication between measuring equipment, executive organs and central station.

Measurement equipment data is transmitted to the central station and from the central station the control commands are transferred to the executive bodies. The remote station monitors the status of the process equipment and signals the appropriate alarms.

Remote stations are programmable logic controllers that have application software, microprocessor and components to control the activation of a PLC device. PLCs are specialized computers whose operating system allows simple and real-time processing of a large number of data and send the obtained results to executives. Under a remote water supply facility, a well, a tank, a shaft, a water-tower are understood.

Wireless data transfer from peripheral stations to a central unit can be done using a radio, wi-fi or GPRS (General Packet Radio Service) connection [5]. For high-speed transmission, radio and wi-fi connections require special conditions, primarily optical visibility. The new way of connecting is realized today by GPRS connections that do not need to invest in infrastructure, because they use existing communications, and data transfer using GPRS is fast, secure and accurate.

The GPRS service does not charge for the duration of the connection, but the amount of downloaded data. The Figure 8. shows the display of an electrical cabinet with a GPRS modem.

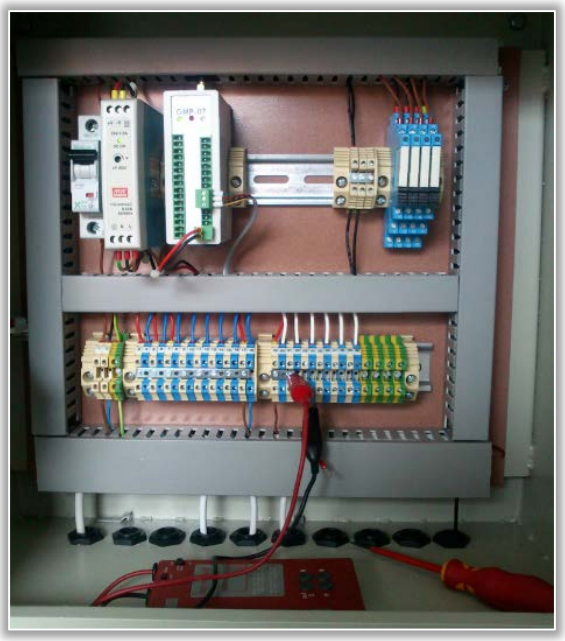

Figure 8. Electrical cabinet with a GPRS modem

RESULTS AND DISCUSSION

Remote monitoring and management systems are widely used in all industries. It is necessary that a communication link between the PLCs and one or more PCs is realized using a TCP /IP protocol and thus provides the possibility of remote monitoring and management from anywhere in the world. You need to know the IP address assigned to the controller and set up the communication server correctly.

Directions for further development of the application of SCADA systems in water supply systems are the creation of a unique dissemination center from which data on the status of all processes in the water supply will be available [6], [10], [12]. Contemporary data processing involves real-time data collection and storage, and information on each control process parameter can be obtained at any time from any location on the cloud storage. SCADA associated with automated processes enables the graphical display of data on the screen, along with numerical values, in a format suitable for the operator [6]. In addition to the graphical representation of the application's user interface, SCADA system also allows display of certain alarms if some of the parameters go outside of the specified range.

CONCLUSIONS

Benefits of automation through SCADA applications are: price-return of invested funds in the short term, significantly lower maintenance costs, smaller interventions and costs in revitalizing or reconstructing equipment and installations in water supply systems, simple expansion and replacement of system elements, higher safety because workers withdraw from potentially dangerous working conditions, rapid integration into existing parts of the system: databases and monitoring of resources and monitoring the activities of system users and operators. Application of SCADA application with GPRS data transfer is easier today because the coverage of the territory with the mobile network provides a centralized communication system [17]. Communication cost is minimal because only the amount of data transferred is charged. Communication is done only in groups that have secured access to data. The SCADA system that is installed can be expanded. Each location within the system must have a built-in GPRS modem, card and PC configuration. Each subsequent object to which the existing system is expanded should have its own modem and card, without new purchases on the side of the control computer. From all it can be concluded that the SCADA system can be upgraded and upgraded and there are no restrictions in the software model, but it is important to meet all hardware infrastructure conditions.

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AUTOMATION OF SCADA SYSTEM DEVELOPMENT

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Abstract: Rapid development of large-scale SCADA systems for industrial applications puts a lot of stress on developers. Each SCADA system consists of a large number of objects unnecessary for communication and data manipulation. Low efficiency and high rate of human made mistakes rise call for automated solutions. This paper introduces application of an Object Generator that automates a way of pre-processing and importing of basic objects to the SCADA system. The Object Generator differs from other solutions by direct communication using APIs in runtime. It works with the Siemens products WinCC as a representative of the SCADA system and the TIA Portal as an integrated platform for control system development. The authors discuss motivation (within the context of maritime applications) and describe advantages and disadvantages of the presented concept. The main advantage of the promoted application is a decrease of human-made-mistakes in the process of linking process data to internals of the SCADA system.
Keywords: SCADA, development, object, security, WinCC

INTRODUCTION

The global maritime security market was valued at USD 17.13 billion in 2017, and is expected to reach USD 25.75 billion by 2023, by witnessing a CAGR of 7.03% during the forecast period, 2018 to 2023. The global maritime safety market is segmented based on technologies and systems into screening and scanning, access control, detectors, geographic information system, surveillance and tracking, weather monitoring, SCADA, communication, and others [5]. During the last decades remote command and control has been made feasible due to the development of networking technology and the advent of Industrial Control Systems (ICS).

ICS are command and control networks and systems designed to support industrial processes. The largest subgroup of ICS is Supervisory Control and Data Acquisition (SCADA) systems [3]. SCADA systems, because of their high-level automation mechanisms and data interpretation capabilities, have managed to reduce waste of time and provide cost savings in logistics, maritime transport and control operations [4]. SCADA systems are routinely seen on ships. These are often referred there to as Distributed Control Systems (DCS), having similar functions to SCADA systems (the field data gathering or control units are usually located within a more confined area). Behind the SCADA concept there is a history of over 50 years of development: from the first idea of supervisor control of systems to the most complex data acquisition and supervisory control systems nowadays [13].

Protecting critical infrastructure from cyberattacks poses unique challenges. The environments can be harsh and systems often use specialized protocols including BACNet, DNP3, IEC-60870-5-104, IEC 60870-6 (ICCP), IEC 61850, MMS, Modbus, OPC, Profinet, S7 (Siemens) and many others that represent the industry's most extensive support of SCADA. After three generations of SCADA – standalone SCADA, distributed SCADA, and networked SCADA, the next phase in the evolution of SCADA and logical platform for an upgrade seems to be Internet of Things (IoT) which revolutionizes SCADA by offering standardisation and openness. Some applications can already be seen, e.g. for real-time water quality monitoring [12]. Interconnection of the networks of both information and cyber-physical systems utilising SCADA, computer-based and wireless systems, including the information, services, social and business functions, defines the cyber environment. Such an environment is not limited to ships' systems but extends to shore based activities of both the ships operators and the port' cities [1]. This paper introduces application of an Object Generator that automates a way of pre-processing and importing basic objects to the SCADA system.

The Object Generator differs from other solutions by direct communication using APIs in runtime. It works with the Siemens SCADA system WinCC (V7.4) and the TIA Portal as an integrated platform for control system development. The authors discuss motivation and describe advantages and disadvantages of the presented concept.

WINCC SCADA CONCEPT

SCADA systems are rather complex and need an entire set of information and communication technologies. These technologies are needed for communication with both lower and higher layers of the architecture. Programming of Programmable Logical Controllers (PLCs) and intelligent devices that take direct control over managed appliances and technologies represent lower layers; higher layers include Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES) that use data from SCADA to utilize management of resources and to improve workflow of the site.

Figure 1 illustrates a general scheme of the SCADA system. The key part of SCADA is a runtime engine that takes responsibility for processing of acquired data. Data originates from communication driver that communicates directly using protocols over physical buses, or it can use software interfaces (e.g. ODBC, or OPC). Data processed by runtime engine is stored in databases for manipulation and archiving purposes.

Nowadays, many companies also implement Application Programming Interfaces (APIs) into their solutions. These APIs make possible to not only import data on your own but also even manipulate with objects within SCADA system.

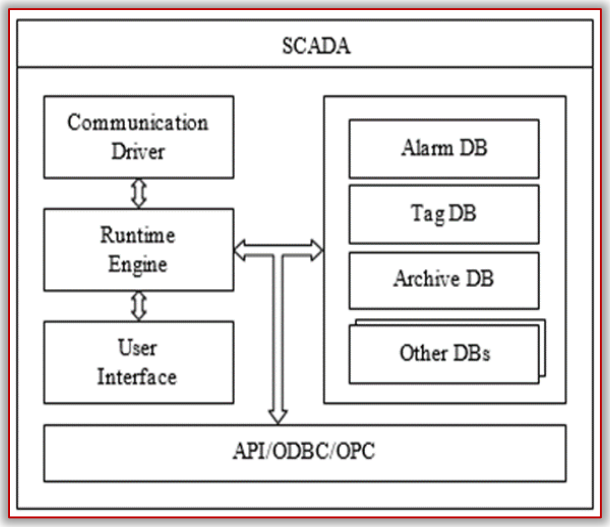

Figure 1. SCADA system internals

With the SCADA system SIMATIC WinCC V7.4, we get an innovative, scalable process-visualization system with numerous high-performance functions for monitoring automated processes, with complete functionality for all industries and features optimum openness.

WinCC consists of two key parts - Configuration Software (CS) and Runtime Software (RS) as depicted in Figure 2. CS takes responsibility for system settings and also provides the graphical interface for a user. On the other side, RS is invisible to the user but represents a key part of the whole system. RS communicates with low level appliances using protocols and application drivers and takes care of data acquisition and its proper manipulation. It also takes responsibility for dedicated databases that are used to store gathered data. Other support subsystems may depend on this system as well.

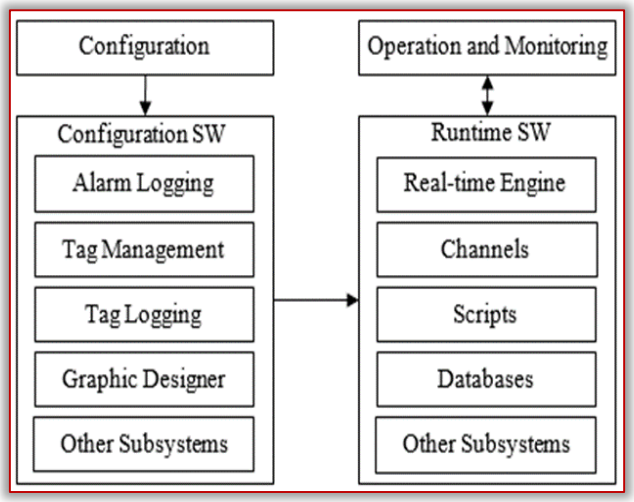

Figure 2. General WinCC Architecture

— Tag Management

Tag Management is a part of CS and takes charge of tag manipulation (adding, removing, modifying) and setting its attributes. The term tag is nothing else but the variable used to store acquired values from the process. One of the parameters held by the tag is an address, which is used to communicate with external PLCs or appliances, as shown in Figure 3.

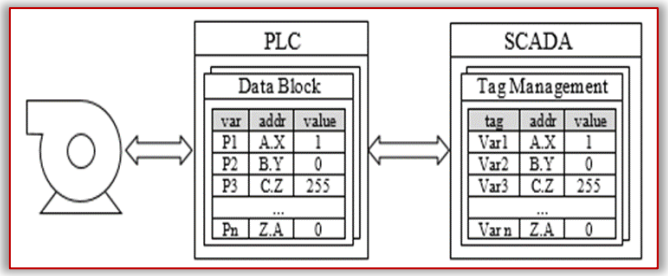

Figure 3. Communication between process control and SCADA

These addresses are points of our interest since developers of SCADA systems must manage them (add, edit, group, etc.) on their own. The number of tags results from technology size; for medium up to huge technological units it could be thousands. Considering this together with the fact that human developers make mistakes this is the main reason for automation.

— Alarm Logging

In order to capture any change of the monitored value, the Alarm Logging subsystem is used. Its primary objective is to help an operator with decision making process and to provide journal for later analysis. In some cases, acknowledgement of message is needed for the purpose of higher priority tasks. The alarms in working environment are generally organized in a table sorted by time, with the latest data found at the top. Alarms in WinCC are divided in two separate groups:

Bit messages – a message is triggered when a bit in tag is changed.
Analog messages – a message is triggered if limit values are exceeded (either over or bellow predefined boundaries). The value is gathered from the PLC in a defined period, and limits are set on the side of the SCADA system.

Figure 4 shows the example of an alarm table.

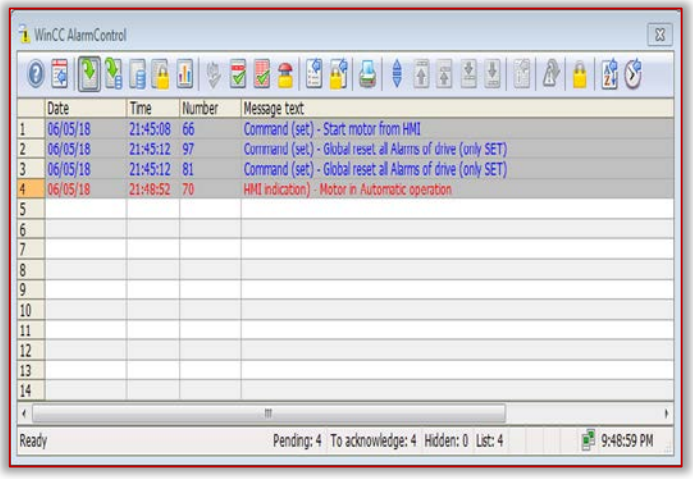

Figure 4. Alarm table example

— Tag Logging

Tag Logging is used for archiving the process value gathered and stored in a tag. Figure 5 shows architecture of Alarm and Tag logging and their relation with runtime software. The archiving subsystem consists of two separate groups – process and compression archives [8]. The former stores each value separately in the order it was read. This approach has some disadvantages related to memory space consumption. It is also essential to

emphasize the notable fact that the value of information decreases over time until it becomes negligible at some point in time. For this purpose, we can use the latter type of archive that uses mathematical and statistical functions to reduce size of useful data. The most used functions are mean, median or other functions (e.g. minimum, maximum, modus etc.).

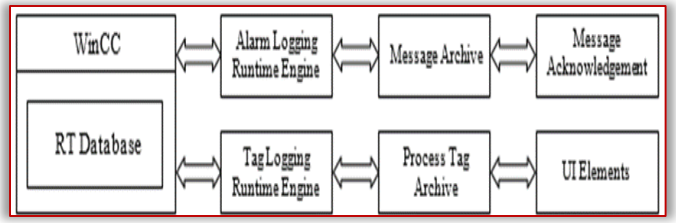

Figure 5. Alarm and Tag Logging architecture

— TIA PORTAL

Intensifying pressure on unification of fragmented development environments of Siemens Company converged to creation of an integrated platform called Totally Integrated Automation – TIA Portal [11]. In addition to programming of PLCs and Human Machine Interfaces (HMIs) in near future it will also be used for design of large scale SCADA applications.

Since the Object Generator works with PLC programs let us briefly discuss this aspect. The user defined program for PLCs is divided into blocks of the following types:

Organization Block (OB) – its main role is to create an interface between the operation system and the user defined program;
Function (FC) – the block without persistent storage, which means no results are stored from previous function call. It is used for encapsulation of routines;
Function Block (FB) – unlike FC, it has allocated memory used for sharing of results among calls, or between other blocks.
Data Block (DB) – it is used as persistent storage area for FB or in global context for all blocks;
System Function/System Function Block (SFC/SFB) – it groups the most used functions provided by the operation system of PLC.

— Data Blocks

A PLC uses data blocks (DBs) as the main part of communication with the SCADA system. The reason is that the process values are directly mapped in variables of data blocks. Data Blocks are divided into two main groups: global and instance ones. Global DBs are used to provide data persistency to all blocks (OB, FC, FB) and they are created by programmers themselves in required numbers.

The instance DB is created automatically at the moment when a new FB is created. Its structure (variables and attributes) is copied directly out of FB it is related to. Each variable of DB consists of:

Name – is used for the purpose of identification;
Data type – defines the size of the allocated memory and format of stored data;
Pre-defined value – is a starting value, in case of no initialization;
Offset – is a variable address restricted to the address space of DB. It is used for direct communication with upper layer systems, such as SCADA, HMI, ERP;
Comment – describes variable usage;
Retain – defines, if variable value should be backed-up in case of restart;
Others – there are other attributes to set, like Writable from OPC/HMI, Setpoint, Monitor value and many others.

— Interfaces description

Both, TIA Portal and WinCC, distribute their APIs as a standalone package, needed to be installed manually. When we talk about the TIA Portal, the API is called OPENNESS (Figure 6) and according to official documentation [7] it offers automation of engineering tasks related to PLC, HMI or project itself.

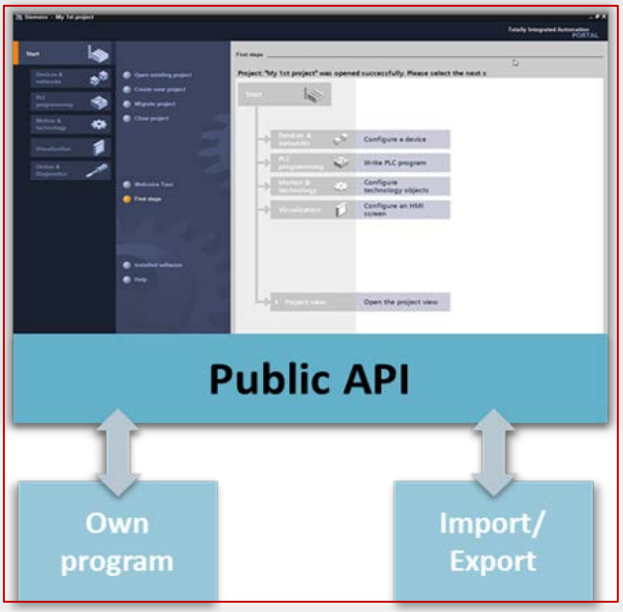

Figure 6. Engineering tasks automation using OPENNESS [10]

The current trend of application development under Windows platform focuses on usage of the C# language. The Siemens Company tries to keep pace with this trend and uses the C# as a language of choice in their TIA Portal application. Because of that, the API works only with the C# language and its implementation in user projects requires usage of Dynamic Linked Libraries (DLLs), which makes possible to interact with the API. Siemens also provides comprehensive documentation for this project.

On the other side, WinCC is developed in the C++ and is dated to 90's, which makes it much older than the TIA Portal. The API distributed for WinCC is called ODK, which stands for Open Development Kit and allows programmers to access data and functions of the WinCC configuration and the WinCC runtime system [9].

Mentioned facts about different languages of APIs make it rather difficult to develop user applications under one programming language. The key reasons are:

C++ does not offer automatic memory management and code written in it is also referred as unmanaged or native;
C# has built in Garbage Collector that takes care of memory handling. We refer to code written in C# as a managed code. Another important C# feature is Common Language Runtime (CLR) execution environment that allows language interoperability [6].

To overcome these differences between languages the authors were forced to use wrappers for C++ (Figure 7).

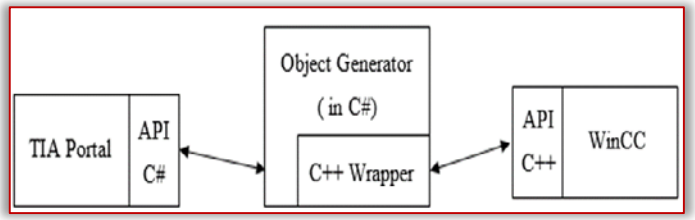

Figure 7. Usage of C++ Wrapper

REALIZATION OF OBJECT GENERATOR

The whole application is written in C#, which makes it easier to communicate with OPENNESS. On the other side we were facing complications referred in Chapter 3.2.

The realization took two steps [2]. The first step was to connect to the TIA Portal and gather all needed information about the project (Device list, Project structure, DB list and FB list). The second step was based on connection to WinCC and automated import of processed objects from the first step. Let us describe each stage of this development and realization.

— Connection to the TIA Portal

The graphical user interface of the Object Generator, shown in Figure 8, allows users to interact with the TIA Portal in several ways. We can open the 'clean' TIA Portal instance and connect to it, or we can manually list the project we want to open and then send it to the TIA Portal. These methods are related when a new instance of the TIA Portal is needed, but the situation changes when a user has already opened a project.

The Object Generator also treats this scenario and provides a simple way to list all available projects across all TIA Portal instances. When a user has chosen the right project to work with, another step consists in processing of gathered project data. The first step is to get all devices and their project structure; the result can be seen in Figure 9. These Data Blocks as mentioned before are not only used as a storage area within the PLC, but also for communication with the SCADA system. After a user chose devices and appropriate DBs he/she wants to work with, the processing initializes.

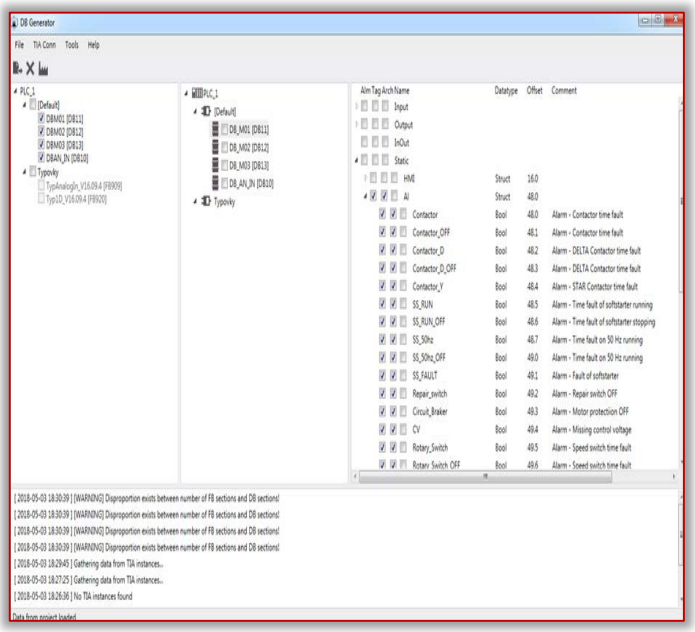

Figure 8. Graphical user interface of the Object Generator

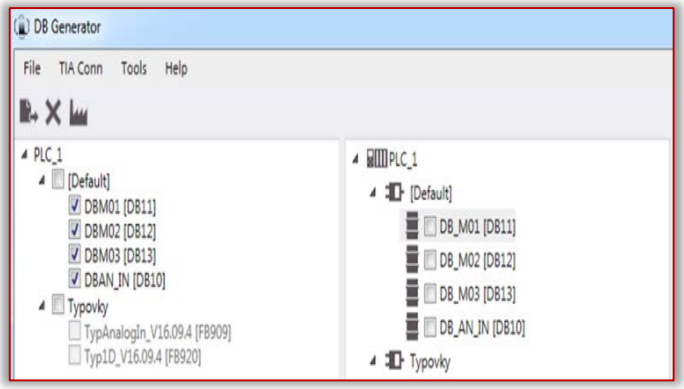

Figure 9. Devices and their blocks structure

In front of each variable there are three checkboxes that allow marking the variable as a tag, alarmed variable or archiving. Once the user checks all wanted variables, the last thing he/she must do is to set attributes for WinCC project.

The only possible way to interchange data with OPENNESS is by using XML structures. Therefore, processing is based on XML parsing and manipulation which extracts attributes such as names of variables within DB, for each variable its datatype, address and comment. Afterwards, the whole structure is presented to user in the form of a tree view (Figure 10).

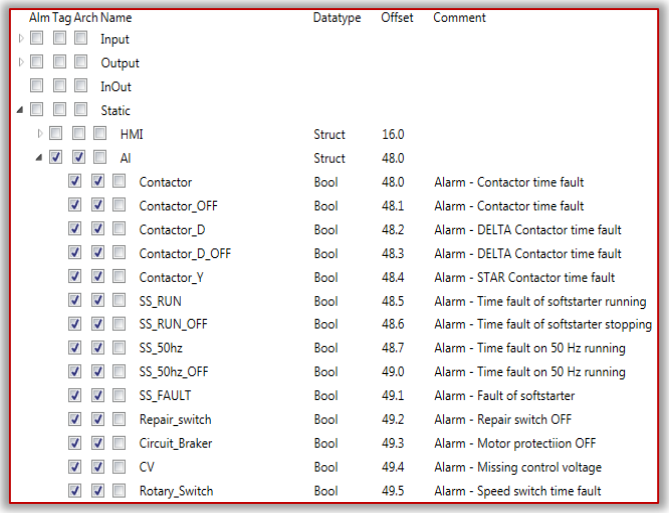

Figure 10. Tree view of variables and option boxes

— Connection to WinCC

In order to initialize import of tags to WinCC user needs to set several options. The first one is the path to WinCC project and in case of archived tags the interval of acquisition. For this purpose, the Object Generator provides a simple dialog window, shown in Figure 11.

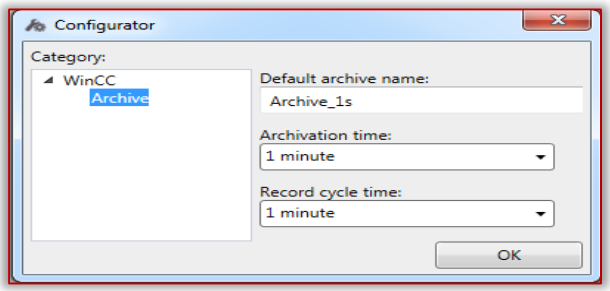

Figure 11. Configuration utility windows

— Other features

The Object Generator also provides a simple way of how to save all processed data and changes in the form of the XML file. The big advantage of this approach can be found in advanced possibilities for a skilled developer. In case of some minor changes in the PLC project, the SCADA developer could manually edit the configuration file with no need to get through mentioned procedures.

During ordinary operation of the Object Generator, many events and actions happen. To keep track of what was done and for case of troubleshooting the logger is available. User can find it at the bottom of the application window (see bottom of Figure 8).

CONCLUSION

The main advantage of the promoted application is a decrease of human-made-mistakes in the process of linking process data to internals of the SCADA system. This also enables reduction of errors, which could potentially be abused and exploited for a cyber-attack. Another benefit results from runtime import and export of raw data without any need to manually handle some arbitrary spreadsheet files. The saving feature helps a user to backup and save unfinished work for later.

The chance for improvements could be found in optimizing time consuming tasks such as XML processing and rendering of processed data. The whole architecture could also be refined and re-factorized with better feel for object-oriented design; using of design patterns, unit tests and better documentation within code.

Despite these potential future improvements, mentioned drawbacks and pitfalls made during development of this application offers great help to SCADA developers and let doors opened for further improvements.

Acknowledgments

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INVESTIGATION OF ENDOCRINOLOGIST AND PATIENTS OPINION ABOUT EFFICIENCY AND SAFETY OF DIABETES MELLITUS TYPE 2 TREATMENT

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Abstract: The high prevalence of diabetes has taken alarming dimensions in the world; this epidemic is in constant progression especially the type 2 diabetes which represents 95% of diabetic patients. In Algeria, Diabetes occupies the fourth place in chronic noncommunicable diseases, and poses a veritable public health problem due to its prevalence and its chronic complications. The aim of this work is; to investigate the epidemiology and to develop practical recommendations for healthcare professionals to increase efficiency and safety of diabetes treatment. For this, a survey was conducted in Annaba region, which is considered as one of the biggest urban centers of Algeria. The number of surveyed patients was 50; whereas the number of endocrinologist was 25. The obtained results show a disbalance in doctor's and patient's beliefs and evaluation criteria in diabetes type 2 treatments. Endocrinologists use the objective criteria measured in laboratory (HbAc level, fasting and post-prandial glucose level), and safety criteria (decrease of hypoglycemia). This criterion was marked as main criteria for the effectiveness of diabetes type 2 treatment by 100%, 80%, 64% and 40% of endocrinologist respectively. Patients evaluate the efficiency of diabetes treatment by subjective criteria, as "I feel myself better", "I am more active". It is remarkable, that (55%) of patients evaluate the efficiency of diabetes treatment by low fasting glucose. Important factor for the patients "decrease of weight" is connected for 36% of patients with effectiveness of therapy. In contrast to this view, only 12% of surveyed endocrinologists evaluate the decrease of weight as therapy efficiency criteria. Only 24% of patients marked the HbAc level as effectiveness criteria, which show the misunderstanding by the patients the importance of this laboratory result. The obtained survey results enable to conclude that surveillance of patients is crucial for the improvement of diabetes control and prevention of diabetes complications.
Keywords: diabetes treatment, criteria, control and prevention

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases, which are characterized by hyperglycemia due to insulin secretion deficiency, insulin action defect or to both of these factors [Sekiou et al.,2018]. Chronic hyperglycemia is associated with development of continuous injury and functions damage of different organs (eyes, kidneys, neural system and cardiovascular system).

Diabetes mellitus, often simply referred to as diabetes, is a group of metabolic diseases in which a person has high blood sugar, either because the body does not produce enough insulin, or because cells do not respond to the insulin that is produced. This high blood sugar produces the classical symptoms of polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased hunger). There are two main types of diabetes: Type 1 diabetes (IDDM): referred to as insulin-dependent diabetes mellitus, and juvenile diabetes. results from the body's failure to produce insulin, and presently requires the person to inject insulin [7].

Type 2 diabetes NIDDM: results from insulin resistance, a condition in which cells fail to use insulin properly, sometimes combined with an absolute insulin deficiency. (Formerly referred to as non-insulin-dependent diabetes mellitus, and adult-onset diabetes.) [8-10]

Other forms of diabetes mellitus include congenital diabetes, which is due to genetic defects of insulin secretion, cystic fibrosis-related diabetes, steroid diabetes induced by high doses of glucocorticoids, and several forms of monogenic diabetes.

All forms of diabetes have been treatable since insulin became available in 1921, and type 2 diabetes may be controlled with medications. Both type 1 and 2 are chronic conditions that usually cannot be cured.

Diabetes without proper treatments can cause many complications. Acute complications include hypoglycemia, diabetic ketoacidosis, or nonketotic hyperosmolar coma. Serious long-term complications include cardiovascular disease, chronic renal failure, retinal damage. Adequate treatment of diabetes is thus important, as well as blood pressure control and lifestyle factors such as smoking cessation and maintaining a healthy body weight [14-17].

The high prevalence of diabetes has taken alarming dimensions in the world; this epidemic is in constant progression which concerns especially the type 2 diabetes which represents 95% of the diabetic patients.

Every 10 seconds in the world is dying 1 patient due to reasons, connected with diabetes mellitus. Each year 1.3 million people are diagnosed with type 2 diabetes. The rapid increase in new cases of type 2 diabetes in persons 30 to 39 years of age and in children and adolescents is of special concern. This epidemic of type 2 diabetes global and closely reflects the epidemic of overweight, obesity, metabolic syndrome, and sedentary lifestyle. An urgent need exists for an authoritative, practical algorithm for management of patients with type 2 diabetes mellitus that considers currently approved classes of medications and emphasizes safety and efficacy, while also considering secondary factors such as the cost of medications or the number of years of clinical experience with use of any specific drug.

EPIDEMIOLOGICAL SITUATION OF DIABETIS

— In the world

The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The prevalence of diabetes is higher in men than women, but there are more women

with diabetes than men. Moreover, the total number of affected people is expected to increase from 382 million in 2013 to 592 million in 2035 (Guariguata et *al.* 2014). The most important demographic change to diabetes prevalence across the world appears to be the increase in the proportion of people >65 years of age (CDC, 2010).

The following table (Table 1) shows the estimates of the expected diabetic population in the world, from: Wild et al., 2004

Table 1: Estimations of the expected number of diabetics worldwide

Region	2000	2030
Europe	33. 3	48
Middle East	15. 2	42. 6
Africa	07	18. 2
Americas	33	66. 8
Asia and Australia	82. 7	190. 5

— In Algeria

In Algeria, diabetes poses a real public health problem because of its prevalence and its chronic complications dominated by cardiovascular complications, diabetic foot, chronic renal failure and retinopathy. According to a survey of the National Institute of Public Health, diabetes occupies the fourth place in chronic noncommunicable diseases.

The Table 2 represents several studies and surveys conducted by the National Institute of Public Health, WHO and others.

Table 2. Surveys and prevalence of diabetes in Algeria

Survey	Results
In 1992, during a survey of 1,302 families	In ORAN, the overall prevalence of diabetes was 2.17%.
In 1994, during his thesis in epidemiology, A Houti	In the region of Oran a prevalence of 6.8% among those aged 30 to 64 years
In 2002, among the Tuaregs of southern Algeria	The prevalence was 0.7% for IDDM; in 2003, the prevalence of NIDDM was 1.3%.
The incidence before age 15 is increasing	In the region of Constantine, the incidence goes from 9.1 in 1997 to 12.3 / 100000 in 2002.
Before the 2000s,	Surveys in the east and west of the country showed a prevalence of type 2 diabetes in the range of 6.4 to 8.2% in those aged 30 to 64 years.
The WHO-STEPS study conducted in 2003: prevalence with age.	In 2 pilot wilayas (Setif and Mostaganem) in subjects 25 to 64 years in both regions showed a prevalence of 4.9% per decade, 4.8%, 7.9% and 8% respectively.
The National Health Survey Algeria, TAHINA	Reports a prevalence of: • The average blood glucose is 0.92g / l (DNS according to sex, middle). • 85.41% normal blood glucose, 5.30% moderate fasting hyperglycemia and 9.29% hyperglycemia. • Hyperglycemia is more frequent in the 60-70 age groups, in urban areas and in the highlands. • The frequency of diabetes detected is 3.50% (DNS sex and environment), frequently detected in 60-70 years old and in tell.
	• The prevalence of diabetes is 12.29% (DNS sex), prevalent among people aged 65 to 70, in urban areas and in the highlands.
A study carried out in 2006,	In Sidi Belabbes noted a prevalence of 10.5%.
According to the records of type 1 diabetes, among young people under 15,	The incidence in Constantine in 2010 was 17.44 / 100,000 and in Oran in 2011 of 26/100 000 and in Algiers from 22.8 / 100,000 children.
A study conducted in 2012 in the Wilaya of Mila and presented in 2013,	Revealed that more than 14% of people diagnosed with diabetes are at risk for diabetes

According to the World Health Organization - Country Profiles for diabetes, 2016, the prevalence of diabetes and risk factors related thereto and shows in the following Table 3.

Table 3. Prevalence of diabetes and risk factors of diabetes in Algeria

	Men	Women	Total
Diabetes	10.2%	10.7%	10.5%
Overweight	53.9%	60.3%	57.1%
Obesity	18.0%	29.3%	23.6%
Insufficient physical activity	25.8%	39.4%	32.5%

Corresponding to data from the new International Diabetes Federation (IDF) 2017 report, "The Atlas of Diabetes", about 1.8 million people have diabetes in Algeria, with a national diabetes prevalence of 6.9 %. In detail, the statistical uncertainty margin for people with diabetes in Algeria is between 1.25 and 2.45 million, corresponding to a national prevalence rate between 4.9 and 9.5%. In neighbouring countries, approximately 1.65 million people are affected by diabetes in Morocco while 762,000 people are diabetic in Tunisia.

SUBJECTS

For the purposes of survey were pooled 25 endocrinologists and 50 patients with diabetes mellitus type 2 (not insulin-users), that were hospitalized in the endocrinology department of Annaba Regional Hospital Algeria". (March, 2017)

The questions concerning the criteria of efficiency of treatment and about the factors, that from the point of patient are the most important for the effectiveness of the treatment were in both questionnaires (for endocrinologists and patients) same. In the questionnaire for patients the questions and answers were adopted for better understanding by patients.

All of survey participants (endocrinologists and patients) were asked about their opinion (their experience) concerning evaluation of the efficiency of diabetes mellitus type 2 treatment.

METHODS

— Survey of endocrinologist concerning efficiency of diabetes mellitus type 2 treatment

The questionnaire for endocrinologists consists from 2 chapters (table 4). The chapter I included questions concerning demographic data, professional stage of the doctor. The chapter II included questions concerning the criteria of efficiency of the diabetes treatment as well as about the factors, that from the point of doctor are the most important for the effectiveness of the treatment (for example, to follow the dietary recommendations, regularly measure glucose and HbAc, take medication regularly,

visit endocrinologist regularly, use herbal medicines with hypoglycemic effect). Doctors were asked to fill the structured survey, choosing not more than 3 criteria from 8 listed.

Table 4: Questionnaire for endocrinologists

Sex
Professional experience, years
Which 3 factors indicate the effectiveness and safety of diabetes treatment?
Decrease of HbAc
Low fasting glucose
Low post-prandial glucose
Decrease of weight
Increase of weight
Patient has less hypoglycemia
Patient feels himself better
Patient is more active
Which 3 factors are most important for diabetes treatment to be effective?
To follow dietary recommendations
More physical activity
Right medication
To take medication regularly
To measure blood glucose regularly
To measure HbAc regularly
To visit endocrinologist regularly
To use herbal medicines with hypoglycemic effect

— Survey of patients with diabetes type 2 concerning efficiency of diabetes treatment

For conducting of patient survey also was developed a questionnaire. The questionnaire for patients included 2 chapters (Table 5). Chapter I included information concerning the demographic data, data about longitude of disease (how many years ago patient was diagnosed with diabetes), about the frequency of measurements of blood glucose and visits of endocrinologist. Patients were also asked if they follow the dietary recommendations. The chapter II included questions concerning the criteria of efficiency of the diabetes treatment as well as about the factors, that from the point of patient are the most important for the effectiveness of the treatment (for example, to follow the dietary recommendations, regularly measure glucose and HbAc, take medication regularly, visit endocrinologist regularly, use herbal medicines with hypoglycemic effect).

Table 5: Questionnaire for patients with diabetes

Sex
Age
Years since diabetes was diagnosed
Average amount of drugs taken
How many times a day do you measure blood glucose? 1. more often than 1 time a day 2. 1 time a day 3. 2-3 times a week 4. I don't remember
How often do you visit endocrinologist? 1. 1 time per month 2. 1 time per 2 months 3. 1 time per 6 months 4. I don't remember
Do you follow the dietary recommendations? 1. yes, regularly 2. yes, not regularly 3. no
Which 3 factors indicate the effectiveness and safety of your treatment?
Decrease of HbAc
Low fasting glucose
Low post-prandial glucose
Decrease of weight
Increase of weight
You have less hypoglycemia
You feel yourself better
You are more active
Which 3 factors are most important for your treatment to be effective?
To follow dietary recommendations
More physical activity
Right medication
To take medication regularly
To measure blood glucose regularly
To measure HbAc regularly
To visit endocrinologist regularly
To use herbal medicines with hypoglycemic effect

RESULTS

— Characteristics of surveyed endocrinologists

For the purpose of this work were surveyed 25 endocrinologists, between the surveyed specialists 64% were female (16 doctors) and 36% male (9 doctors). The average professional stage of the survey participants was 15 ± 7 years. The minimal stage of participant was 5 years and the maximal 31 years. The main characteristics of surveyed endocrinologists are presented in table 6.

Table 6: Characteristics of surveyed endocrinologists

Endocrinologists characteristics	Indicator	% from total amount
Sex		
Female	16	64
Male	9	36
Professional stage, years	15 ± 7	
Minimal professional stage, years	5	
Maximal professional stage, years	31	

— Characteristics of surveyed patients

The total number of surveyed patients was 50. The inclusion criteria were: diagnosis with diabetes mellitus type 2; use at least of 1 hypoglycemic medicine; not insulin-users; volunteering to take part in the survey.

The main characteristics of the surveyed patients are presented in the table 7. From all surveyed patients, 32 are male (64%) and 18 females (36%). The average age was 54 ± 8 years, the youngest respondent was 37 years old and the oldest – 65 years old. The average diabetes stage (the amount of years since diabetes was diagnosed) was 7 ± 4 years, the minimal stage was 2 years and the maximal stage was 18 years. From all surveyed patients 82% take more than one hypoglycemic drugs (41 respondents).

Table 7: Characteristics of surveyed patients

Patients characteristics	Indicator	% from total amount
Sex		
Female	18	36
Male	32	64
Average age, years	54 ± 8	
Minimal age, years	37	
Maximal age, years	65	
Years since diabetes was diagnosed	7 ± 4	
Minimal age, years	2	
Maximal age, years	18	
Patients, that take more than 1 drug	41	82
Total amount of patients surveyed	50	100

— Criteria of effectiveness of diabetes treatment (endocrinologists and patients perspectives)

Efficiency criteria indicate the effectiveness and safety of diabetes treatment for the patients and endocrinologists perspective

The results of the survey concerning the factors that indicate the effectiveness and safety of diabetes treatment for the patients and endocrinologists perspective is presented in Figure 1.

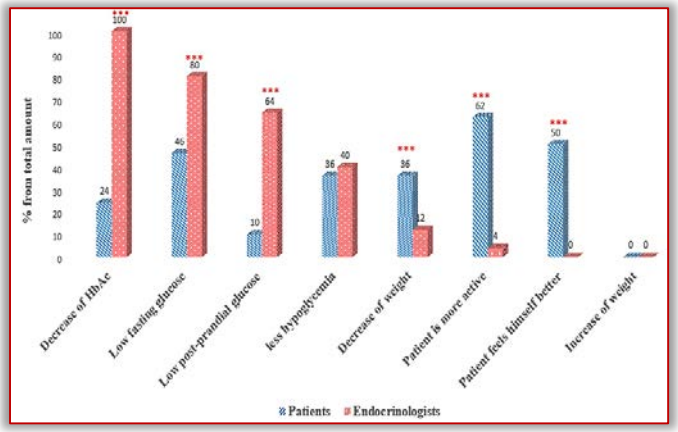

Figure 1: Criteria of diabetes treatment efficiency
* Significantly different from the values of endocrinologist's opinions compared to those of the patients at p<0.05.

The values are expressed as the percentage from the total amount of 25 endocrinologists and 50 patients concerning the efficiency criteria of diabetes treatment.

As show the results of the survey, all doctors marked the "decrease of the HbAc" as main criteria of effectiveness of diabetes treatment (25 participants, 100%), This criterion was noted only by 12 patients, that is around quarter from all of patients (24%). The laboratory criteria "Low fasting glucose" was marked as important criteria of effectiveness and obtained 2 places in 80% of doctors, and marked 46% of respondents (23 patients). Decrease of post-prandial glucose was marked as important effectiveness criteria by 16 respondents, that is more than a half of all surveyed specialists (64%), a minimal amount of points has got the criteria "Low post-prandial glucose", by patients only (5 patients 10%).

Safety aspect "Patient has less hypoglycemia" was mentioned by 10 endocrinologists (40%). and 18 patients (36%).

Other criterias, such as "decrease of weight" with 3 specialists (12%), and increase of physical activity of patient ("Patient is more active") marked 62% of respondents as main criteria for the effectiveness of the diabetes treatment (31 patients), and one specialists (4%). The subjective criteria "I feel myself better" was marked by 50% of surveyed patients indicate as the effectiveness criteria of the diabetes treatment (25 patients). It is important to admit, that criterias "Increase of weight" that is not specific for patients diabetes type 2 were not mentioned by surveyed specialists and none of patients indicated "Increase of weight" as efficiency criteria.

Factors that are most important for the effectiveness of diabetes treatment for the patients and endocrinologists perspective

The results of survey concerning the factors, that are most important for the effectiveness of diabetes treatment, are presented in the Figure 2.

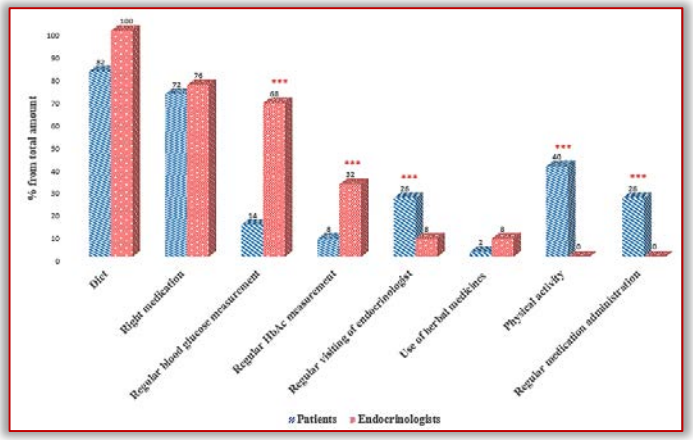

Figure 2: factors that are important for efficiency of diabetes treatment
* Significantly different from the values of endocrinologist's opinions compared to those of the patients at p<0.05

The values are expressed as the percentage from the total amount of 25 endocrinologists and 50 patients concerning the factors that are most important for the effectiveness of diabetes treatment

As show the results of the survey, the following of the dietary recommendations was marked by all specialists as the most important factor for the effectiveness of diabetes treatment (25 doctors,100%), 82% of respondents (41 patients) marked this factor as important for the effectiveness of diabetes treatment

It was remarkable, that 19 endocrinologists (76%), and 36 patients (72%) marked "Appropriate medication" necessary to ensure desired clinical result.

17 of the surveyed endocrinologists, that is three quarters of all respondents (68%) noted "Regular blood glucose measurement" and 8 specialists (32%) marked "Regular HbAc measurement" necessary for fulfillment for good diabetes control. Patients show low compliance to "Regular blood glucose measurement" (7 patients, 14%) and "Regular HbAc measurement" (4 patients, 8%).

Factors "Regular visiting of endocrinologist" and "Use of herbal medicines with hypoglycemic effect" were marked only by 2 specialists (8%), that shows that doctors support the opinion about high importance of the self-management of diabetes by patients. Also, doctors show low compliance to use of herbal medicines with hypoglycemic effect. 21 of the surveyed patients, that is almost a half of all respondents (42%) noted "Use of herbal medicines with hypoglycemic effect" as important factor for the efficiency of the

diabetes treatment. 20 respondents (40%) marked "Physical activity" necessary for fulfillment for good diabetes control. On the other hand the regular use of medication is not seen by the patients as important.

— Diabetes control and recommendations fulfillment by patients with diabetes

Blood glucose measurements

The results of survey concerning the frequency of blood glucose measurements that is important for the effectiveness of diabetes treatment, are presented in the Figure 3.

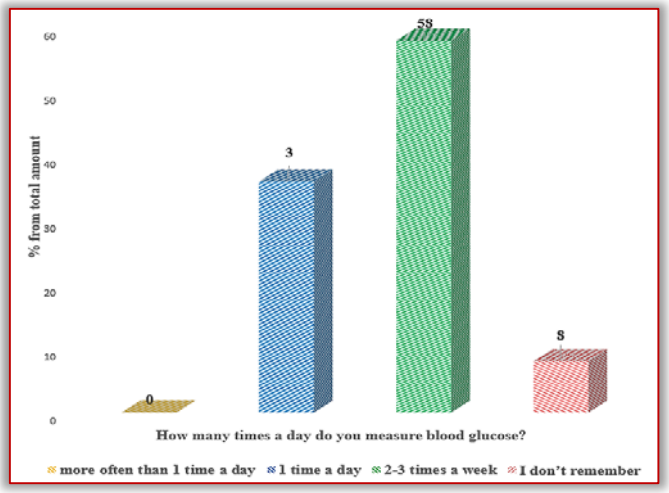

Figure 3: Frequency of blood glucose measurements

The values are expressed as the percentage from the total amount of 50 patients concerning frequency of blood glucose measurements.

As show the results of the survey, about frequency of blood glucose measurements none of patients marked "more ofter than 1 time per day" (0%, 0 patients). 18 patients answered, that they make it "1 time a day" (36%). The biggest part of respondents marked the frequency of blood glucose measurements as "2-3 times a week" (29 patients). And only 4 answered "I don't remember" (8% of surveyed patients).

Endocrinologist visits

The results of survey concerning the frequency of endocrinologist visits that is important for the effectiveness of diabetes treatment, are presented in the Figure 4

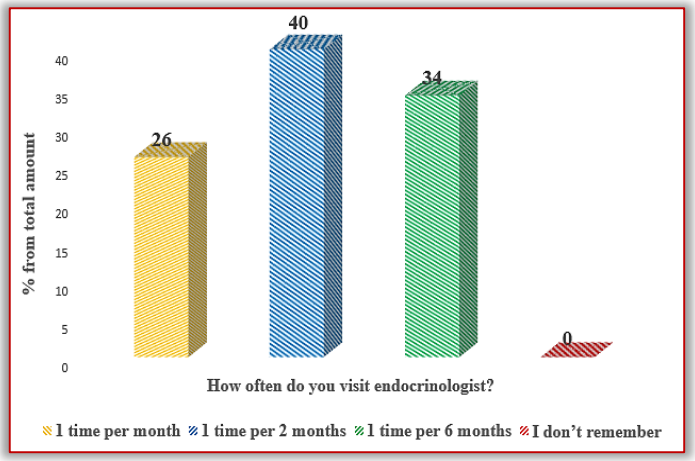

Figure 4: Frequency of endocrinologist visits

The values are expressed as the percentage from the total amount of 50 patients concerning the frequency of endocrinologist visits.

The results of the survey, concerning the question about frequency of endocrinologist visits, show that 26% of respondents marked "1 time per month" (13 patients). Other 20 patients (40%) marked that they visit endocrinologist "1 time per 2 months". One-third of surveyed patients (17 respondents, 34%) have consultation by the specialist "1 time per 6 months".

Follow the dietary recommendations

The results of survey concerning the following of the dietary recommendations that is important for the effectiveness of diabetes treatment, are presented in the Figure 5.

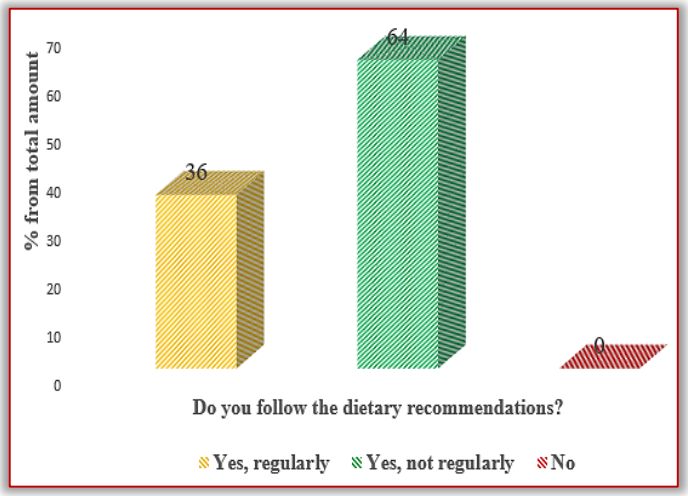

Figure 5: Frequency of follow the dietary recommendations

The values are expressed as the percentage from the total amount of 50 patients concerning the following of the dietary recommendations.

According to the survey results, 36% of respondents follow the dietary recommendations (18 patients). The biggest part (64%) estimate adherence to the dietary recommendations as "unregular" (32 patients). And none of them answered, that they do not follow the dietary recommendations.

DISCUSSION

The survey results highlighted the disbalance in doctor's and patient's beliefs and evaluation criteria in the diabetes type 2 treatment. As representatives of the traditional medicine, for the evaluation of the diabetes treatment result doctors use the objective instrumental data, such as HbAc level, fasting and post-prandial glucose. It resembles the international guidelines. This criterion was marked as main criteria for the effectiveness of the diabetes type 2 treatment by 100%, 80% and 64% of endocrinologist respectively. As soon as according to the UK Prospective Diabetes Study study decrease of the HbAc level to 1% is associated with decrease of the cardiovascular risk, stroke risk and with significant lower development of the microvascular complications that ensures higher quality if patient's life.

According to the international guidelines (EASD, European Association for study of diabetes, ADA, American Diabetic Association) the essential elements of the diabetes control include the change of the life style (following of the dietary it is remarkable, that surveyed doctors showed high adherence to the international

guidelines also in the aspect of the post-prandial glucose control. It was proven in many studies that exactly the post-prandial glucose is for 60% responsible for the HbAc level. On the other hand, exactly this indicator is very difficult to control by in- and outpatients.

The safety aspects of the diabetes treatment, as amount of hypoglycemia was mentioned by 40% of surveyed specialists, that shows understanding of the role of the hypoglycemia in the development of micro- and macrovascular risk. It was proven in several studies (such as the Diabetes Control and Complications Trial DCCT and UKPDS) that exactly variations of the glucose level are more harmful than the hyperglycemia itself. That's why several approaches to the diabetes type 2 control describe the criteria for the diabetes control in elderly care higher than in adult's diabetes treatment.

It is remarkable, that patients although having some diabetes stage (the average time since diabetes was diagnosed was 7 ± 4 years) showed very low adherence to the objective efficiency criteria.

By the evaluation of the efficiency of the diabetes treatment patients were usually guided by the subjective criteria, such as "better self-feeling" and "increase of the physical activity" that were marked by 62% and 50% of patients respectively. The good tendency was showed by the patients in understanding of the role of the fasting glucose, it was marked by 46% of patients as diagnostic criteria. It is worth to mention, that hypoglycemia is problem for 36% of patients that mentioned it as efficiency criteria for the diabetes type 2 treatment.

The survey results enable to conclude, that only 24% from surveyed patients with diabetes type 2 understand the importance of the HbAc level for the evaluation of their treatment.

The survey results show the significant gap between the beliefs and understanding of the efficiency criteria for the diabetes type 2 treatment from endocrinologists and patient's perspectives. The misunderstanding between them enhance the decrease of the compliance of the patient, lower diabetes control and development of complications.

Regular exercise has been shown to improve blood glucose control, reduce cardiovascular risk factors, contribute to weight loss, and improve well-being. ADA technical reviews on exercise in patients with diabetes have summarized the value of exercise in the diabetes management plan. Regular exercise has been shown to improve blood glucose control, reduce cardiovascular risk factors, contribute to weight loss, and improve well-being. Identification of areas of concern will allow the design of an individualized physical activity plan that can minimize risk to the patient. All levels of physical activity, including leisure activities, recreational sports, and competitive professional performance, can be performed by people with diabetes who do not have complications and have good glycemic control.

It is essential for the diabetes treatment to ensure the regular control of blood glucose (1-2 times a day), regular measurement of HbAc (1 time per 3 months if patient has de-compensation or sub-compensation and 1 time per 6 months if patient has compensation).

The existing guidelines provide recommendations concerning the rational hypoglycemic medicines choice. But it is also evident, that compliance of patients to the treatment is decreasing with increase of medicines taken and with time. This means that to ensure the therapeutic result, it is necessary not only choose the appropriate medication, but ensure the regular administration of prescribed medicines.

It is necessary to note, that the use of herbal medicines is not included into the Guidelines of ADA and EASD, due to absence of evidence of their effectiveness.

The results of the survey show high adherence of endocrinologists to the International Guidelines. This was proven by obtained results of endocrinologist survey concerning the factors that are important for the effectiveness of diabetes type 2 treatment. All specialists marked following of the dietary recommendations (100%) essential for the effectiveness of diabetes treatment. It is notable, that patients also evaluated diet important (was marked by 82% of patients). On the other hand, according to the survey results, only 36% of patients follow the dietary recommendations regularly.

It is notable, that endocrinologists make bigger ascent on the choice of the appropriate medication (76%) and do not pay attention on the frequency of administration of prescribed medicines (this factor was not marked at all). It is worth to admit, that patients also put appropriate medication as the most important factor of the diabetes control (this factor was marked by 72% of patients). And understanding of role of regular medication administration was shown only by 26% of patients.

Endocrinologists also mark regular blood glucose and HbAc measurements as important factors for the diabetes treatment that was marked by 68% and 32% doctors respectively. From the patients' perspective, regular blood glucose measurement is evaluated very low (only 14% of patients) and HbAc measurement has got only 8% of points (only 4 patients marked this factor).

The survey results enable to conclude that patient show high adherence to the herbal medicines use. 42% of patients marked it as important factor of diabetes control. By the doctors, the use of herbal medicines with hypoglycemic effect is not seen important for patients with type 2 diabetes mellitus (only 8% of doctors marked this factor), that is resembles the principles of evidence-based medicine.

It is necessary to admit, that increase of physical activity is seen as important factor by 40% of patients, but between doctors nobody marked this factor.

The regular visiting of endocrinologist was marked as essential factor for the diabetes treatment by 8% of doctors and by 26% of patients that shows the overestimation of the role of the endocrinologist in the diabetes treatment.

According to actual guidelines, the best result can be achieved only by implementation of the model of active involvement of the patient into the diabetes treatment. It means, that educated and responsible patient can conduct self-management of the diabetes and be not dependent from the doctor.

The obtained survey results show, that only 36% of patients with diabetes mellitus type 2 measure blood glucose 1 time a day. More than a half of patients (58%) measure blood glucose 2-3 times a week. And 8% of patients do not even remember when they measured the blood glucose last time.

CONCLUSIONS

The presented survey enables to conclude, that endocrinologists and patients have different perspectives for evaluation of the effectiveness of the diabetes treatment. Endocrinologists usually use the objective criteria that are measured in laboratory (fasting and post-prandial glucose level, HbAc level) and safety criteria (decrease of the hypoglycemia). The subjective factors as for example self-feelings of patients, their physical activity are not estimated by the endocrinologists as efficiency criteria.

Patients usually evaluate the efficiency of the diabetes treatment by subjective criteria, as "I feel myself better", "I am more active". It is remarkable, that around half of the surveyed patients evaluate the efficiency of the diabetes treatment by the low fasting glucose (55%). Important factor for the patients "decrease of weight" is connected for 36% of patients with effectiveness of therapy. In contrast to this view, only 12% of surveyed endocrinologists evaluate the decrease of weight as therapy efficiency criteria.

The objective criteria HbAc level is evaluated as effectiveness criteria by all endocrinologists (100%) and only by 24% of patients that shows the misunderstanding by the patients the importance of this laboratory result.

For the treatment of diabetes mellitus type 2, the doctors' endocrinologists can use the theoretical approach that means the use of international and national Guidelines, clinical protocols, hospital protocols etc. Other approach is setting a background for the experimental approach, that means the use of self-experience and experience of competent collegues as guideline for development of strategy for diabetes mellitus treatment for each patient.

To provide the intensive and efficient treatment of DM type 2, it is necessary to involve recommendations and efficiency criteria that are known and used in the country. Provision of the effective diabetes treatment has positive effect not only on the health status of the individual patient. It results in the decrease of adverse effects, prevents complications that in the case of diabetic patients include diabetic foot, diabetic neuro- and encephalopathic, chronic renal failure, retinopathic. This complications cause patient's disability that has not only social effect, but also financial effect on the individual, city and state budget.

As all over the world recognized and evident efficiency criteria for the diabetes type 2 treatment are known the decrease of HbAc, provision of control of fasting glucose and post-prandial glucose. As safety aspect of the diabetes treatment is recognized decrease or absence of day and night hypoglycemia.

The change of patient's weight is recognized as supporting criteria of diabetes treatment, as soon as by long state of decompensation patients are losing weight. In this case increase of weight is a supporting efficiency criteria of diabetes treatment. In case of overweight patients, by the use of metformin decrease of weight will be also indicated as efficiency criteria (supporting criteria as soon as it is connected with the change of patient's life style. The patient's physical activity and self-feeling are not indicated as evident criteria of diabetes treatment efficiency, because they have subjective character and can not be measured.

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ALUMINIUM MATRIX COMPOSITES – AN OVERVIEW ON THE MATERIALS SUBSTITUTION AND EFFICIENT USE OF MATERIALS

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Abstract: Development of metal matrix composites has been an important innovation in materials engineering over the past decades. Metal matrix composites offer several attractive advantages over traditional engineering materials due to their superior properties. Therefore, the metal matrix composite become economical alternatives to the monolithic alloys due to their improved specific strength, stiffness and wear resistance combined with better physical properties such as low density and low coefficient of thermal expansion. Materials substitution significantly affects the trend toward more efficient use of monolithic materials. The increasing use of alternative materials in aircraft, automotive and construction applications has motivated the metal industry to provide lighter weight aluminium alloys and metal matrix composites. This paper presents an overview of aluminium matrix composite systems on aspects relating to processing of matrix from re–melted aluminium wastes.

Keywords: metal matrix composites, aluminium matrix, re–melted aluminium wastes

INTRODUCTORY NOTES

Metal matrix composites (MMCs), as the name suggests, consist of fibres or particles surrounded by a matrix of metal. The use of a metal matrix offers the potential of producing a composite with very high stiffness and strength as well as very high temperature resistance.

The aim involved in designing metal matrix composite materials is to combine the desirable attributes of metal and ceramics. The addition of high strength, high modulus refractory particles to a ductile metal matrix produce a material whose mechanical properties are intermediate between the matrix alloy and ceramic reinforcement. Metals have a useful combination of properties such as high strength, ductility and high temperature resistance but sometimes have low stiffness, whereas ceramics are stiff and strong though brittle.

Metal matrix composites (MMCs) comprise a relatively wide range of materials defined by the metal matrix, reinforcement type, and reinforcement geometry. In the area of the matrix, most metallic systems have been explored for use in metal matrix composites, including Aluminium (Al), Magnesium (Mg), Titan (Ti), Iron (Fe), Nickel (Ni), and Copper (Cu). Among metallic matrices, aluminium based matrix remains the most explored metal matrix material for the development of MMCs. This is primarily due to the broad spectrum of properties offered by aluminium-based matrix composites at low processing cost.

From a reinforcement perspective, the materials used are typically ceramics since they provide a very desirable combination of strength and relatively low density. Candidate reinforcement materials include SiC, Al_2O_3, B_4C, TiC, TiB_2, graphite, and a number of other ceramics. In addition, there has been work on metallic materials as reinforcements, notably Wolfram (W) and steel fibers.

Silicon Carbide (SiC) particle reinforced aluminium composites have received more commercial attention than other kinds of MMCs due to their high mechanical properties, wear resistance, low coefficient of thermal expansion and high thermal conductivity. They are remeltable and that can be produced by large quantities by the process analogue to that used for commercial aluminium alloys at cheap cost. Therefore they are more competitive on the MMC market and find wider application in industries.

The morphology of the reinforcement material is another variable of importance in metal matrix composites. The three major classes of reinforcement morphology are continuous fiber, chopped fiber or whisker, and particulate. Metal matrix composites can be classed as having either continuous or discontinuous fiber reinforcement. Discontinuous reinforced MMCs appear to offer more potential due to their ease of manufacture.

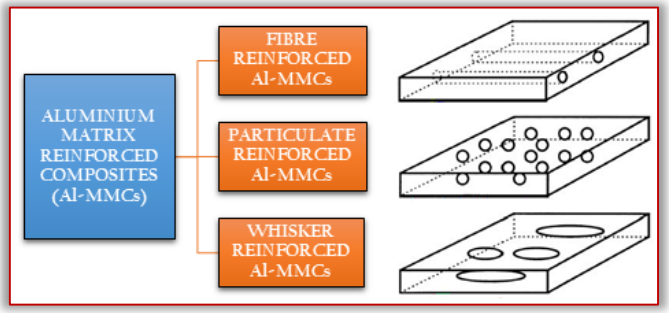

Figure 1. Types of aluminium-based matrix composites

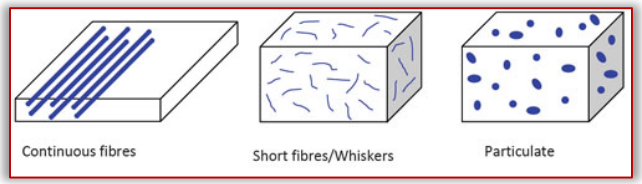

Figure 2. Types of reinforcements

Typically selection of the reinforcement morphology is determined by the desired property/cost combination. Generally, continuous fiber reinforced MMCs provide the highest properties in the direction of the fiber orientation but are the most expensive.

Chopped fiber and whisker reinforced materials can produce significant property improvements in the plane or direction of their orientation, at somewhat lower cost. Particulates provide a comparatively more moderate but isotropic increase in properties and are typically available at the lowest cost. Particle reinforcing in composites is a less effective means of strengthening than fiber reinforcement. The principal advantage of particle reinforced composites is their low cost and ease of production and forming.

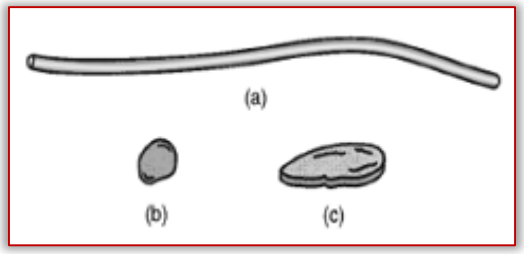

Figure 3. Possible shapes of the reinforced phases in a composite materials: long fiber (aligned continuous, aligned discontinuous, random), (b) particle (spherical, cubic or platelets), and (c) short fiber (whiskers) or flake

By adding to the three variables of metallic matrix, reinforcement material, and reinforcement morphology, the further options of reinforcement volume fraction, orientation, and matrix alloy composition and heat treatment, it is apparent that there is a very wide range of available material combinations and resultant properties.

Most of the studies worked on the specifics of the MMC systems and their components, their manufacturing processes, and their properties, not on the aspects on the materials substitution which significantly affects the trend toward more efficient use of monolithic materials. The technical difficulties associated with attaining a uniform distribution of reinforcement and good wettability between substances are the main research directions.

Combining high specific strength with good corrosion resistance, metal matrix composites (MMCs) are materials that are attractive for a large range of engineering applications. Given the factors of reinforcement type, form, and quantity, which can be varied, in addition to matrix characteristics, the composites have a huge potential for being tailored for particular applications. One factor that, to date, has restricted the widespread use of MMCs has been their relatively high cost. This is mostly related to the expensive processing techniques used currently to produce high quality composites.

ABOUT THE BEVERAGE CANS AND THEIR RECYCLING

Beverage cans today are among the lightest beverage packages. As metal is a permanent material, it has excellent environmental credentials. Drink cans (or beverage can) are often used for beer, cider and energy drinks.

Cans which have been used and discarded by consumers can also be reused, and as mentioned above, recycled material makes up a significant percentage of the aluminium used for beverage cans. The savings from recycling are quite significant to the industry. Beverage cans are fully and infinitely recyclable without loss of quality. Because they are infinitely recyclable, metals are a permanent resource.

Figure 4. Recycling aluminium beverage cans – concept

The raw material of the drink cans (or beverage can) is aluminium (75% of worldwide production). The aluminium base, for beverage cans consists mostly of aluminium, but it contains small amounts of other metals as well. These are typically 1% Magnesium, 1% Manganese, 0.4% Iron, 0.2% Silicon, and 0.15% Copper.

Figure 5. Aluminium beverage can

Aluminium is one of the most cost-effective materials to recycle. When recycled without other metals being mixed in, the can–lid combination is perfect for producing new stock for the main part of the can. The loss of magnesium during melting is made up for by the high magnesium content of the lid.

Figure 6. Beverage can lids

The lid is made of a slightly different alloy than the aluminium for the base and sides of the can. The flat lid must be stiffer and stronger than the base, so it is made of aluminium with more magnesium and less manganese than the rest of the can. This results in stronger metal, and the lid is considerably thicker than the walls.

ALUMINIUM PACKAGING SCRAP SOURCES

Worldwide production of aluminium beverage cans is steadily increasing, growing by several billion cans a year. In the face of this rising demand, the future of the beverage can seems to lie in designs that save money and materials.

Recycled aluminium has become an increasingly important component of metal supply for which effective and efficient technology is needed. The alloy compatibility of the components of the beverage can makes it uniquely suitable for the closed-loop recycling concept and is responsible for the consistently high value of used beverage cans.

Packaging, representing the second largest source of aluminium scrap at global level, deserves a key role in the transition towards the circular economy. The recycling rate of aluminium cans is higher than any other used packaging material. Different aluminium packaging scrap sources were considered:

— mixed packaging aluminium scrap, and
— used beverage can scrap.

Figure 7. Mixed packaging aluminium scrap

Figure 8. Collected used beverage can scrap

To further improve the performances of the aluminium beverage can sector towards circular economy implementation the key actions are:

— to reduce the weight of the lid,
— to develop methods to separate the body and lid at the point of collection, and
— to investigate the potentials of a closed supply chain loop for aluminium cans in terms of combined environmental and economic value creation.

Aluminium cans are recycled over and over again in a true "closed loop" recycling process. But they can typically "up-cycled" into products like MMCs matrix material. Reflecting an increased interest in eco-friendly products, particularly ones that are priced at an affordable level and proving profitable for the manufacturers, the up-cycling can be profitable in the case of MMCs matrix material too. Therefore, recycling of used aluminium beverage cans into MMCs matrix material – in terms of combined environmental and economic value creation – has been tried as a favourable aluminium product recycling method.

Figure 9. Aluminium cans recycling – concept

Up-cycling, also known as creative reuse, is the process of transforming by-products, waste materials, useless, or unwanted products into new materials or products of better quality or for better environmental value. The goal of up-cycling is to prevent wasting potentially useful materials by making use of existing ones. This reduces the consumption of new raw materials when creating new products.

Up-cycling is the opposite of down-cycling, which is the other half of the recycling process. Down-cycling involves converting materials and products into new materials of lesser quality. Most recycling involves converting or extracting useful materials from a product and creating a different product or material.

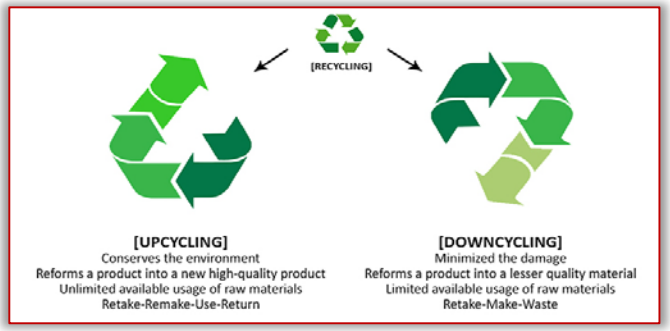

Figure 10. Up-cycling – concept

Aluminium cans are the most sustainable beverage package and are infinitely recyclable. As the most valuable package, aluminium cans are, by far, the most recycled beverage container. Empty cans have the highest economic value of all packaging materials and demand for secondary metal far exceeds the supply. Recycling is an essential part of metal packaging's life cycle. Overall, cans represent a perfect example of truly recyclable packaging and a product that fits a circular economy model very well.

Unlike the can recyclers, who are totally dedicated to a single product of aluminium alloys, automotive recyclers must deal with a number of different alloys with different destinations and relatively low values.

Under these circumstances, no extra purification steps would be required before the aluminium is recycled into high-performance products. This would allow development of new alloy options for potential direct use in new added values components.

CONCLUDING REMARKS

In recent years, the demands for light-weight structural materials with high specific strength to weight ratio and recyclability have increased dramatically in the automotive industry. Aluminium and its alloys are potential candidates to meet the above mentioned requirements.

Demand for lightweight materials in the automotive, aerospace, construction and other related industries has increased in recent years due to environmental concerns, government regulations and consumer demand. Lightweight metal alloys are the preferred choice of these industries due to their low density and high specific strength, as well as other attractive features such as corrosion resistance, dimensional stability, etc. Lightweight metal alloys are widely considered nowadays for their functionality and aesthetics.

As for reinforcement materials, research objectives for MMCs were mainly focused on continuous fiber reinforcement in the early stages MMCs development. However, because of the complex manufacturing process and the relatively high cost of fibrous MMCs, more and more studies have been focused on using discontinuous particles as a reinforcement. With a high melting point, high hardness, and thermal stability ceramic particles such as SiC, have been widely utilized as reinforcements.

With recent advances in the relevant manufacturing technologies, production of these tailor compound materials has become feasible at low cost.

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Note

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FIVE-LEVEL DTC CONTROL OF INDUCTION MACHINE DRIVE USING FUZZY LOGIC CONTROLLER FOR LOW TORQUE RIPPLE

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Abstract: This paper presents an improved five-level direct torque control (DTC) based on fuzzy logic. The major problem that usually associated with DTC drive is the high torque ripple. To overcome this problem a torque hysteresis band with variable amplitude is proposed based on fuzzy logic. The fuzzy proposed based on fuzzy logic. The fuzzy proposed controller is shown to be able to reduce the torque and flux ripples and to improve performance DTC, especially at low speed. The validity of the proposed methods is confirmed by the simulative results.
Keywords: Direct torque control, Induction machine, Five-level inverter, Fuzzy logic controller, Torque hysteresis

INTRODUCTION

In many industrial applications, direct torque control (DTC) of induction motor is well-known control method which provides fast dynamic réponse compared with other control methods like field oriented control (FOC). The DTC has been proposed for induction motor control in 1985 by Takahashi and similar idea that the name of direct self-control developed in 1988 by Depenbrock [1]. The DTC provides very quick response with simple control structure and hence, this technique is gaining popularity in industries. Though, DTC has high dynamic performance [2]. However the DTC technique presents the disadvantage of large flux and torque ripples [3].

Over the past years, the utilization of multilevel inverter topology in the DTC system has gained popularity or the medium and high voltage applications [4]. Commercially three basic multilevel converters are presented in the literature as diode-clamped converters cascade H-bridge converters and flying-capacitor converters [5].

The multilevel inverter fed electric machine systems are considered as a promising approach in achieving high power/high voltage ratings. Moreover, multilevel inverters have the advantages of overcoming voltage limit capability of semiconductor switches, and improving 2 harmonic profiles of output waveforms. The output voltage waveform approaches a sine wave, thus having practically no common-mode voltage and no voltage surge to the motor [6].

To sleeve the problem of DTC, various techniques have been proposed including the use of variable hysteresis bands, predictive control schemes, space vector modulation techniques and intelligent control methods [2].

This paper is devoted to fuzzy logic five-level direct torque control (FLDTC) is used to improve dynamic response performance and decrease the stator flux and torque ripples.

STRUCTURE OF FIVE-LEVEL INVERTER

Multilevel inverters have been developed to overcome harmonics in output, and improve the shape of output to reach sinusoidal waveform [7]. Multilevel power conversion technology is a very fast growing area of power electronics with good potential for further development. The most attractive features of this technology are in the medium to high-voltage application range (2-13 kV), which include motor drives, power distribution, power quality and power conditioning applications [8]. The topology that has been used in this paper is a three phase full bridge five levels diode clamped inverter and this topology is shown in Figure 1. The voltage across the phase winding of the induction motor can attain one of the five levels –2*V*dc, -Vdc, 0, 2Vdc or *V*DC, depending upon the switching states of the inverters [9].

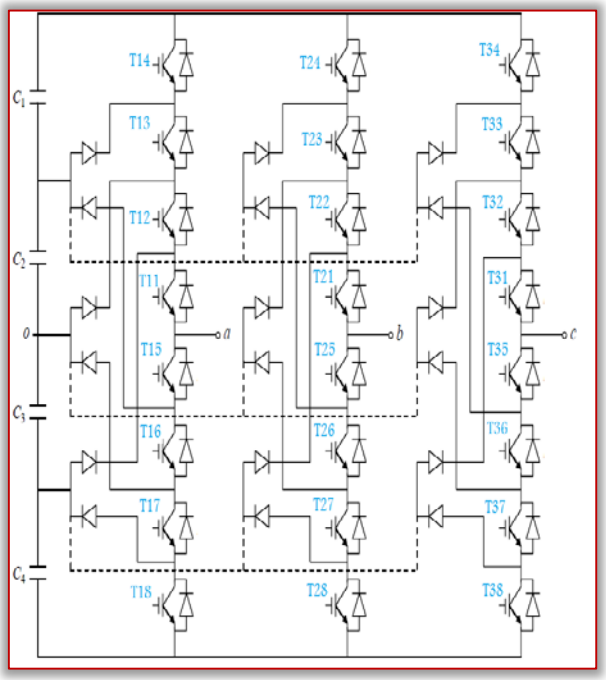


Figure 1. Five-level diode clamped voltage source inverter

The five-level diode-clamped inverter leg has 4 dc link capacitors, 8 switches, five-levels output phase voltage and 9 levels output line voltage. Although each active switching device is required to block only a voltage level equal to the capacitor voltage of Vc= E /4, the clamping diodes require different ratings for reverse voltage blocking. The necessary conditions for the switching states for the five-level inverter are that the dc-link capacitors should not be shorted, and the output current should be continuous [10].

The representation of the space voltage vectors of a five-level inverter for all switching states is given by Figure 2.

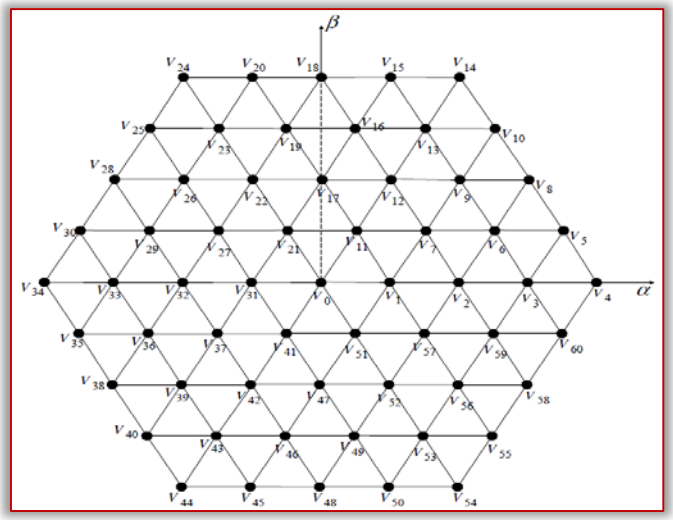


Figure 2. Space vector diagram of five-level inverter

DIRECT TORQUE CONTROL STRATEGY

The main idea of direct torque control is to directly control the torque and flux produced by the machine, without current control, as it is the case in FOC [11]. DTC technique can be easily implemented using two hysteresis controllers (one for flux and the other for torque), torque and flux estimators and a switching table to select the proper voltage vector. The basic functional blocks used to implement the DTC scheme are represented in Figure 3 [12].

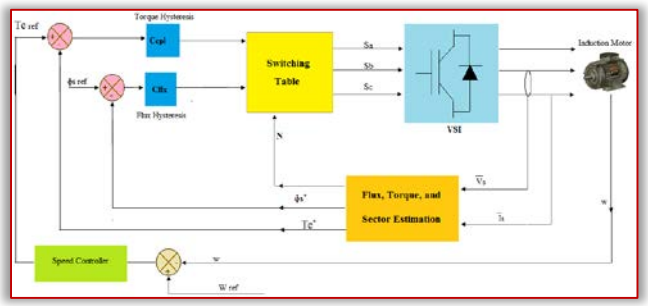


Figure 3. Block diagram of DTC of IM drives

In the DTC motor drive, the stator flux linkage and the electromagnetic torque can be directly controlled by the selection of optimum inverter switching states. The flux and the torque errors are kept within acceptable limits by hysteresis controllers. The DTC allows for very fast torque responses and flexible control of the induction motor [13].

The components of stator flux are given by [14]:

$$\begin{cases} \Phi_{s\alpha} = \int_0^t \left(V_{s\alpha} - R_s \cdot i_{s\alpha}\right) dt \\ \Phi_{s\beta} = \int_0^t \left(V_{s\beta} - R_s \cdot i_{s\beta}\right) dt \end{cases} \quad (1)$$

The magnitude of the stator flux can be estimated by:

$$\Phi_s = \sqrt{\Phi_{s\alpha}^2 + \Phi_{s\beta}^2} \quad (2)$$

The stator flux sector is determined by the components $\Phi_{s\alpha}$ and $\Phi_{s\beta}$. The angle between the referential and Φ_s is equal to [15]:

$$\theta = \operatorname{arctg}\left(\frac{\Phi_{s\beta}}{\Phi_{s\alpha}}\right) \quad (3)$$

Torque can be calculated using the components of the estimated flux and measured currents:

$$Te = \frac{3}{2} p\left(\Phi_{s\alpha}\, i_{s\beta} - \Phi_{s\beta}\, i_{s\alpha}\right) \quad (4)$$

The switching selection block in Figure 3 receives the input signals Ccpl, Cflx and N generate the desired control voltage vector as given in look-up table shown in Table 1.

Table 1. Switching Table of five-level inverter

Sector N	Cflx					
	1			0		
	Ccpl					
	1	0	-1	1	0	-1
1	14	2	54	24	32	44
2	18	7	58	28	37	48
3	24	12	4	34	42	54
4	28	17	8	38	47	58
5	34	22	14	44	52	4
6	38	27	18	48	57	8
7	44	32	24	54	2	14
8	48	37	28	58	7	18
9	54	42	34	4	12	24
10	58	47	38	8	17	28
11	4	52	44	14	22	34
12	8	57	48	18	27	38

The stator flux and torque are controlled by two comparators with hysteresis illustrated in Figure 4. The dynamics torque are generally faster than the flux then using a comparator hysteresis of several levels, is then justified to adjust the torque and minimize the switching frequency average [16].

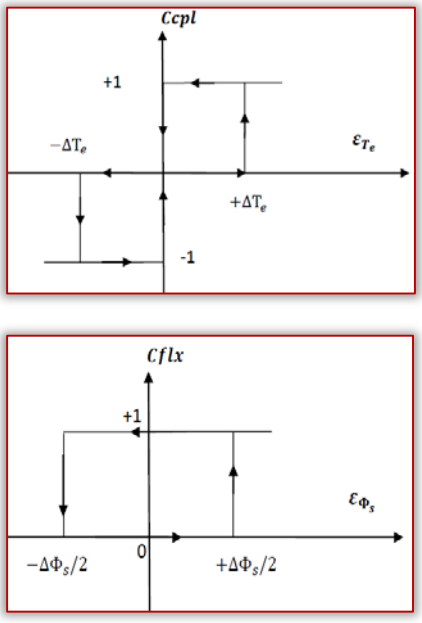


Figure 4. Comparators with hysteresis used to regulate flux and torque

DESIGN OF FLC TORQUE RIPPLE OPTIMIZATION

In order to improve the five-level DTC performances, a complimentary use of the fuzzy logic controller is proposed. Lotfi Zadeh, the father of fuzzy logic, has classified computing as hard computing and soft computing [17]. Fuzzy control is based on a logical system called fuzzy logic which is much closer in spirit to human thinking and natural language than classical logical systems. Nowadays fuzzy logic is used in almost all sectors of industry and science. One of them is load frequency control. The main goal of LFC in interconnected power systems is to protect the balance between production and consumption. Because of the complexity and multivariable conditions of the power system, conventional control methods may not give satisfactory solutions [18].

The principle of fuzzy logic direct torque control is similar to traditional DTC. The difference is using a fuzzy logic controller to replace the torque hysteresis loop controller. As shown in Figure 5.

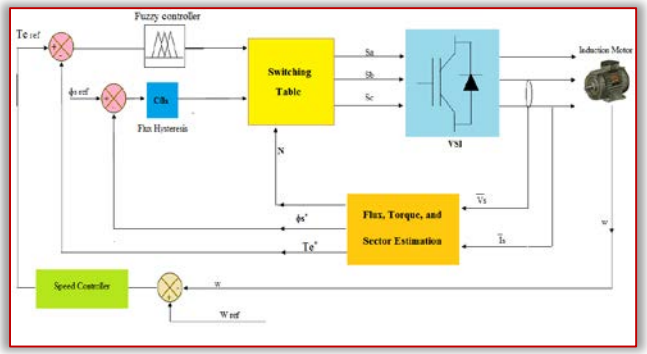


Figure 5. Fuzzy logic DTC scheme

To get a better control performance a fuzzy logic controller has been introduced to be a compliment to the hysteresis controller. The fuzzy controller design is based on intuition and simulation [19].

In this paper, a Mamdani-type FLC is developed to adapt the torque hysteresis band in order to reduce the ripples in the motor-developed torque. In conventional DTC technique, the amplitude of the torque hysteresis band is fixed. However, in this proposed scheme, the FLC controls the upper and lower limits of the torque hysteresis band on the basis of its feedback inputs. The fuzzy systems are universal function approximators. The FLC is used as a nonlinear function approximator producing a suitable change in the bandwidth of the torque hysteresis controller in order to keep the torque ripples minimum [2]. The block diagram for fuzzy logic based torque hysteresis controller is shown in Figure 6.

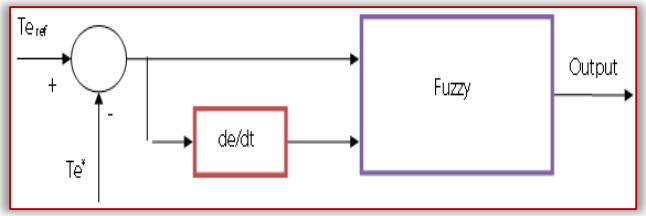


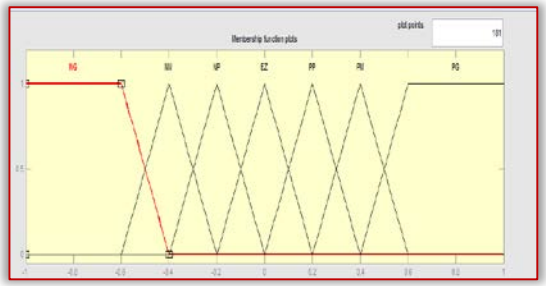
Figure 6. Fuzzy logic control of torque hysteresis controller

Since the two inputs and single output are having seven subsets, 49 rules are to be formed [20]. The rules are formulated and given in Table 2. The centre of gravity method is employed for defuzzification.

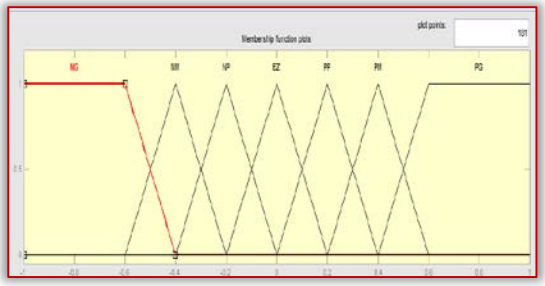
Table 2. Fuzzy rules of torque hysteresis controller

e / Δe	NL	NM	NP	EZ	PS	PM	PL
NL	NL	NL	NL	NL	NM	NP	EZ
NM	NL	NL	NL	NM	NP	EZ	PS
NP	NL	NL	NM	NP	EZ	PS	PM
EZ	NL	NM	NP	EZ	PS	PM	PL
PS	NM	NP	EZ	PS	PM	PL	PL
PM	NP	EZ	PS	PM	PL	PL	PL
PL	EZ	PS	PM	PL	PL	PL	PL

The design of fuzzy rules involves writing rules that relate the inputs variables to the output variable [21]. These rules are expressed as IF-THEN statements and the syntax is as follows: IF e is NM AND Δe is PL THEN S is PS. Figure 7 and 8 show the membership functions of input and output variables respectively.



(a)



(b)

Figure 7. Input variables membership functions:
(a) Error; (b) Change in error

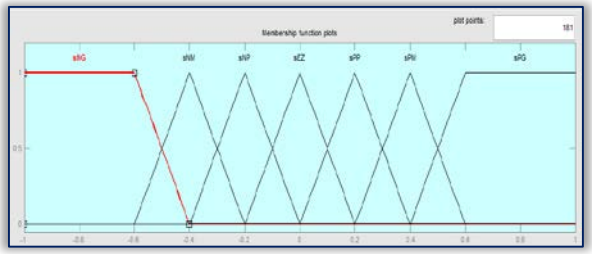
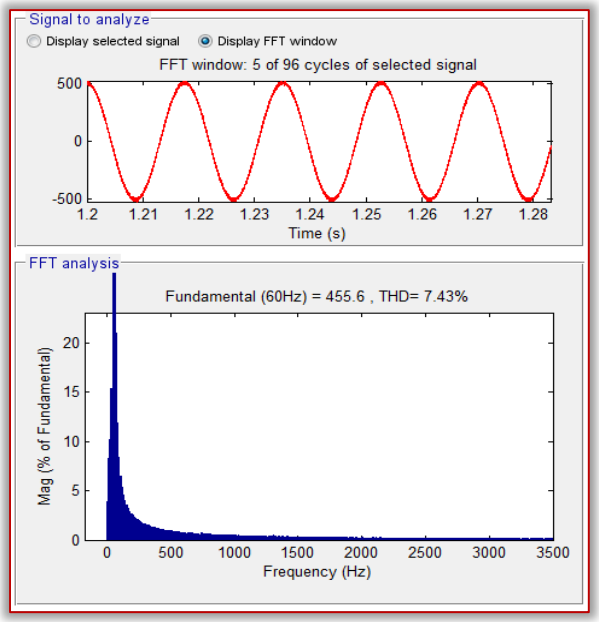


Figure 8. Output variable membership function

SIMULATION RESULTS

The simulations of the five-level FLDTC induction motor drive are compared with five-level DTC. A 3-phase, 3 pole, induction motor with parameters of Rs=0.228Ω; Rr=0.332Ω; Ls=0.0084H; Lr=0.0082H; Lm=0.0078H; J=20 Kg.m2 are considered. The performance analysis is done with stator current, stator flux and torque plot.

The dynamic performance of the five-level DTC control with induction motor is shown Figure 9. The dynamic performance of the five-level DTC control with Fuzzy logic controllers is shown Figure 10.



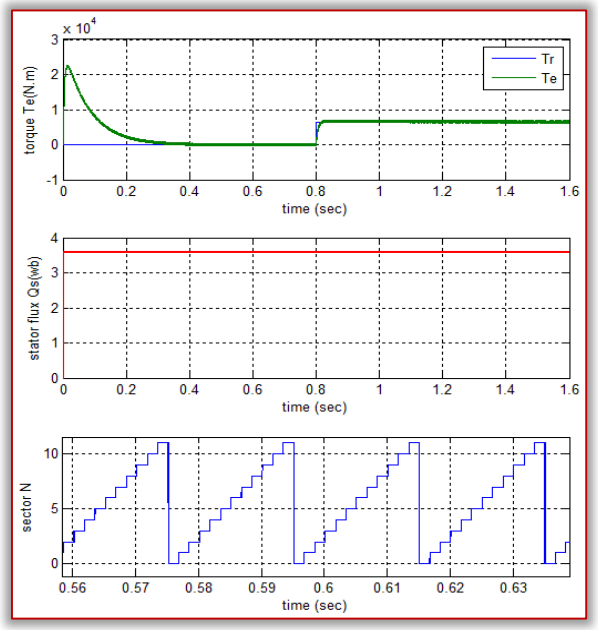
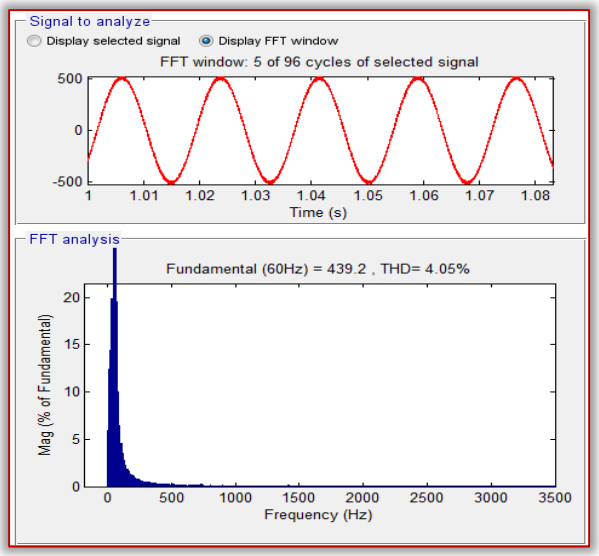


Figure 9. Dynamic responses of five-level DTC for induction motor



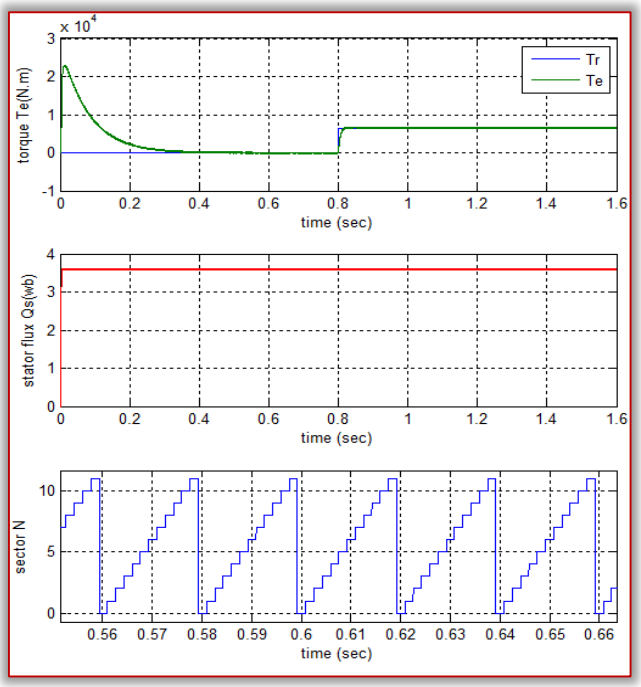
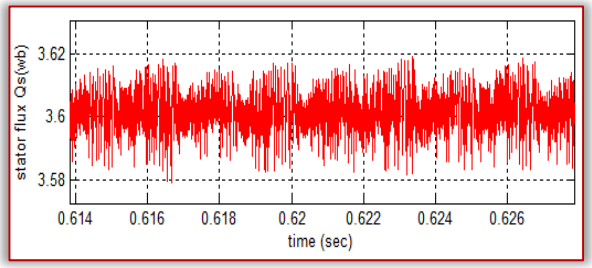
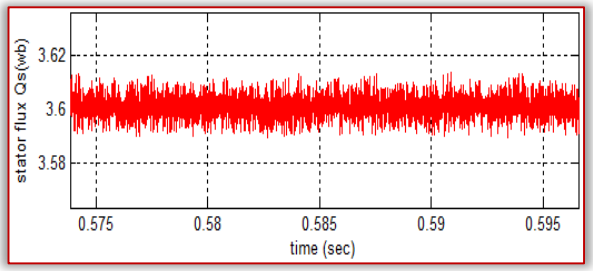


Figure 10. Dynamic responses of five-level DTC with fuzzy logic controller for induction motor

Figure 11 shows the stator flux responses of both the conventional and fuzzy five-level DTC schemes. It is found that the proposed variable band torque hysteresis controller based DTC scheme exhibits smooth response and lesser ripple in flux as compared to the conventional five-level DTC scheme.



(a)



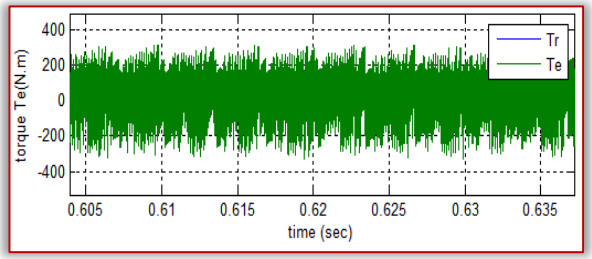
(b)

Figure 11. Zoom of stator flux:
(a) Five-level DTC; b) Five-level DTC with fuzzy controller

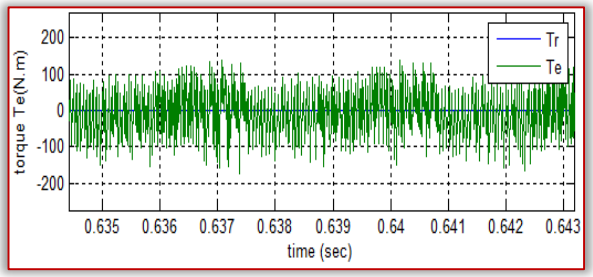
Torque response comparing curves are shown in Figure 12. See figure the torque ripple is significantly reduced when the fuzzy controller is in use. The fuzzy controller provides the desired amplitude according to the torque ripple level and operating condition, as it is shown in the paper.

Steady state current comparing curves are shown in Figure 13. Compared with steady state current waveform, traditional five-level DTC model maintaining the current waveform of sine, but there is a little large pulsation, there are some harmonics which will lead to

torque ripple in the wave form, while the fuzzy logic DTC current waveform is relatively smooth, so, effectively reduces the harmonic.

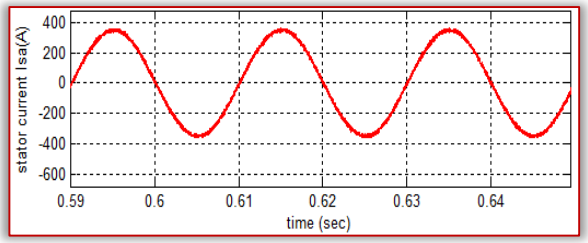


(a)

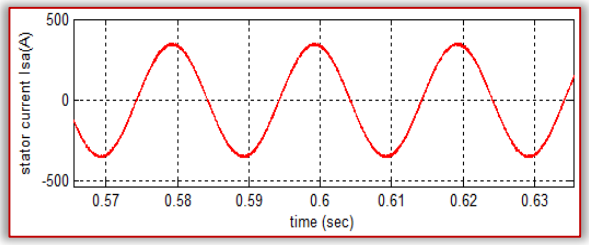


(b)

Figure 12. Zoom of torque:
a) Five-level DTC; b) Five-level DTC with fuzzy controller



(a)



(b)

Figure 13. Zoom of stator current:
a) Five-level DTC; b) Five-level DTC with fuzzy controller

CONCLUSION

This paper presents a five-level DTC for the induction motor with fuzzy logic controller. This controller determinates the desired amplitude of torque hysteresis band. The five-level DTC with fuzzy logic controller decreases considerably the electromagnetic torque ripples and stator flux. The main advantage is the improvement of torque and flux ripple characteristics at low-speed region, this provides an opportunity for motor operation under minimum switching loss and noise. Thus the proposed DTC scheme has achieved better torque and stator flux under Simulink environment.

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CONSIDERATIONS REGARDING THE HEMP HARVESTING

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Abstract: Hemp is one of the oldest plants cultivated in Romania (over 2000 years). In the past, there was a tradition in hemp cultivation, and nowadays there are existing European and national programmes that aim at increasing the surfaces cultivated with hemp. The hemp has over 25, 000 utilizations, starting from food, paints and fuel up to clothes and building materials [2]. According to European laws, In Romania might be cultivated only the hemp varieties with a tetrahydrocannabinol content smaller than or equal to 0.2%. The hemp varieties chosen for direct payments are Denise, Diana, Lovrin 110, Silvana and Zenit.[3]. This article tackles several combines and equipment designed to mechanized harvesting of hemp cultivated on larger surfaces due to its food and energy potential.
Keywords: hemp, hemp harvesting, varieties, plant, energetic potential

INTRODUCTION

The hemp has a non-branched stem, long lanceolate leaves with serrated edges and dense semi-compact inflorescences. Plant leaves are hairy, male flowers forming poliniferous panicles, and female leaves are green and the fruit is a greenish-grey achene, (Bruce D.M. et all, 2001).

It is made of three parts, all useful: seeds can be used to prepare different food, oil and medicinal products; fibres are used in industry (to clothes up to cars) – they form the stem middle layer and are covered by a thin protecting stratum; the wooden core remained after extracting the fibres is the part used (lime included) for buildings (although we found information showing that it is possible to use the whole stalk –meaning that fibres and ligneous core should not separate).

We number several varieties of hemp (10, 11,12):

Denise – is a mixed monoecious variety, for fibres and seeds, homologated in 1999, obtained by hybridization, cross breeding and repeated selections, aiming to obtain high yield of stems and seeds ; it represents a variety with mixed cultivation features, being more resistant to spring low temperatures, allowing an early sowing. It blossoms by 4-5 days earlier than Secuieni 1, in the first stage the female flowers bloom ; the interval of blossoming lasts 20-25 days. The stem crop has a growing period of 120-130 days and 140-150 days for seeds. The average stem harvest can range between 8.2-10.5 t/ha depending on the agrofond applied and thermal and rainfall regime. The seed harvest reaches 1200 kg/ha, and fibre content is of 29-30%, determining a production of 2900-3200 kg/ha technical fibres.
Zenit – is obtained by hybridization and monoecious selection of Secuieni and a local population De Arieş. It is a monoecious variety with the smallest content of THC for homologation. Plant size is very reduced and the growing period is of 110-120 days.It is a specific variety designed to seed, -1100-1500 kg/ha, but also to fiber production (28% content of technical fibres and a production of 7.8-8.5 t/ha stems), can be obtained.
Diana is a variety obtained by selection and repeated crossbreeding between Hungarian dioecious varieties of high yield of stems and fibres, but tardy and with coarse fibre and monoecious selections from laboratory genetic sources.
Dacia –Secuieni, is a variety of monoecious hemp, homologated in 2011 for stems and fibres. It was achieved by selection of line AR-1 component of Diana variety brought at maximum yield after genetic and biological degradation through uncontrolled multiplication within the process of obtaining seeds and dioecious line K-7.
Secuieni – Jubileu – is a monoecious variety, homologated for production of seeds and oil, 33.8% content, as well as for its quality. It is a very precocious variety, the seed maturation happening in early august, by 15 – 20 days earlier than Zenit variety. Production of stems and fibres is close to Zenit variety, being an ultra-precocious derivation of its component families. [5]. Sowing density: at hemp for fibres- 70 kg/ha distance between rows 12.5 cm; at hemp for seeds- 15-25 kg/ha distance between rows 70 cm[12]

Hemp seeds contain: 36% oil, 28% proteins, 14-27% non-nitrate elements, 17.8-26.3% cellulose and 2.5-6.8% ashes. Due to this composition, hemp seeds can be used for extracting oil used directly for food and for obtaining margarine. Non-refined oil is designed to obtain varnishes, paints, linoleum, soap and waxed cloths. Seed is widely used directly, as such, or in concentrated fodder, bird food (especially for feeding exotic birds: parrots, canaries, peacocks, etc.).

Figure 1 - Hemp crop

Figure 2. Hemp inflorescence, [12]

The cakes remained after extracting the oil are used as such or in concentrated fodder for feeding birds, calves, horses, fish, etc. – 600 g of cakes equal as nutritive value 1000 g grains of cereals. Cakes should be carefully used for feeding cows with calf, as they provoke abortions. Hemp wood represent about 55% out of stalk weight and contains over 50% cellulose. The flake dust resulted when extracting the fibres or whole plant is used for obtaining: paper, agglomerated plates – phono-insulating panels, for furniture industry, artificial silk, puff for phonic insulation between the building plates. The seed crop chaff is a very valuable fertilizer: 10 t of chaff equal 40 t of litter. Leaves and inflorescences are used in medicine. [6]

Hemp harvesting can be performed in two stages both for fibres and seeds. For fibre hemp, the plants should be cut and left in the field, and in second stage after drying, their leaves are shaken and tied as sheafs of 20-25cm diameter and transported to melting houses. For seed hemp, the plants should be cut and left in the field to dry 7-8 days. Threshing the inflorescences is made by cereal harvesting combine. Seeds threshed are immediately cleaned, conditioned and dried.[8] In Figure 4 is shown the harvesting combine for seed hemp.

Figure 3. Hemp manual harvesting, [12]

MATERIALS AND METHODS

In olden times, hemp harvesting was made manually (fig 3), but, as surfaces cultivated with hemp increased, the harvesting methods modernized, thus appearing the harvesting machines of hemp both for seeds (Grabowska L.) and stalks. In Figure4 is presented a hemp field mowing with side rear mower. The hemp is mown and left in furrow for being tied as sheafs. In this case, hemp stem has different utilizations in industry.

Mechanized harvesting can be performed with Multi Combine HC 3400 (Figure 5), which is a self-propelled combine designed to hemp harvesting, launched in 2015, in Slovenia, at World Congress of Hemp. MultiCombine HC 3400 is endowed with a header similar to that of cereal harvesting combine. This header comprises: cutting apparatus with knife blades, rasp bar, header, conveying belt of material cut towards the right end of header, where it discharges the material to another elevator that takes over the material and transports it to the combine body.

Figure 4 - Rear side mower [2]

The Multi Combine HC3400 body is tipping for enabling the harvested material discharge, respectively the hemp extremities where seeds are located, (Kaniewski R.). During the field movement, the combine tows the header on the transporting cart and folds the conveying belt of right part, belt that takes over the header material for easily displacing and surpassing the clearance issues.

Figure 5 - Multi Combine HC3400 for hemp harvesting [8]

In Figure 6a), we have: Tractor CLAAS XERION 4000, working in field, for harvesting the hemp crop. This tractor is endowed with a cabin that can rotate front-rear and with an equipment made of two harvesting headers. In front, there is one Jaguar type header for cutting the stems of hemp and in upper part, there is a rotor type equipment that cuts the hemp top (where seeds are placed). On right side, the tractor has a conveyor that takes over the material harvested by header rotor type that harvests only the hemp extremities and transport them to trailer [9].

In Figure6b, tractor Claas Xerion 4000 discharges the harvested material into the red trailer, towed by John Deer tractor, that transports the material. Body of tractor Xerion 4000 equipped for hemp harvesting, is tipping and is endowed with two hydraulic lifting cylinders, inclination of body under an angle of 30 degrees, conveyor chains on the body bottom, that are driven when the material is unloaded to the other trailer that ensures the transport to the farm.

Figure 6 - Claas Xerion 4000 [8]

RESULTS

In Figure7a, we present the equipment for hemp harvesting that is endowed with a wide belt on longitudinal bars of rasp bar, where elastic teeth are placed, (popularly called hedgehogs). This belt is mounted for protecting the plant to be piqued by elastic fingers or to clogg. The belt may be made of wood, plastic, textolite, light sheet iron, rubber, and helps to introduce the plant into the cutting apparatus in right position. After cutting the material, it is transported to the header right end, where it is taken over by the conveyor mounted at the header end and is discharged on the conveying belt of elevator mounted on the truck that goes in parallel with tractor that harvests the hemp.

In Figure 7b is presented the frontal image of both tractor and truck going in parallel during the harvesting. The truck is endowed with an elevator of conveying belt type, that takes over the material harvested from the header. This conveying belt is mounted on left side of truck, situated between tractor and truck in the picture shown. At the end of the conveying belt, there is one person that controls the discharge of material into raphia square bags of about 900x900x900mm size.

Figure 7. Hemp harvesting equipment [7]

Hemp seeds harvesting with John Deer 660i caterpillar combine is shown in fig 8 a, b) that is endowed with two headers extension and chopper of CSU type mounted in rear left side. Harvesting is performed by upper header, namely the cereal header with rasp bar and cutting apparatus with blades that cut the hemp extremities (where seeds are) and then the threshing flow is performed, obtaining the seeds in combine tank.

The lower header is of Jagur type and chops the ligneous fibre, transforming it in chaff and incorporating it into soil when ploughing.

Figure 8 - Caterpillar combine John Deer 660i during hemp harvesting [7]

Figure 9 - Combine Claas of Jaguar type [4]

Figure 10 - Shortening the hemp with windrower [11]

In Figure 9, we can see the combine Claas Jaguar 650 type, endowed with 2 extended equipment, one original, the lower equipment that chops the ligneous fibre, leaving in furrow the fibre separated from hemp, and the second upper one of header type that cuts the extremities and remove them into furrow through the

right part of upper header, leaving in another furrow the extremities with seeds harvested, (Kobayashi Y., 2003). The harvested material, namely the seed extremities are left in furrow for several days for drying, approximately 7-8 days, after which they are threshed by the combine.

Shortening the hemp with windrower Figure 10, is performed in order to obtain short size harvest and enable the harvesting with combine with straw header. By this method, a short height hemp is obtained and harvesting is facilitated, beacuse there is no need of two harvesting equipment (one that cuts the plant extremities and other that cuts the ligneous fibre) as in case of high hemp of about 2 meters height.

CONCLUSIONS

Hemp is a plant that can be successfully cultivated in our country because of its good adaptation features. The crop has a wide range of utilizations in industry of construction, textile, cars, pharmaceutics and it has found that it also has a high energetic and food potential. Recently, the surfaces cultivated with hemp have increased, as well as the varieties number that give a better yield and are more resistant to draught, illness and pests. Hemp harvesting both for fibres and seeds has modernized very much, the agricultural machinery manufacturers being permanently concerned of creating high-performance harvesting machines. While certain manufacturers adapted the hemp harvesting equipment to tractors, others built self-propelled combines for hemp harvesting. Optimization of technology of cultivation of energy and food potential plants is an ongoing development activity, the hemp crop bringing by efficient capitalization, great profits to farmers.

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Note:

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PRODUCTION AND FUEL CHARACTERISATION OF BIOETHANOL FROM DIKA–NUT SHELL

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Abstract: With a view to finding alternative fuel to fossil fuel for internal combustion engines as a result of its negative impact on the environment and energy crisis, bioethanol fuel was produced through fermentation and distillation process from dika–nut shell and characterized. The maximum yield of bioethanol was 36.8ml in 120hours of fermentation and the total quantity of bioethanol produced from 600g of the treated dika–nut shell was 127.7ml. The result of fuel characterization of the bioethanol indicated its density, specific gravity, water content, kinematic viscosity, flash point, pour point, cloud point and refractive index to be 0.89 g/cm^3, 0.89, 2.2, 4.1mm^2/s, 15^{0}C, 4.6^{0}C, 19.3^{0}C and 1.40 respectively.

Keywords: Dika–nut shell, fermentation, bioethanol, ASTM, fuel

INTRODUCTION

Energy consumption increase worldwide is caused by population increase and to close the gap between the energy supply and demand, crude oil has been extensively used (Shruti and Kalburgib, 2016). However, the emissions from the burning or combustion of crude oil derivatives and in general, fossil fuels pollute the environment thereby jeopardizing the lives of the inhabitants. It is being viewed to substantially promote environmental emergency worldwide (Hossain et al, 2011, Chandel et al, 2007). Besides the adverse environmental effects of the use of fossil fuel, its non–renewable nature makes it to be prone to exhaustion. Since the use of fossil fuel cannot be for gone, concerted efforts have been made to conserve its use and reduce its emission. One of the laudable ways of conserving it is the use of alternatives which are renewable and have positive effects on the environment. As a result of incessant energy crisis, occasioned by the mismatch between the energy demand and supply, governments of world nations have called for the utilization of other energy sources (Ingale et al 2014). So a daunting research for renewable energy sources based on biomass have been encouraged in order to reduce the rise in the energy demand in the globe and the speedy depletion of fossil fuel reserves (Balat et al 2008). The efficient utilization of pollution free energy source instead of fossil fuel is being sought and the most fascinating issues is the increasing awareness that ethanol is a substitute for fuel and liquid fuel based lubricants (Uthman and Jimoh, 2012). According to Jaiswal et al (2016), worldwide awareness about climate change and the dire need to cut down emissions have warranted the substitute of bioethanol for gasoline or the use of blends of bioethanol and gasoline.

Ethanol can be obtained from petroleum through chemical process and can also be obtained from plants or organic matter or sugar substrates fermentation. More so ethanol can be realized from the various classes of yeast (Jaiswal et al, 2016). The ethanol obtained from fermentation (ethyl alcohol) is simply called bioethanol and can be used as fuel besides its use as a solvent among others (Promon et al, 2018). Ethanol can be produced from eatable and non–eatable plants but producing from the former threatens food security, hence emphasis has been on its production from food waste and organic wastes. Notable examples are maize wastes and discarded newspapers (Akpan et al, 2008), sugarcane waste and maize waste(Braide et al, 2016), wastes, apple, kiwifruit, and peaches wastes (Cutzu and Bardi, 2017), peeled skins of carrot, onions, potatoes and sugar beet peels (Mushimiyimana and Tallapragada ,2016), waste from pine apple, barley, corn, copra cake (Hemalatha et al, 2015), apple, banana, papaya ,grapes(Janani et al 2013), sugar cane (Berhe and Sahu,2017), coffee (Kefale et al, 2012, Woldesenbet et al, 2016), rice, sweet sorghum, millet (Harinikumar et al, 2017) and groundnut shell (Nyachaka et al, 2013).

Dika–nut which is merely called African or bush or wild mango is a product of forest like timber. The trade on this product has become a remarkable income source to the rural dwellers and poor urban dwellers in Nigeria (Arowosoge, 2017). When the dika–nut are used as food, the nut is cracked or cut open and the shells are disposed of indiscrimately resulting in poor environmental conditions. Although the shells are being used in carbonized form for the reinforcement of natural and artificial rubber (Ohaeri and Ohaeri, 2015), saloon liquid waste treatment (Ewansiha et al, 2014) and fillers (Tenebe et al, 2013), so much is still being wasted. So the possibility of producing ethanol from the dika–nut shell which can used as alternative fuel in internal combustion engine, is being investigated in this research work.

MATERIALS AND METHOD

— Collection of dika–nut shell samples

The dika–nut shells were collected from refuse dump in some homes in Opoji community of Edo State, Nigeria. They were washed with water to remove dirts and dried in an electric oven (manufactured in England by Gallekamp) at 60^0 for 72hours (Nyachaka et al, 2013) to achieve reduction in the moisture content so as to enhance effective grinding.

— Bioethanol production from the dika–nut shell

The washed and oven dried dika–nut shells were ground with mortar and pestle and sieved to obtain particle sizes of 3mm. Weighed 100g of the ground dika–nut shells were put into each of

six 500ml capacity conical flasks and 72% concentrated tetraoxosulphate VI acid was also introduced into each of the flasks and heated in a water bath at 30^{0}C for a 2hour in accordance with the method described by Venkatramanan et al (2014). Thereafter, they were autoclaved for 18 minutes at a temperature of 121^{0}C, cooled at normal room temperature, filtered with Whitman filter paper in order to obtain a solution containing a mixture of sugar and acid. The filtrate was treated with 0.4M NaOH thereby adjusting the pH to 4.5 in line with the method stated by Rabah et al (2014). Brewer's yeast (Saccharomycess cerevisiae) was added at concentrations of 0.05mg/l and pH of 4.5 and fermentation was allowed to occur in 24, 48, 72, 96,120 and144hours for the first, second, third, fourth, fifth and sixth flask respectively, at ambient temperature taking a cue from Olufemi and Oyetuji (2015). After each fermentation period, the flask was emptied into another flask with round bottom and put on isomantle attached to a refining column enclosed in flowing tap water. Another flask of the same type was secured at the other end of the refining column for the collection of the alcohol which is the distillate at the standard temperature for the production of ethanol (78^{0}C) in line with the method described by Adetunji et al (2015). The quantity of alcohol collected was measured with a graduated cylinder.

— Characterization of bioethanol from dika–nut shell

The bioethanol produced from the dika–nut shell was characterized by determining its density, specific gravity, water content, kinematic viscosity, flash point, pour point, cloud point and refractive index. The specific gravity was obtained by using Digital density meter, DDM 2910 manufactured in USA in accordance with ASTM D4052–16 method. Kinematic viscosity was determined at 40^{0}C by using Ubbeholde viscometer 7143 manufactured in India following ASTM D445–06 method. Flash point was determined by using Pensky Marten apparatus according to ASTM D93–06 standard method. Cloud point was determined in line with ASTM D2500–17a Method. Pour point was determined using ASTM 97–17b method. Refractive index was obtained using a Misco PA202 Palm Abbe Digital Handheld Refractometer manufactured in USA. Water content was determined by using ASTM E 1064–05 method (Coulometric Karl Fischer Titration).

RESULTS AND DISCUSSION

The variation of quantity of bioethanol produced from the dika–nut shell with the fermentation period is shown in Figure 1.

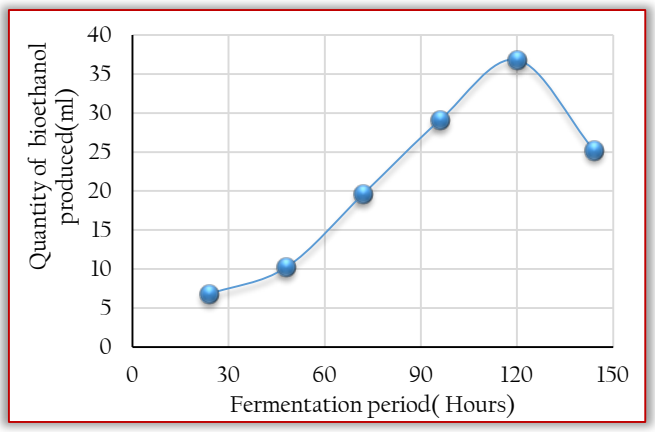

Figure 1: Variation of quantity of bioethanol produced from the dika–nut shell with fermentation period

It can be seen from figure 1 that as fermentation period increased from 24hours to 120hours, the quantity of ethanol produced increased from 6.8ml to 36.8ml. This progressive ethanol production with increase in fermentation period was also experienced by Oyeleke and Jibrin (2009) in the production of bioethanol from guinea cornhusk and millet husk and Olayide et al (2015) in the production of Bio–ethanol from Cassava Peels.

When the fermentation period was increased to 144hours, the quantity of ethanol produced dropped to 25.2ml. This drop in ethanol production should be attribute to decrease in the process of fermentation as a result of the reduction in sugar content (Kourkoutas et al, 2004), inhibition experienced by the ethanol as well as other by–products in the medium of fermentation (Akponah and Akpomie, 2011). However the total quantity of bioethanol produced from 600g of dika–nut shell was 127.7ml.

The experimentally determined fuel properties of the bioethanol produced from the dika–nut shell are shown in Table 1.

Table 1. Fuel properties of bioethanol produced from dika–nut shell

S/N	Properties	Experimental values	ASTM Standard values for bioethanol (Abdulkareem and Ogochukwu, 2015)
1	Density	0.89 g/cm^3	0.99g/cm^3
2	Specific gravity	0.89	0.87
3	Water content	2.2	NA
4	Kinematic viscosity	4.1mm^2/s	5.0mm^2/s (max)
5	Flash point	15^{0}C	18.60^{0}C
6	Pour point	4.6^{0}C	5.2^{0}C
7	Cloud point	19.3^{0}C	23^{0}C
8	Refractive index	1.40	1.36

The density and specific gravity of bioethanol is relatively close and slightly higher respectively than the standard density and specific density of bioethanol as evident in Table 1. The evaluation of fuel kinematic viscosity is required for the creation of actual fuel atomization and the engine power and combustion efficiency are affected by injection viscosity (Sirvio et al, 2018). The kinematic viscosity of the bioethanol was found to be 4.1mm^2/s which is 0.9 mm^2/s shy of the maximum standard value shown in Table 1. High injection pressure and pumping losses are experienced when highly viscous fuels are used and this result in poor combustion (Sirvio et al, 2018), emissions of unburned hydrocarbon (Heywood, 1998). Flash point which connotes fuel flammability also reveal the susceptibility of fuel to causing hazard during its storage or transit (Muhaji and Sutjahjo, 2018). The flash point of the bioethanol obtained was 15^{0}C against the standard value of 18.60^{0}C. However the flash point has no effect on the performance of an engine (Kheiralla et al, 2011). The pour point was evaluated to be 4.60C against the standard value of 5.2^{0}C and the cloud point of the bioethanol was determined to be 19.3^{0}C which is 3.7^{0}C lower than the standard value of 23^{0}C depicted in Table 2. The obtained cloud point is high enough not to cause fuel filter clogging (Bafghi et al, 2014). The pour and cloud points are of great importance in identifying the fuel behaviour as a result of cold weather condition

(Ajav and Akingbehin, 2002). The refractive index of the bioethanol was found to be 1.40 which is 0.04 higher than the standard value of 1.36 as evident in Table 2. For accurate measurement of the drop size and spray velocity of fuel an in–depth knowledge of the refractive index of the fuel are required (Fernandes, 2008). The values of the fuel properties of the bioethanol produced from dika–nut shells are very close to the standard values.

CONCLUSION

The depletion of fossil fuels as a result of high demand for use and the environmental pollution associated with its burning, has necessitated the search for substitute. On that note, dika–nut shell which are disposed indiscriminately in rural communities of southern part of Nigeria were studied for the production of bioethanol. Based on the result of the study, dika–nut shell is a good substrate for the production of bioethanol that can be used for internal combustion engines instead of fossil fuels that pollutes the environment with its emissions. The utilization and value of dika–nut shell has increased by using it to produce bioethanol.

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NATURAL FIBRE REINFORCED POLYMER COMPOSITES FROM TEXTILE WASTES – AN OVERVIEW ON NEW POSSIBILITIES

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Abstract: The current interest for natural fibres from textile wastes as an environmentally correct composite reinforcement has motivated the investigation of new possibilities. For instance, the textile fibres from the textile wastes were recently found to have adequate mechanical properties to reinforce polymer composites. Most natural fibre composites, including the textile waste inserted composites, however, are fabricated with traditional non–degradable polymer matrix but still presenting a recycling advantage over the common glass fibre reinforced polymer composites. Therefore, textile waste inserted composites stand out as a relevant class of engineering materials. The greatest challenge in working with natural fibre reinforced polymer composites is their large variation in properties and characteristics. However, with appropriate attention to fibre and resin design and structural geometry, natural fibre composites may prove a viable alternative to traditional materials in the future. Industrial ecology, eco–efficiency, and green chemistry are guiding the development of the next generation of materials, products, and processes.

Keywords: polymeric composite materials, bio-reinforcement, bast fibers (flax, hemp or jute)

INTRODUCTORY NOTES

The major advantage of composites is the ability to modulate properties and thus obtaining a wide range of materials, the usage of which can be extended to almost all areas of technical activity. Composite materials are the first materials whose internal structural design is conceived by man, not only in their molecular chaining, but by giving them favorable resistances in preferential directions. The initial purpose of composites was to increase the competitiveness of classical materials, whose strength and stiffness properties could no longer be improved by other means. From this point of view, it is understood that the maximum efficiency of the reinforcement of a certain material is obtained by introducing, in its structure, fiber reinforcing elements.

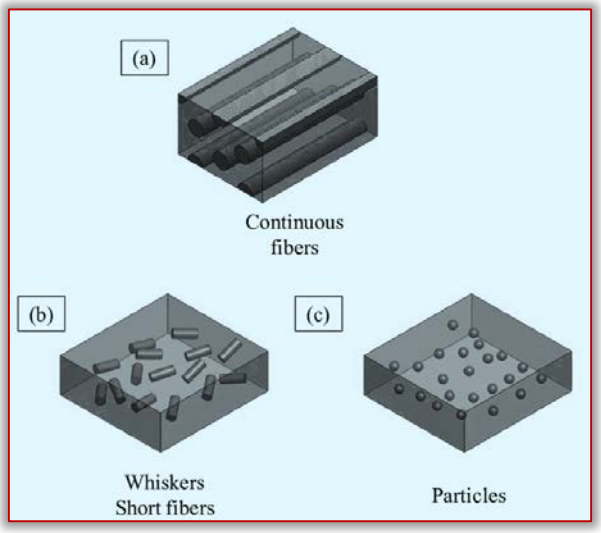

Figure 1. Typical Reinforcement Geometries for Composites: (a) continuous fibers; (b) short fibers or whiskers; (c) particles

Having the background of the need for a sustainable resource of raw materials as well as environmental problems caused by plastics and metallic materials, which are hardly degradable, the leading industries are always looking for new materials, especially those with low impact on the environment, which after end–of–life cycle are easy to recycle and biodegradable to deliver outstanding performance but to be produced as environmentally friendly as possible.

For decades, the development of polymer composites has been driven almost exclusively by performance criteria such as high specific stiffness. It is only in recent years that life cycle considerations have become prominent features in the design of composite-based products, with a gradual increase of recycling efforts, and growing interest for durability analyses. The issues of loop-closing, resource efficiency, waste reduction, and life-extension are to be seen as many facets of the life-cycle engineering concept, developed as an integrated method to design, manufacture, use, and recover materials and products for optimal resources turnover, as presented in Figure 2.

Figure 2. End–of–life cycle – concept

Durability is a key concept for the development of polymer composites, since uncertainties about long-term behavior of these materials often translate into conservative design. There is,

however, no general definition of durability, since it obviously depends on the application to be used in an unknown future.

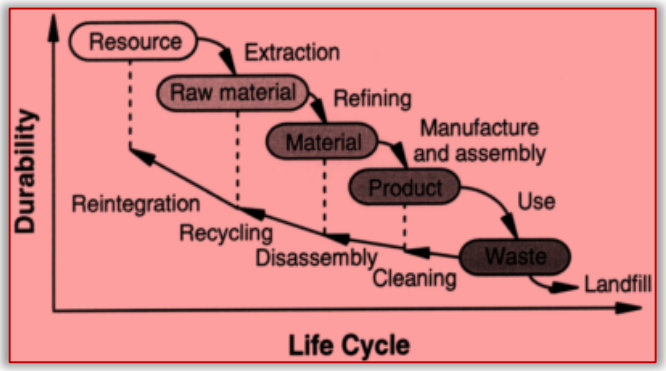

Figure 3. Durability – a key concept

With this approach in mind, the objective of life cycle engineering may be seen as maintaining the durability of the constituent materials shown in Figure 3 to the highest possible level during the whole life cycle.

MARKET TRENDS OF COMPOSITES

Increasing market demand for end products made of lightweight composites ranging from aircraft structures, automotive parts, pressure vessels, constructions, sport products and wind turbine blades, leads to a fast-growing composite materials market. The top business objectives, common to all composites manufacturers, are:

- exploring new materials for new composite solutions,
- exploring new manufacturing processes,
- automating manufacturing processes for faster and more predictable production,
- improving process and quality control of composites,
- cost reduction in various composite parts
- reduce raw materials and waste reuse possibilities, and
- increase ecological sustainability of composites, consist in environmentally friendly resin and fiber systems.

In response to the growing market demand, and in search of a competitive advantage, leading companies significantly invest in technology, research of new materials and innovative manufacturing processes to increase throughput and profitability while improving process and quality control.

Over the past few years there has been a significant developments and innovations in the composites industry across various industries. Market trends of composites are:

- Trends in new and innovative technologies. Composite play a crucial role in the innovative industries and the recent move of aircraft structures or automotive parts manufacturing towards automated tape laying (ATL) and automated fiber placement (AFP) is expected to drive the market during the forecast period.
- Trends in fibers destined to advanced composites. Companies are continuously investing in innovating and developing high strength natural fibers to improve both mechanical and chemical requirements. Additionally, the recent trend on developing green materials would give momentum to development of high strength natural fiber to increase penetration in automotive, construction, and various other industries;
- Trends in new resin systems destined to advanced composites. Companies are launching new resin types that focus short cycle times, especially on shorter cure time in the range of 1–2 minutes for mass volume applications, adapted for new and innovative forming technologies like High Pressure Resin Transfer Molding (HP-RTM) or Compression Molding.

Such objectives indicate that companies dealing with composites invest in the areas of new materials research, process innovation and look for ways to increase production throughput while investing in improvement of process and quality control. Also, the focus on green materials would give momentum to development of natural reinforcements to increase penetration in various advanced industries.

Therefore, the latest trends in composites technology:

- The lightweight characteristics and cost reduction factor of composites will continue to fuel innovations in the airplane, automotive and wind energy industries. Automobiles in particular are feeling the pressure to reduce fuel consumption so expect to see more manufacturers utilizing new composite solutions.
- Expect the advanced and innovative industries to use new reinforced composites to replace parts currently made with other materials or other types of composites.
- The increased focus on green technology will result in high strength fibers to increase penetration in manufacturing. Resins, together with natural fibers, have sustainability. They can create lightweight components for interior/exterior structural parts. Moreover, in the future, natural-inspired materials may replace traditional composites and come to dominate the industry.
- The transport industry has for some time been engaged in the application of new lightweight materials for structural design, with advanced lightweight composites replacing traditional metal materials more and more in both structural and non-structural parts. The rail industry could also benefit from the use of structural new materials.
- A class of biological materials found within numerous natural systems, most notably trees, cellulose materials have captured researchers' attention for their extreme strength, toughness, lightweight and elasticity. Cellulose materials are an attractive alternative because they are naturally available, relatively inexpensive, renewable and nontoxic, and can be easily extracted from wood and plant pulp by-products.

Therefore, continuous innovation is expected in development of higher performance fibers and core materials to meet higher mechanical and chemical requirements.

APPLICABILITY OF TECHNICAL TEXTILES IN COMPOSITES

The applicability of technical textiles in engineering has experienced an exponential growth over the last decades, although in the technical fields requiring mechanical stress is still limited. However, textile materials have particular advantages in terms of formability and dynamic impact properties, and thus composite materials with textile reinforcement are one of the main areas of application of technical textiles.

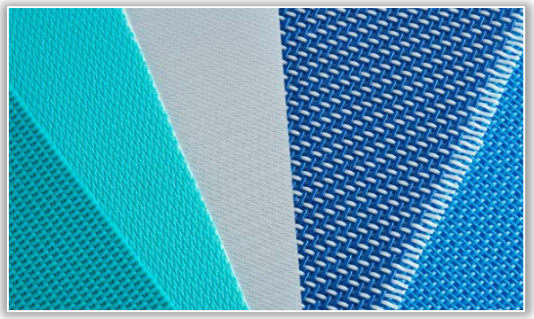

Figure 4. Typical technical textiles

Technical textiles are fabrics and textiles designed and made primarily for their technical and performance properties, rather than for aesthetic and decorative features. Textiles or composites based on technical textiles are intended to replace many of the current metal or plastic materials used in the leading or consumer industries.

Figure 5. Composites based on technical textiles

Imposing these composite materials in the cutting–edge areas of the technique is also due to their technological features:

- easy machinability, with the possibility of obtaining finite pieces in a single operation or by not very difficult operations,
- operations in many cases possible mechanized and automated, which determines the location of costs at relatively low, competitive levels. These advantages are an important economic parameter that reduces the direct cost of making parts, structural elements, or building elements.

The very diverse manufacturing technologies of these materials involve processes for:

- obtaining the polymer matrix,
- preparing the textile reinforcement components,
- impregnating or treating the textile reinforcement,
- making the textile reinforcement (in the form of knit, fabric, and braiding),
- making the composite itself and so on.

THE POTENTIAL USES OF RECOVERED TECHNICAL WASTE

In a circular economy resources are kept in a circulatory system over the longest possible use phase. In this sense, circularity means reusing and recycling materials and products, to keep them at their highest value - in order to turn discarded resources valuable resources. The idea is to develop methods or technologies to repair, reuse and recycle goods according to the hierarchy of waste striving always to reach the highest effectiveness of a raw material by choosing the next step of a product which is most valuable and needs the least new input: reuse before recycling. The materials are often used for several purposes and returned again and again in the recycling cycle. The ecological advantage of the circular economy is that it produces less waste and minimizes the extraction of resources. In fact, the aim of a circular economy is the resource-efficient and sustainable use of natural resources, their reuse and recycling within a circulatory system and the prevention of waste.

For economic and environmental reasons it is necessary that as much of this waste as possible is recycled instead of being disposed of in landfill sites. In reality the rate of textile recycling is still relatively low. Considering the diversity of fibrous waste and structures, many technologies must work in concert in an integrated industry in order to increase the rate of recycling. In this sense, recycling in textiles presents several promising technologies and ideas for recycling systems.

The textile recycling, on the other hand, most often refers to the reprocessing of pre- or post-consumer textile waste for use in new textile or non-textile products. Moreover, if the fabric of a product is recovered and reused in new products, it is considered as fabric recycling, albeit sometimes this is referred to as material reuse. If a product from recycled material is of higher value (or quality) than the original product, it is termed upcycling. The term upcycling is also often used when materials or parts of an old product are rearranged and reutilized to create a new product. Such new combinations might preserve the textile value.

Concluding the concerns in the field of textile waste, we can mention, according to technical, economic, social, ecological criteria, the following directions of action:

- establishing modalities for waste disposal at the end of life–cycle losing production cycles, using and recycling waste;
- designing and launching new products by improving the quality of materials to extend the life of products made from these materials;
- identification of the various internal and external organizations necessary for practice recovery

By processing on classic traditional / nonconventional traditional technologies, the potential uses of recovered technical fiber can be:

- phono– and thermo–insulating materials / building materials (which are used in the textile branch by the production of non–woven textiles, upholstery wadding for furniture and cars, insulating materials, geotextiles, and representing about 60% of the recovered waste: yarn waste knitted fabrics, knitted fabrics, knitted fabrics, knitted fabrics and strips);
- textile composites (which are used in the automotive, naval, construction, military technique, and so on) industries;

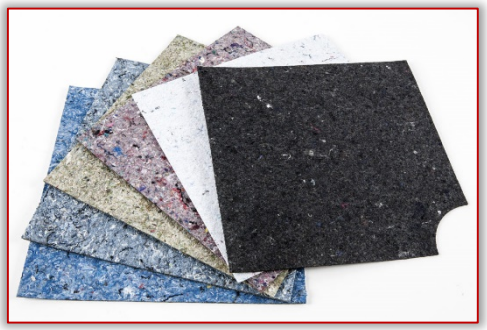

Figure 6. Insulating materials from recovered technical textiles

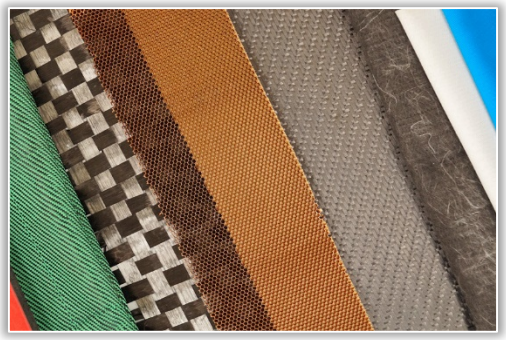

Figure 7. Textile destined to composites

CONCLUDING REMARKS

The rise of composites have already transformed most of the world's industries and will continue to grow in the years to come. The researches in this area of composite materials will focus on:

- making advanced composites less expensive and energy-intensive to manufacture.
- making composites easier to recycle, and
- develop new fibers and resins to open up even more applications for composite materials.

In the future, the composites industry will continue growing into more applications and markets. Environmentally friendly composites will incorporate recycled plastic and bio-based polymers to feed the growing demand for stronger, lighter, and more environmentally friendly materials. Within the field of composite materials, we find a wide range of processing techniques based on the use of reinforcing materials mainly focused on textile structures and matrices of polymeric materials.

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Note

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GSM COMMUNICATION AND CONTROL OF THE ROBOTIC ASSISTANT FOR THE ELDERLY

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Abstract: Designing a communication unit for an assistant robot designed for the elderly and ambulatory patients in need of assistance. The communication unit uses the GSM / GPRS network. This module will later be able to control the robot. The communication unit works with two ATmega328 processors that are interconnected and also with the main control microprocessor that provides control of the motors. The main task of the communication module can send warning messages in case of an accident or SOS signal when you press the emergence button. The next task is to process and learn about environmental safety of the patient through some sensors such as flammable gas sensor, recording the barriers warning of dangerous inclination. The last task is to create a communication tunnel between the patient, the senior and the family, or the operator who takes care of the patient by remote access. This communication is solved as well as through a mobile phone, but the robot calls only from phone numbers that are pre-programmed. This communication module will be some warning messages and automatically notified. After creating a database of sounds communication module can convert text messages to audio interpretation.
Keywords: GSM, DTMF control, microcomputer, CO sensor

INTRODUCTION

The robotic assistant is primarily intended for carers who care for patients who can´t walk or have a degree of dementia or disability that can´t work without the support and caregiver. Such patients do not require other robot features such as stability in the state or fixation of the patient during treatment. They have close contact with the caretaker who cares about them.

However, the robot is also intended for patients who do not need the caregiver and use it as a support for walking, rehabilitation, or robot serving in the elderly's home for help such as lifting things out of the country, providing a senior environment, or communicating with the patient / senior his family, or an operator who cares about a patient from a remote workplace. For these purposes, the robot has a communication module that is only one of several robot parts. This module is based on a GSM / GPRS microprocessor called sim800. Through it, it can connect to a standard GSM network as well as a mobile phone. It can receive calls, SMS messages, and it can also be connected to the Internet. The prototype of the assistant robot used the sim800 microprocessor built on a development module designed for prototype Arduino boards. This prototype, however, is not intended for serial production and serves only to debug the electronic, program and hardware parts. The prototype electronics are unnecessarily large, and a new integrated electronic unit is designed to be more compact and reliable.

The communication module consists of two ATmega328 and ATmega2560 microprocessors interconnected via a serial line. One ATmega328 microprocessor communicates via a serial line with a GSM module, which we can call the microprocessor as a GSM controller. The second ATmega2560 microprocessor is designed to play sounds, but also performs the function of processing various analogue and digital inputs.

It also connects a communication module with a master microprocessor. Below in the picture Figure 1 is a schematic diagram of a connection where a method of communication between microprocessors and connected peripheral devices is shown.

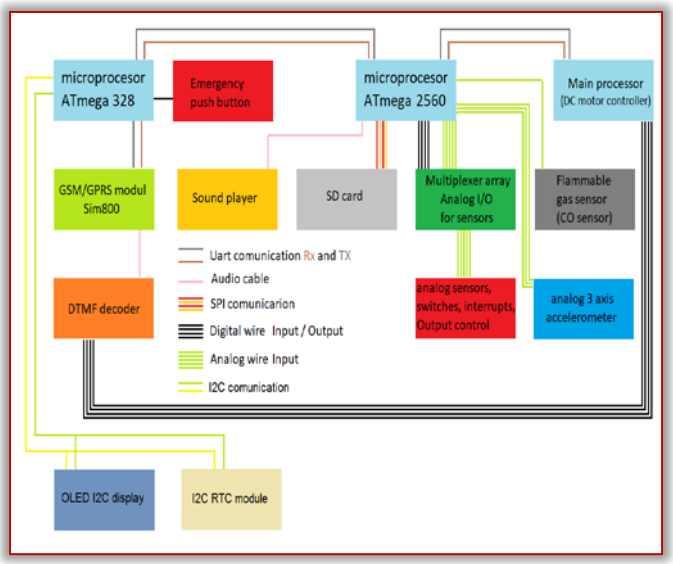

Figure 1. Block diagram of the communication module

In addition to the two microprocessors and the GSM processor, the sim800 also includes an RTC - Real Time Clock, an OLED display, an SD card slot, and five sixteen channel I / O switching multiplexers. The communication module also includes a 3-axis accelerometer and carbon monoxide sensor. Both the accelerometer and the gas sensor have an analogue output and are connected directly to the processor without switching the multiplexer.

I briefly want to mention the principle of communicating with the GSM module and the processor through AT commands. With the help of specific commands such as "AT + CMGF = 1 \ r" and "AT + CMGS = TELEPHON NUMBER", for example, an SMS message will be created. After entering this command, the GSM module does not wait for the AT command but all the received text from the microprocessor is inserted into the SMS message. Waiting for the

unanswered characters char 26 (ctrl + z) this symbol will terminate the writing action and then send the SMS.

The GSM module and the processor communicate over the serial UART line and use the RXD and TXD pins to connect them to the cross. Through these pins, the two microprocessors communicate with each other. Communication is bi-directional.

The GSM module sends the microprocessor the response. For example, on the basic AT command "AT", the GSM module responds with "OK" this command does not set anything. It serves to verify communication between processors. If the answer is not so there is a problem in communication. However, there may be several problems. Most often this may be a bad connection of the RXD and TXD pins but the wrong bit rate may be set, the module may be turned off or a microprocessor sending error (program error)

FUNCTION AND DETERMINATION OF THE COMMUNICATION MODULE

— The main role of the communication module

Thanks to the GSM module, a robot can communicate with the patient's family or a doctor and the family or physician can communicate with the patient. Of course, the best possible solution is to be with such a patient in person, but if it is for no reason, for example, the family members live and work abroad or are so busy that they can´t spend most of the floor with the patient. This is a convenient alternative. In addition to creating connections with other people, this module can receive and send SMS messages. A special feature is the ability to convert text to sound. However, the text-to-audio conversion is strictly defined and it is not possible to generate but play only the sound.

The recorded sounds are saved in the ".WMV" format and stored on the SD card. This text-to-audio conversion does not require any access to the external server or generates words "robotic" as some chips allow. However, this device is dependent on your own recorded sound database. However, this text-to-audio transfer has the advantage of being able to play special words that would not be able to play the different existing ones because they are not familiar with those words.

This option is suitable for older patients who can become accustomed to some words that can´t be read by conventional audio players. These words can be uploaded by the patient's own family. It is also possible to record recordings, for example, to recall medicines that will be more extensive, for example, "grandmother do not forget to give evening medication" and this soundtrack will be evoked by the text "EveningMedicine". This text can be generated by the robot itself as a result of a time alert set to remind drugs or through SMS messages sent by family members.

The robot is thus able to play messages sent by people, system recordings indicating dangers, reminders or later releases of this project, as well as social interactions and narratives such as "Hello good morning" or "Your lunch is ready, I wish good taste".

Another advantage of playing this text can be when the family uses the app to record their own sounds in their own language and their voice that may be more enjoyable to the patient or senior than the voice of a stranger or a "robotic" generated voice.

On the other hand, it may be more time-consuming to create your own word database. But the robot can be delivered with a certain database of words, and the family can supplement this database and possibly replace some words.

Of course, somebody in the family can send a SMS message to their buddy or somebody who helps them, and some of the SMS messages will not be able to play audio because they will not be recorded in the database. In this case, this communication module will generate a TXT file on the SD card and write the words used in the SMS message but can´t be played, the communication module can be programmed so that if the case occurs, it sends the SMS message by returning the sent number "These words could not be played".

Then, according to this list, someone in the family can upload the necessary recordings / missing recordings via the app. The text-to-audio conversion is based on the fact that the received message or the generated text by the robot is broken down into the individual words that must be separated in the text by the space bar. These words are then stored in a spreadsheet, and then the processor searches for and plays back the recordings.

Figure 2 is a listing of the microprocessor to the computer (this listing is only for demonstration and work on the development in the real application, the listing will not be, would be unnecessary). For SMS messages sent from a mobile to a robot communication module, it is necessary for the messages to begin and end with "#". This character better determines the beginning and end of the accepted string of characters.

Because the GSM module also sends the phone number from which the SMS message was sent, as well as the date and time, in addition to the SMS text message. However, if SMS messages do not start with "#", it can mean instruction for the microprocessor program, such as sending the battery status, or if everything with the patient is fine.

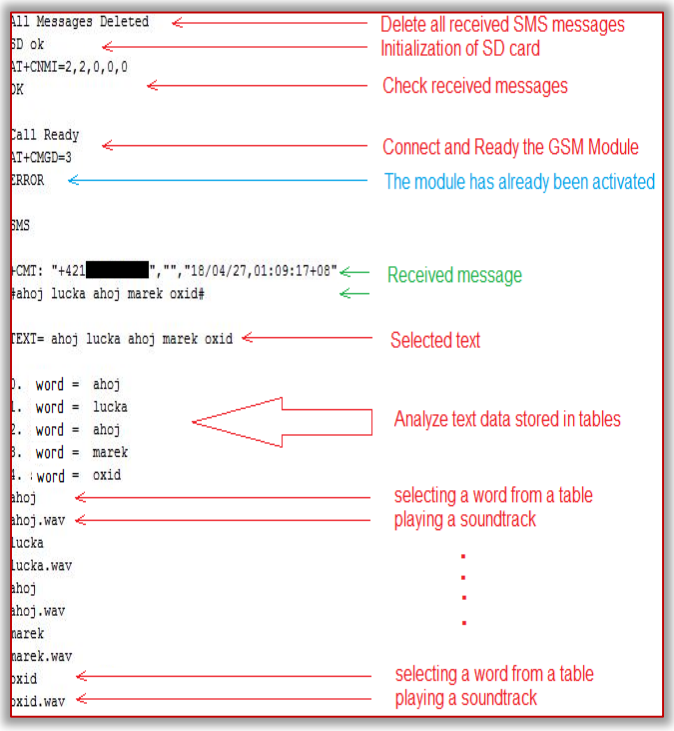

Figure 2. Module initialization, SMS reception, text analysis and wordplay

— Patient protection and warning messages

The second important role of this robot is to ensure safety for the patient or senior. Although a robot is not fully capable of protecting a patient from various dangers, he can at least provide him with protection in certain cases. Currently, this communication module only has a carbon monoxide sensor, which also detects the presence of flammable gases such as natural gas, BUTANE.

So, in addition to poisonous carbon monoxide, the module can also detect the presence of flammable gases. However, it is difficult to identify the difference between flammable gases and carbon monoxide. It is mainly because the combustible gases contain a large percentage of carbon monoxide. The need to distinguish whether space is filled with flammable gas or poisonous carbon monoxide is not necessary. The essential thing is the ability to record dangers. This MQ-9 gas sensor module is equipped with analogue output as well as digital. The digital output is set by the potentiometer directly on the sensor. Of course, analogue input is better to determine the concentration. However, the digital output may indicate a sharp change in the concentration and activate the external interrupt whose function will be to instantly send the SMS message.

The robot can then switch to safe mode and assume that there is a flammable or explosive gas in the room. Under this assumption, all components that could scrape off (electric motors) can be shut off to cause an explosion or fire. In operation, however, there may still be different sensors and sensors and, of course, a communication module. He or she can send the message immediately to the family members or directly to the fire brigade or other security component. If the household is transformed to partially intelligent and there are ventilation fans in the room, of course the engine should be built-in somewhere out of space or free of scratches, so the robot can activate it remotely and thus partially or completely ventilate the rooms to save the elderly or the patient. This situation can occur mainly in seniors who suffer from a high stage of sclerosis and may forget to ignite a stove or an open gas cook without burning and thus escaping natural gas.

The position safety feature currently available for this communication module is a 3-axis accelerometer. It has separate analogue inputs that do not go through the multiplexers, so the processor can measure the rotation speeds relatively quickly. In addition to the impacts, the accelerometer can also record rotation and the ground due to gravity acceleration. In case the robot and the patient are just flown to the ground even if it is not to be done because the robot is dimensioned for it, the processor can record this status and send a warning message.

All of these sensors affect the safety of the patient. However, in the later stages, a large number of other sensors will be added. One of these may be a thermal sensor or a small thermo-camera that could identify a fire and call firefighters. Alternatively, if the robot was equipped with a built-in powder or fire extinguisher, he could fire himself.

The robot may also have sensors of a different type such as a blood pressure sensor, a pulse or infrared thermometer, and through these sensors, the physician can see health data from the patient. Of course, it is always better when a doctor looks directly at the patient, but sometimes it can be time consuming or affordable, and then such a remote examination would have to be enough.

The last security element is the emergency button that the patient can call for help, after pressing the SOS alert message sends to the pre-programmed telephone numbers.

— Robot control with a DTMF decoder

Thanks to the GSM module, the robot is also able to connect to the Internet, specifically to a server. Using a page or mobile app, such a robot could also be remotely controlled. A small camera on the robot or camera system in the apartment is possible and it is possible to manipulate the robot and go home, measure the pulse, blood pressure, and so on.

However, the Internet connection has one disadvantage that should first be overcome, the disadvantage is that such a robot could begin to control the overwhelmed security element by another unauthorized person. This could lead to a patient or a senior being endangered and lead to health hazards, or could open the front door and rob the apartment. There is, however, one alternative to remote control of the robot that would be safer. This option is tonal control. Once a call has been made between the operator and the robot, the operator can control the robot by using keypad tones on mobile or applications to generate these tones. These tones are converted into logical outputs by the demodulator in the robot. These tones are 16 together and can be written with 4 logical outputs. These outputs then go to the main processor, and by using a combination of tones or individual tones, the robot can remotely control the operator.

Taking control over this way of control can be far more challenging and therefore safer. A telephone number is required to make a call, and it is pre-programmed in the communication module; in the case of a call from another number, the module will be considered as unauthorized access and terminates the call and sends the SMS message to the phone number to which it sends the alert messages. In order to further protect this method, the robot can wait for a password or PIN code to be entered by voice dialling after a call.

CONCLUSION

The robot communication module for care and assistance with walking or self-employed patients / seniors is a prototype in development that will be further expanded and improved. Emphasis will be placed on enhancing text-to-speech to make this system as user-friendly. In the final version, this communication module can be used as a separate programmable unit for other robots as well.

The next level of development will be the integration of the GPS system and the extension of the position sensor (accelerometer) to the gyroscope and magneto meter for accurate positioning in exterior and interior.

When used outdoors, in conjunction with ROBOTIC ASSISTANT FOR THE ELDERLY, it can send the patient's position while walking or if the patient is lost. Multiple sensors are planned to be inserted into the base assembly to monitor the surrounding area without the need for shooting.

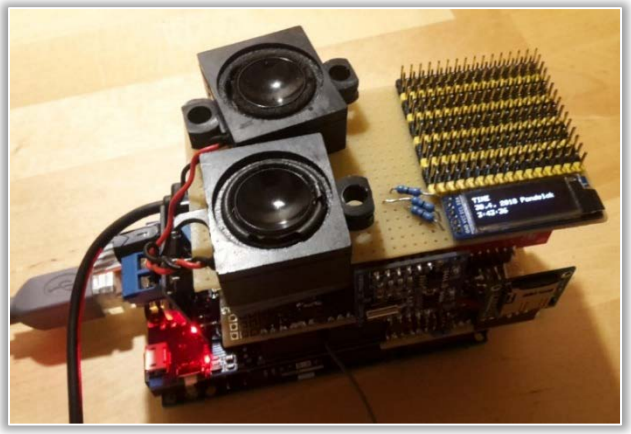

Figure 3. The prototype of the communication GSM module

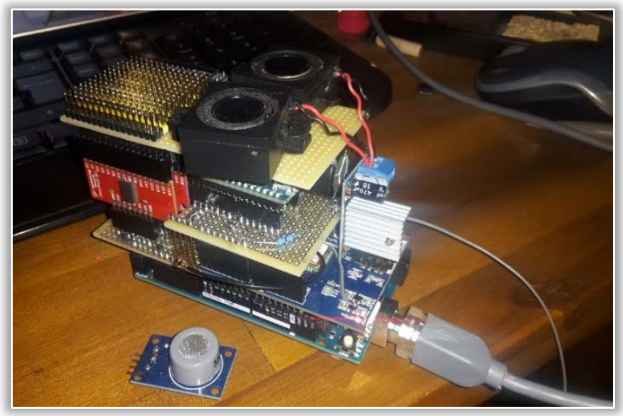

Figure 4. The prototype of the communication GSM module and gas sensor MQ-9

One option is to improve the CO2 sensor in conjunction with organic part detection, barometer, thermometer and hygrometer. Also, a casing is developed in which it will be completely stowed and will have attachment points to allow this communication module to be connected to any device. Figure 3 and Figure 4 shows the prototype of the communication GSM module.

Acknowledgment

I would like to thank my colleagues who supported me in this work with technical support but also with many useful advice.

Note:

This paper is based on the paper presented at 12th International Conference for Young Researchers and PhD Students – ERIN 2018, organized by Slovak University of Technology in Bratislava, Faculty of Mechanical Engineering and Slovak Association of Mechanical Engineers (SASI), in Častá-Papiernička, SLOVAKIA, 2 – 4 May 2018.

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VALIDATION OF DECLARED PARAMETERS OF WATER-RING VACUUM PUMP AND ITS ENGINE

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Abstract: The testing of the liquid-ring pump needs to take into account the operational quantities, difference in the measured differential pressures and efficiency of the motor drive. The paper describes specialised testing measurements of guaranteed operational parameters and properties of a liquid-ring pump in order to identify its real operational values, efficiency, and parameters. A special measurement stand was constructed for the purpose. We tested the efficiency of the liquid-ring pump, and the electrical quantities of the motor. The identified parameters and properties were compared with those declared by the producer – supplier. The results of the laboratory measurements show that the values declared by the producer differed by as much as 30 % to the detriment of customers.
Keywords: water-ring pump, efficiency, operational parameters, measurement verification

INTRODUCTION

Recently, products of Eastern countries of origin, particularly from China, have appeared on the European and American markets. This is not to speak only of readily available components and goods for everyday use, but even more complex components and units that embody interesting alternatives to be used in industrial applications and operations. These are products of precise engineering, electronic parts, components, mechanical parts as well as finished devices. As may be expected, their major advantage is an interesting price/performance ratio. However, it is important to be cautious, particularly if the products bear upon Chinese standards that are different to European ones [1,2].

With regard to the uncertainties when assessing product quality, a question arises – what the real quality, usage value, and real parameters of technologically more complex products are. This paper discusses a liquid-ring pump of a Chinese origin. Considering the fact that it is a machine equipment that is rather demanding as for the production process quality requirements, we aimed to assess and test the device. Similar devices supplied by established local European producers maintain a high standard of quality in the long term, which is also reflected in their price. The question is whether the parameters of a cheaper alternative device are such as declared by the producer / supplier. The testing of the liquid-ring pump needs to take into account the operational quantities, difference in the measured differential pressures and efficiency of the motor drive [3,4,5,6].

EXPERIMENTAL

— Testing the parameters of vacuum pump

Within the experimental measurements we tested a liquid-ring pump produced by CHINCO, type 2BV2-061, serial number C1611132, year of manufacture 2016. The maximum declared lifting capacity is 52 m^3/h and water consumption is 2.5 l/min.

A testing stand was used to verify the amount of extracted air and reaching the required suction pressure by the liquid-ring pump. For this purpose, the stand was equipped with a measuring segment with a centric orifice plate to measure the quantity of the flowing air for the pump suction and a draw-off to read the static suction pressure and delivery of the liquid-ring pump.

The thermal-technical parameters of air were measured for different settings of service water consumption. Several states of the liquid-ring pump, for which operational conditions were set, were tested. Based on the results of testing the different states, four tests were defined to determine the lifting capacity of the liquid-ring pump. First, the liquid-ring pump was operated at a constant amount of service water, which was not added in the course of the Test 1. Test 2 was carried out with a minimum water flow rate (1.13 l/min). The water rated consumption was gradually increased to 1.82 l/min in Test 3, and to 2.5 l/min in Test 4. All the tests lasted from 5 to 10 min. The time table of testing is listed below in Table 1.

Table 1: Parameters of water flow (consumption) during the testing of the vacuum pump at the testing stand

Test No.	1	2	3	4
Time [sec.]	16:45-16:55	16:56-17:02	17:03-17:11	17:11-17:21
Maximal Flow Rate [m3/h]	0,58	0,6	0,62	0,62
Minimal Flow Rate [m3/h]	0,03	0,06	0,03	0,02

During all the stated tests, we continuously measured and read air pressure and temperatures at the relevant metering points of the testing stand, the atmospheric pressure of ambient air, including the relative humidity (air pressure in the pump suction p1 (kPa), differential air pressure at the orifice dp (kPa), and the amount of sucked water into the liquid-ring pump Qv (l/min)). The different values were recorded during the tests using a measuring instrument Ahlborn Almemo with a storing interval of 5 s. The measured data were processed in the form of graphical records – see Figures 1 and 2.

The temperature was measured using thermocouples of "K" type placed in the pumping pits. Air flow at the testing stand input was measured using a centric orifice plate designed and made for this purpose. The mass flow was calculated on-line according to

equations set in ČSN ISO EN 5167 from the values measured on the throttle device (differential pressure, static pressure, temperature). The static pressure was measured using calibrated pressure converters by Honeywell, with 0.15 precision and electric output 4 – 20 mA. The final absolute pressure was measured and evaluated according to the equations below:

$$p = pr + pa \quad (1)$$

$$pr = pm + pH_2O \quad (2)$$

where: p - final absolute pressure [MPa, kPa], pr - pressure corrected to suction head [MPa, kPa], pa - atmospheric pressure [MPa, kPa], pm - pressure measured by a pickup [MPa, kPa], pH_2O - correction to lift suction head [MPa, kPa].

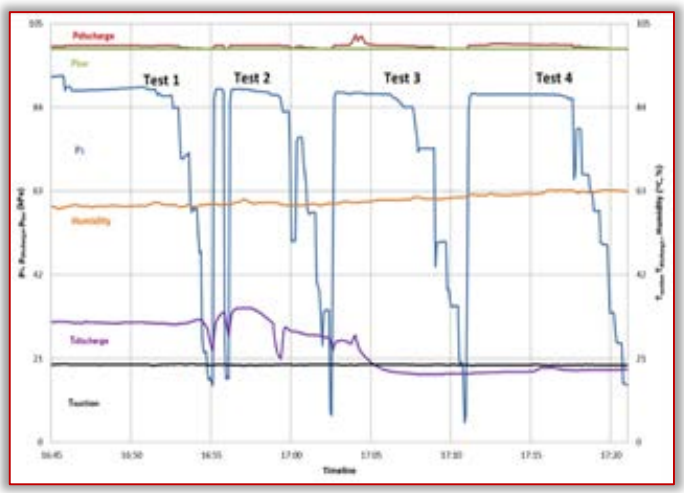

Figure 1: Parameters measured during the tests

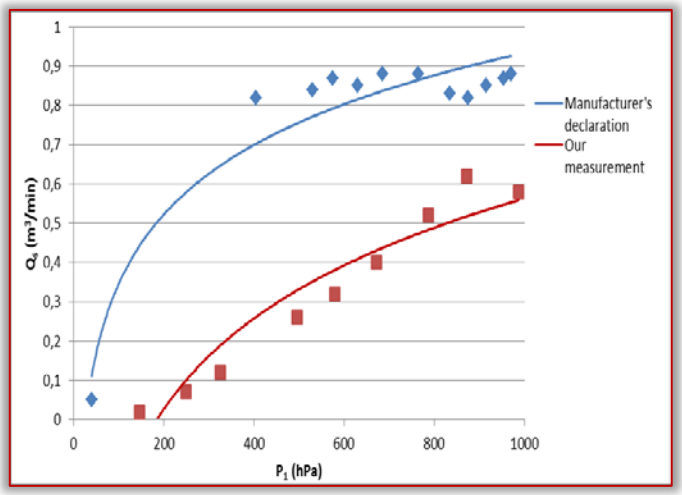

Figure 2: Measured performance of the liquid-ring pump during the tests compared to the performance declared by the producer

The measured values of pressure, temperature, and air quantity in dependence on suction pressure during the different tests were plotted into charts (Figures 1 and 2). They provide the information required to compare the real operational parameters with those declared by the producer. In this article there are also listed charts of several testing measurements to avoid possible mistakes and uncertainties of measurement.

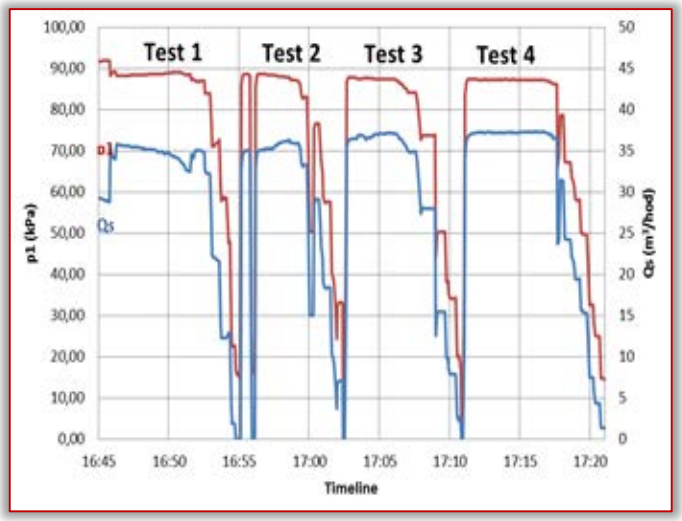

Figure 3: Measured values of absolute pressure and sucked air in vacuum pump suction

— Motor measurements

The liquid-ring pump is driven by a motor, the parameters of which we also tested. The motor parameter values declared by the producer are stated in Table 1. These are the device parameters written on the label and specified by the manufacturer. Same values are also listed within the documentation.

Table 2: Parameters on the motor label declared by the producer

TYPE YX3-90S-2T	No. 31618059 A		
P 1.45 kW	U 380 V	AC 3.2 A	
η 81.3 %	COS φ 0.84	RPM 2865 r/min	
FREQ. 50 Hz.	IP 55	CONN. Y	WT. 22 kg
INS. CL. F	DE/ODE BRG 6206N/6205N		DATE 2016/09
CE ANUI WANNAN ELECTRIC MACHINE CO., LTD Q/WN.281-2012			

The electric input was measured using an electronic wattmeter Yokogawa WT230, and own measurements were carried out on the motor terminal board of the pump. The input current was upstream the voltage inputs that were connected directly to the motor terminal board. The connection arrangement is represented schematically in Figure 4.

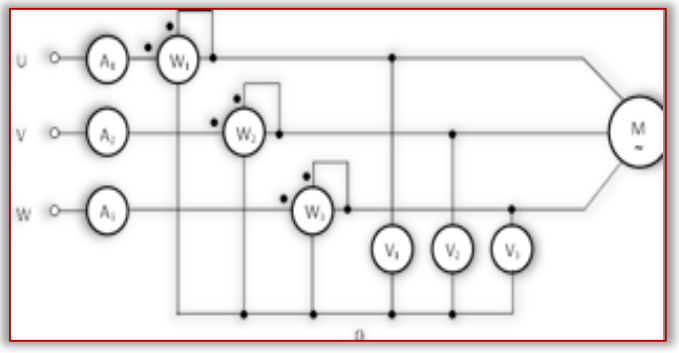

Figure 4: Scheme of measuring the electric input.

The measurements were executed under identical conditions. The basic parameters of wattmeter settings were as follows:

Table 3: Parameters of wattmeter

Voltage compliance: XU=300V~
Compliance current: XI=5A~
Acc. To measure the current: 0.1% of reading + 0.1% of range
Acc. To measure the voltage: 0.1% of reading + 0.1% of range
Acc. To measure the output: 0.1% of reading + 0.1% of range
Input resistance of the voltage input: 2 mΩ
Input resistance of the input current: 6 mΩ

— Measured results

The electric inputs were measured at the set constant flow rates of the medium. All the parameters were measured at the laboratory testing stand at constant conditions to obtain precise values. Testing was carried out multiple times to keep the measurements credible. All the parameters (voltage, current, apparent input, blind current, active current, phase factor) were measured for each phase separately. The last row in Table 2 gives an accumulated value for the whole system (Σ 3f).

The shaded cell of the three-phase active current P for the whole system may be taken for the comparisons with the value guaranteed by the producer. The measurement uncertainty is determined from a formula to calculate an error of measurement stated by the pump producer. The tables below summarize the obtained values and show the real values obtained while testing at the testing stand.

Table 4: Test No. 1. (P1=1937.9±6.4 W).

Flow rate q=0,0 l/min						
Phase	U [V]	I [A]	S [VA]	Q [var]	P [W]	PF [-]
U	234,10	3,446	806,9	484,3	654,4	0,800
V	234,20	3,442	806,2	480,0	647,8	0,803
W	234,36	3,434	804,9	481,9	644,8	0,801
Σ 3f			2418,0	1446,2	1937,9	

Table 5: Test No. 2. (P_1=1900.8±6.4 W).

Flow rate q=0,0 l/min						
Phase	U [V]	I [A]	S [VA]	Q [var]	P [W]	PF [-]
U	234,95	3,408	800,7	487,3	635,4	0,794
V	234,83	3,391	796,2	474,8	639,1	0,803
W	234,77	3,353	787,1	476,8	626,3	0,796
Σ 3f			2384,1	1438,9	1900,8	

Table 6: Test No. 3. (P_1=1955.7±6.5 W).

Flow rate q=0,0 l/min						
Phase	U [V]	I [A]	S [VA]	Q [var]	P [W]	PF [-]
U	234,77	3,407	799,8	489,7	623,4	0,791
V	234,77	3,411	800,8	474,6	645,1	0,806
W	234,30	3,333	780,0	469,0	623,3	0,799
Σ 3f			2380,7	1433,3	1900,7	

Table 7: Test No. 4. (P1=1955.7±6.5 W).

Flow rate q=0,0 l/min						
Phase	U [V]	I [A]	S [VA]	Q [var]	P [W]	PF [-]
U	235,41	3,513	827,1	508,7	652,1	0,788
V	235,29	3,505	824,9	491,1	662,7	0,803
W	234,98	3,430	806,0	488,8	640,8	0,795
Σ 3f			2457,9	1488,6	1955,7	

CONCLUSIONS

It is clear from the measured values that the liquid-ring pump does not reach the suction output (52 m^3/h) declared in the product technical documentation. Moreover, along with a falling suction pressure, the sucked amount (lifting capacity) is also decreasing, which is inconsistent with the Pump Performance Curve measured on 23 November 2016 in the producer's testing lab.

When verifying the values declared by the motor producer, the highest information value is associated with the electric input measurement results. In fact, the measured input was 1.937 kW, the producer declares 1.45 kW, though. This implies that the real input is higher by more than 30 %. The other measured quantities are of a secondary importance and do not have a significant impact on the system efficiency. The insulation state of the motor complies with the operation safety requirements.

The measurements showed that the values declared by the producer did not correspond with the identified values. It must be pointed out that the differences between the measured values and the values stated by the producer may affect the operational usage value of the device. A problem may arise when a customer needs to exploit the whole spectrum of the declared input/quantity delivered, and having installed the device, they may be dissatisfied with failing to reach the desired parameters. The working operation may be jeopardized and an economic loss may amount to 20-30 %. Due to the scope of the paper, we do not report a number of other tests we also carried out in order to eliminate undesirable influences, or technological defects. They did not prove an influence of other factors and thus could not have affected the measurements.

Acknowledgment

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Note

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PHARMACEUTICAL PRODUCTS REMOVAL FROM WASTEWATER

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Abstract: The chemical pollution of water resources with pharmaceuticals is a major challenge facing the humanity in this century. The purpose of this paper was to reviewed methods for removing pharmaceutical products pollutants from wastewater. To assess the efficiency of pharmaceuticals removal from wastewater were presented several methods for removing these residues of drugs. These methods were adsorption on different adsorbent materials, photodegradation and removal during sludge treatment. Among other methods, the adsorption method in the presence of nanoadsorbants is supposed to be one of the best because of its important characteristics. This is due to the remarkable capacity of nanoadsorbants to adsorb a variety of pollutants. Researchers have a special interest in depollution wastewater from the pharmaceutical industry due of their impact on the environment. Water pollution due to drug and pharmaceutical residues is an alarming issue. It is due to the fact that these residues affect human beings and as a result of the degeneration of their biological activities can lead to enzymatic, hormonal and genetic disorders. Pharmaceutical products are widely used in human and veterinary medicine and are present in various samples of water, they can be removed or discharged directly into the domestic wastewater. Moreover, wastewater treatment plants due to insufficient technology to remove these pollutants do not eliminate most pharmaceuticals. Non-eliminated pharmaceutical products get into the groundwater and could be harmful to aquatic organisms even when are present at low concentrations (ng·L-1). Nanomaterials are widely explored as highly efficient adsorbents, photocatalyst and disinfectants for wastewater treatment. Generally, they exhibited various advantages, such as high adsorption capacity, fast kinetics, specific affinity towards targeted pollutants, enhanced photocatalytic response for a broad light spectrum, and strong anti-bacterial activity. The conventional treatment techniques inefficiency for removal pharmaceuticals from wastewater suggests that more attention should be given to for the finding the new treatment processes in order to avoid environmental pollution.

Keywords: pharmaceuticals, pollution, wastewater, nanoadsorbents

INTRODUCTION

Currently literature shows that pharmaceuticals are releasing continuously into the environment in extremely large amounts from various sources such as pharmaceutical industry (waste and wastewater from hospitals), consumption by humans (95% of the dose can be excreted or discharged directly into domestic wastewater), the use of veterinary medicines (Farre M. et. al. 2007, Hong H.N et al. 2007, Imran A. et al, 2016, Renou S. et al, 2008).

Due to the fact that the pharmaceutical products are easily dissolved in aqueous media and do not usually evaporate at normal temperatures or pressures, they can accumulate in the soil and aquatic environments through sewage, treated sludge and irrigation with wastewater not properly treated.

Current research findings clearly demonstrate that current wastewater treatment technologies do not sufficiently remove pharmaceuticals and/or their metabolites and by-products of degradation from wastewater and therefore allow them to enter into surface water, underground water and soil (Kulikowska D. 2008).

Although some pharmaceuticals degrade after consumption or release into the environment, most of them remain unchanged and eventually become persistent in the environment. It is known that most of these chemicals remain bioactive even at extremely low concentrations after excretion from the body or after getting into the landfills and water, have unpredictable biochemical interactions when mixed and may tend to accumulate in the food chain with a negative impact on aquatic organisms and on consumers. As a result, pharmaceuticals, metabolites and their degradation products are of concern for their potential environmental effects (Cilek E.C. et al 2016).

Recent literature indicates that the flow of pharmaceuticals from municipal wastewater treatment plants is an important source of chemical pollution in surface water and seawater (Debska J., et. al. 2004).

Although the reported concentrations of individually reported pharmaceuticals worldwide are low and is not sure that can cause any danger to human health, exposure to a mixture of such compounds can disrupt the human body's balance, increase antibiotic resistance and pose a threat to the health of living organisms.

Some of the potential effects reported on living organisms were: delayed development of fish and frogs, delayed frog metamorphosis, increased feminization of fish populations and a variety of reactions, including modified behavior and reproduction (Shraim A et. al. 2017, Escher B.I., et. al. 2011).

MATERIAL AND METHOD

— Photodegradation

Photocatalysts, particularly those with high stability and activity have been regarded as suitable materials for applications in energy and the treatment of pollutants (Zhang Q. et. al 2018).

Numerous photocatalysts, such as Bi-based photocatalysts, doped TiO_2, Bi_2O_3, Bi_2WO_6, $BiVO_4$ and BiOX have been employed for the photocatalytic degradation of organics in wastewater or the ambient atmosphere (Zhang Q. et. al 2018).

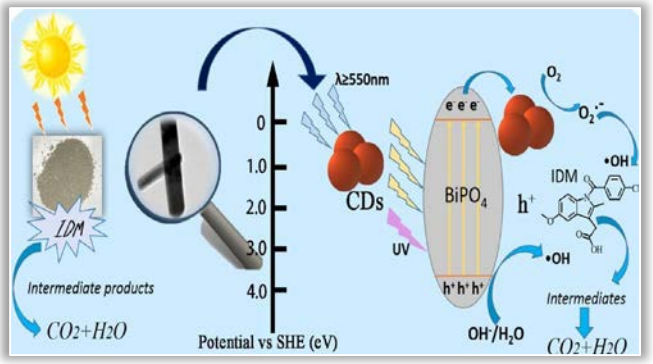

Figure 1- Proposed photocatalytic degradation pathways of indomethacin (IDM) under simulated sunlight irradiation with 3.0 wt% CDBP (novel carbon dots/$BiPO_4$) composites (Zhang Q. et. al, 2018).

Recently, pharmaceutical and personal care products have emerged as pollutants in ambient aquatic environments, which have attracted increasing concern, due to their potentially hazardous effects on ecosystems and humans (Escher B.I., 2011). Because of their stable chemical structures, and thus, they have detected in urban wastewater cycles, and even in drinking water. Some pharmaceuticals have been suspected of directly imparting toxicity to certain aquatic organisms (Rosal R., et. al. 2010)

Several pharmaceutical compounds have been shown to degrade due to the action of sunlight. The most extensively studied of these compounds is the analgesic/anti-inflammatory drug diclofenac, which has been shown to degrade in the aquatic environment due to ultraviolet (UV) light. Other compounds such as the topical antimycotic drugs naftifine, sulbentine, cloxiquin, tolnaftate, and chlorphenesin have also been shown to be light sensitive and an overall elimination rate of 0.03 day−1 due to photochemical degradation was observed for triclosan in the epilimnion of Lake Greifensee by Jones et. al. 2005.

Jones et. al. assessed the biodegradability of the clinically important antibiotics cefotiam, ciprofloxacin, meropenem, penicillin G, and sulfamethoxazole using the closed bottle test (CBT). None of the test compounds met the criteria for ready biodegradability. Of all the compounds studied, only penicillin G was found to be biodegradable to some degree, with approximately 27% being removed after 28 days. Even when the test was prolonged to 40 days, the removal rate was only increased to 35% indicating the compound was relatively stable (Jones et. al. 2005).

RESULTS

— Adsorption

In the field of wastewater treatment, nanotechnology exhibited great potential in improving the performance and efficiency of water depollution as well as providing a sustainable approach to secure water supply.

Until now, numerous studies have shown that nanomaterials have vast capability and potential in water, in particular, in the areas of adsorption membrane process 2011), catalytic oxidation (disinfection and sensing (Zhang Y. et. al. 2016).

Adsorbents or membrane based separation process are two most widely used technology for treatment of water and wastewater. Conventional adsorbents often face challenges such as low capacity and selectivity as well as the short adsorption-regeneration cycle, which significantly reduced the cost effectiveness of the adsorbants. Nanomaterial based adsorbants, i.e., nanosized metal or metal oxides, carbon nanotubes (CNTs), graphene and nanocomposites, often feature large specific area, high reactivity, fast kinetics and specific affinity to various pollutants. Their adsorptive performance towards certain pollutants is sometimes several magnitude higher than conventional adsorbents. Besides adsorption, membrane separation is also a key module in the treatment stage, enabling water reclamation from unconventional water sources such as municipal wastewater (Zhang Y. et. al. 2016). Nanocatalysts of high surface-to-volume ratio showed significantly enhanced catalysis performance over their bulk counterparts.

Additionally, the band gap and crystalline structure of the nanosized semiconductors exhibited size-dependent behavior. Their electron hole redox potential and photo-generated charge distribution varied with varying sizes (Zhang Y. et. al. 2016),

Separating and recovering nanomaterials from water after reaction has long been a technical bottleneck to overcome. Magnetic nanosized iron oxide adsorbants offered a viable and convenient solution by utilizing an external magnetic field (Hua et al., 2012). Another important magnetic adsorbent is nanosized magnetite considering its low cost, simple manipulation and environment-friendly properties.

Nanosized manganese oxides (NMnOs) exhibited superior adsorptive performance towards certain pollutants than other metal oxides because of its polymorphic structures and higher specific area (Tesh et al., 2014).

— Removal during sludge treatment

Many pharmaceuticals are not thermally stable and so might be expected to break down during processes such as composting due to heat (as well as chemical and biodegradation). Guerin investigated soil composting as an alternative to incineration for the treatment of a silty clay soil that had become polluted with residues of Probenecid (an antigout drug) and Methaqualone (a barbiturate substitute no longer available due to harmful side effects). In pilot scale trials, Probenecid was reduced from 5100 mg kg−1 to <10 mg kg−1 within 20 weeks during mesophilic treatments. The study also confirmed that thermophilic composting was effective under field conditions (Guerin, T.F, 2001).

CONCLUSIONS

The results sustain further research on this subject of interest by investigating different types of pharmaceutical products with some removal techniques.

Pharmaceuticals are used in large amounts in human medicine and reach the aquatic environment mainly through sewage treatment systems, where their concentrations can reach micrograms per liter levels. Some predictions can be made based on their physical and chemical properties, but their fate and behavior are not clear. There is little experimental evidence showing levels of pharmaceutical compounds in sewage effluent or sludge and even less showing they should be of concern. However, their biological activity alone may support ecotoxicity assessments of chemicals with high production volumes, especially in view of the increasing importance of freshwater resources and use of drug compounds.

Nanomaterials are widely explored as highly efficient adsorbents, photocatalyst and disinfectants for water treatment. Generally, they exhibited various merits, such as high capacity, fast kinetics, specific

affinity towards targeted pollutants, enhanced photocatalytic response for a broad light spectrum, and strong anti-bacterial activity. They are arguably the most promising candidate for the development of next generation wastewater treatment technology.

In this paper we presented three removal techniques for pharmaceutical products from wastewater. The most promising technique is the adsorption of pharmaceutical products onto nano adsorbants.

Despite the increasing research activities in this field, there is still a considerable need for future work and further investigation in order to assess the significance of pharmaceutical products in terms of their persistence and potential.

Note:

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NATURAL GAS – AN ENERGY AND ENVIRONMENTAL SAVIOR DURING THE 21ST CENTURY

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Abstract: Climate change is inevitable. Contributing to this change are (i) natural effects, which include the Earth in an interglacial period and (ii) various other effects such as anthropogenic effects, which include the release of non-indigenous gases into the atmosphere. However, the exact contribution of each effect to global climate change is not known with any degree of certainty. Natural gas has been proposed as a savior for the environment insofar as it released less carbon dioxide during combustion that crude oil or coal. This paper examines the properties of natural gas and how this fuel might affect the environment.
Keywords: climate change, natural gas, anthropogenic activity

INTRODUCTION

The most general definition of climate change is a change in the statistical properties of the climate system when considered over long periods of time, regardless of cause. Accordingly, fluctuations over periods shorter than a few decades, such as El Niño, do not represent climate change. The term sometimes is used to refer to climate change caused by human activity, as opposed to changes in climate that may have resulted as part of Earth's natural processes. In this sense, especially in the context of environmental policy, the term climate change has unfortunately and incorrectly been associated with anthropogenic (human activities) global warming as the causative factor. Within scientific journals, global warming refers to an increase in the surface temperature of the Earth while climate change is amore all-inclusive term that includes global.

The issue of global climate change is often associated with the use of fossil fuels as sources of energy. Of most concern is the increase in emissions of carbon dioxide (CO2) due to emissions from fossil fuel combustion:

$$C_{\text{fossil fuel}} + O2 \longrightarrow CO2 \quad (1)$$

Natural gas produces carbon dioxide when it is burned for energy but the combustion of natural gas produces considerably less carbon dioxide per unit of usable energy than combustion of other fossil fuels such as coal or crude oil, and their respective products. However, carbon dioxide emissions are not the main cause of observed atmospheric warming and there are several other causes that contribute to the global warming phenomenon [1]. The focus solely on carbon dioxide as the is due to.

Human activity produces vastly more carbon dioxide than all other greenhouse gases put together. However, this does not mean it is responsible for most of the earth's warming. Many other greenhouse gases trap heat far more powerful than carbon dioxide [2].

Thus, the focus of this paper is the properties of natural gas and how this fuel might affect the environment.

NATURAL GAS

Natural gas, which includes shale gas, gas from tight formations, and coalbed methane (Speight, 2018), is predominantly methane, occurs in underground reservoirs separately or in association with crude oil [3,4,5]. The principal types of hydrocarbons produced from natural gas are methane (CH4) and varying amounts of higher molecular weight hydrocarbons from ethane (CH3CH3) to octane [CH3(CH2)6CH3]. Generally the higher molecular weight liquid hydrocarbons from pentane to octane and collective referred to as gas condensate.

While natural gas is predominantly a mixture of combustible hydrocarbons (Table 1), many natural gases also contain nitrogen (N2) as well as carbon dioxide (CO2) and hydrogen sulfide (H2S). Trace quantities of helium and other sulfur and nitrogen compounds may also be present. However. Raw natural gas varies greatly in composition and the constituents can be several of a group of saturated hydrocarbons from methane to higher molecular weight hydrocarbons, especially natural gas that has been associated with crude oil in the reservoir, and non-hydrocarbon constituents (Table 1). The treatment required to prepare natural gas for distribution as an industrial or household fuel is specified in terms of the use and environmental regulations. Briefly, natural gas contains hydrocarbons and non-hydrocarbon gases. Hydrocarbon gases are methane (CH4), ethane (C2H6), propane (C3H8), butanes (C4H10), pentanes (C5H12), hexane (C6H14), heptane (C7H16), and sometimes trace amounts of octane (C8H18), and higher molecular weight hydrocarbons. Some aromatics [BTX – benzene (C6H6), toluene (C6H5CH3), and the xylene isomers (o-, m-, and p-CH3C6H4CH3)] can also be present, raising safety issues due to their toxicity. The non-hydrocarbon gas portion of the natural gas contains nitrogen (N2), carbon dioxide (CO2), helium (He), hydrogen sulfide (H2S), water vapor (H2O), and other sulfur compounds (such as carbonyl sulfide (COS) and mercaptans (e.g., methyl mercaptan, CH3SH) and trace amounts of other gases. In addition, the composition of a gas stream gas from a source or at a location can also vary over time which can cause

difficulties in resolving the data from the application of standard test methods [6,7].

Table 1. Composition of Natural Gas from a Petroleum Well

Category	Component	Amount (% v/v)
Paraffins	Methane (CH_4)	70-98
	Ethane (C_2H_6)	1-10
	Propane (C_3H_8)	Trace-5
	Butane (C_4H_{10})	Trace-2
	Pentane (C_5H_{12})	Trace-I
	Hexane (C_6H_{14})	Trace-0.5
	Heptane and higher molecular weight (C_{7+})	Trace
Cycloparaffins	Cyclohexane (C_6H_{12})	Trace
Aromatics	Benzene (C_6H_6) + other aromatics	Trace
Non-hydrocarbons	Nitrogen (N_2)	Trace-15
	Carbon dioxide (CO_2)	Trace-1
	Hydrogen sulfide (H_2S)	Trace-1
	Helium (He)	Trace-5
	Other sulfur and nitrogen compounds	Trace
	Water (H_2O)	Trace-5

However, prior to use, natural gas must be processed to remove the non-methane constituents [3,5,8]. Gas processing (also called gas cleaning or gas refining) consists of separating all of the various hydrocarbons and fluids from the pure natural gas [3,5,8-14]. While often assumed to be hydrocarbons in nature, there are also components of the gaseous products that must be removed prior to release of the gases to the atmosphere or prior to use of the gas in another part of the refinery, i.e., as a fuel gas or as a process feedstock.

Gas processing involves the use of several different types of processes to remove contaminants from gas streams but there is always overlap between the various processing concepts. In addition, the terminology used for gas processing can often be confusing and/or misleading because of the overlap [10]. Gas processing is necessary to ensure that the natural gas prepared for transportation (usually by pipeline) and for sales must be as clean and pure as the specifications dictate. Thus, natural gas, as it is used by consumers, is much different from the natural gas that is brought from underground formations up to the wellhead.

OTHER SOURCES OF METHANE

— Natural sources

The main natural sources of methane are wetlands, termites and oceans. Wetlands are by far the largest source with methane being produced from the anaerobic decomposition of organic matter covered by water. Because this process involves the action of bacteria, the rate of methane production is strongly temperature dependent. Maximum methane production is experienced at temperatures between 37 and 45°C (100 and 112°F) and so future increases in global temperature may enhance methane production from wetlands, thereby reinforcing the greenhouse effect.

Methane is also produced by the digestive processes of termites, resulting in approximately 5% of world methane emissions. This value is unlikely to change as termite populations are not expanding despite greater availability of biomass due to deforestation.22 Methane emissions from termites should be treated as a significant, but background, source that is likely to remain constant.

Oceans contribute approximately 2% to global methane emissions. The methane is produced by methanogenic bacteria within sinking particles in surface waters. The production of methane from oceans is spatially dependent, with much methane arising from methanogenesis in marine sediments, particularly in nutrient rich areas such as estuaries. There is also an anthropogenic component to ocean emissions, with bacterial populations being increased by high nutrient levels from agricultural fertilizer run-off and waste treatment effluents.

— Anthropogenic sources

The key anthropogenic sources of methane include fossil fuels, agriculture, landfill and the burning of biomass. Methane emissions arising from the fossil fuel industry form the largest anthropogenic source of methane. The main sources of fossil fuel-related methane emissions are the release of natural gas from coal mining and leakage from gas processing and distribution pipes [15-17]. Pockets of methane that have been trapped between layers of coal during its formation and methane within the coal itself are released once the coal is mined. Agricultural practices also result in significant methane emissions, the two major sectors being rice production and the rearing of livestock [18,19]. Thus, the relative lifecycle carbon intensity of a range of potential natural gas sources must be more fully understood, particularly methane leakage.

Methane is produced as part of the natural digestive processes of ruminant animals such as cattle, sheep and goats. Food is broken down by bacteria in the rumen, aiding digestion, since stomach enzymes are insufficient to break down plant polymers. However, the action of these bacteria yields methane, carbon dioxide and ammonia as gaseous by-products. With an increasing global population, coupled with higher living standards, livestock numbers are increasing world-wide.

Landfill sites also provide an anaerobic environment where methanogenic bacteria break down waste organic materials. Somewhere between 40 and 60% of landfill gas is methane, depending on the composition of the waste. The remainder is mainly carbon dioxide with other trace gases. The amount of methane emitted to the atmosphere from a landfill site is strongly dependent on the design and operation of the site. Unchecked, the landfill gas will simply permeate through the waste or along cracks in the compacted waste or bedrock. Modern landfill sites use impermeable liners and a capping layer to control the movement of the gas, which may then be collected. However, even the best caps are only 85% efficient25 with the remaining 15% of methane escaping through the cap.26. This is offset by breakdown of up to 90% of the methane in the capping layer by methanotrophic bacteria.

The burning of biomass releases substantial quantities of methane into the atmosphere each year. Biomass burning results mainly in the production of carbon dioxide, but if fires smolder and

combustion is incomplete, methane and other volatile organic compounds are released. The extent of methane emissions is dependent on the completeness of combustion and the carbon content of the fuel used.

— Methane hydrates

Although currently neither a source nor a sink, methane hydrates are by far the largest store of methane on the planet and account for 53% of all fossil fuels on earth. They are a crystalline solid mixture of water and methane (essentially methane trapped in ice) and are found in ocean floor sediments and arctic permafrost.

The methane in ocean sediment hydrates is trapped by the high pressure deep in the ocean but is released above a depth of 400m as the pressure drops. The energy industry is keen to take advantage of this and mine these deposits.29 Methane contained in arctic tundra, trapped within the frozen solid structure of the hydrate, is a more serious issue. Should temperatures rise, the methane hydrate will melt, releasing methane gas to the atmosphere. There is concern that, if rising global temperatures due to anthropogenic climate change cause the arctic permafrost to melt, massive quantities of methane would be released into the atmosphere, causing a catastrophic run-away greenhouse effect beyond even the upper 5.8ºC estimate postulated by the IPCC. Such a process is believed to have occurred in the Paleocene-Eocene Thermal Maximum, which occurred approximately 55 million years ago, when global temperatures increased by 5ºC (90F) average and which lasted for 150,000 years.

GASES IN THE ATMOSPHERE

The atmosphere (excluding moisture) consists of nitrogen (78%) and oxygen (21%) as well other gases, including greenhouse gases such as carbon dioxide, are collectively classified as trace gases due to their low concentrations. There is the belief that human activity is altering the composition of the atmosphere by increasing the concentration of greenhouse gases. Greenhouse gases occur naturally in the atmosphere and their presence results in what atmospheric scientists call the greenhouse effect. It is important to remember that the greenhouse effect is what keeps the earth warm enough to be habitable. The current concern is directed at an enhanced greenhouse effect, one that would put more heat-absorbing gases into the atmosphere, thereby increasing global temperatures.

The recent attention given to the greenhouse effect and global warming is based on the recorded increases in concentrations of some of the greenhouse gases due to human activity. Of particular interest are water vapor, carbon dioxide (CO2), methane (CH4), nitrogen oxides – such as nitrous oxide (N2O) nitric oxide (NO), and nitrogen dioxide (NO2), and ozone (O3) – and all of these gases occur naturally and/or are also produced by anthropogenic activity [20].

Carbon dioxide (CO2) is considered the most important human-influenced greenhouse gas. Scientific measurements reveal an unmistakable global increase in the amount of carbon dioxide, which arises primarily from the burning of fossil fuels (motorized vehicles, electric power plants, and homes heated with gas or oil) and the burning and clearing of forested land for agricultural purposes. But is carbon dioxide the real culprit for global climate change?

Methane (CH4) is the major constituent of natural gas and it is also a product of natural biologic processes, but its output can also arise from anthropogenic activity. This gas is emitted from the decay of organic matter in waterlogged soils (for example, wetlands and rice paddies) and from the digestive tracts of grazing animals (for example, ruminants). The additions from human activities include:

- # emissions from livestock,
- # emissions from landfills, and
- # leakage from natural gas during production and transportation [21,22].

Methane, the principal constituent of natural gas, is a much more effective greenhouse gas than carbon dioxide and has adverse effects on the atmosphere [23]. The infrared absorption of a methane molecule is almost 30 times that of a carbon dioxide molecule. However, the effective lifetime of methane in the atmosphere is much shorter. Nevertheless, an increase in the concentration in the atmosphere could result in a major change in the effects on the climate. Moreover, substitution of natural gas for crude oil and coal can be an important interim strategy to moderate carbon dioxide emissions while better non-fossil sources are developed and deployed.

The emissions of methane during the lifecycle of natural gas may be much higher than conventional estimates and the total greenhouse gas emissions may, as a result, be close to, or even higher than, those from the lifecycle of coal – particularly in the case of shale gas [24]. Clearly, there is a need for research to quantify much more reliably the methane emissions associated with natural gas. This can result in in findings that are unfavorable to the use of natural gas and there is need for serious quantification of any derived data.

It is therefore important to reduce global emissions to such a level that they are outweighed by methane sinks, so that the concentration of methane in the atmosphere decreases and its subsequent warming effect is reduced.

CONCLUSIONS

Natural gas has been promoted as a fuel that will allow society to continue to use fossil energy over the coming decades while emitting fewer greenhouse gases than from using other fossil fuels such as coal and crude oil. It is a fact that less carbon dioxide is emitted per unit of energy released during combustion when burning natural gas is compared to coal or crude oil, natural gas is composed largely of methane which is an extremely potent greenhouse gas. In fact, methane is responsible for nearly as much global warming as all other non- carbon dioxide greenhouse gases put together. Methane is twenty-one times more powerful a greenhouse gas than carbon dioxide.

The current information for global climate change points to global warming/climate change being influenced by the sum of all effects with no one effect (such the anthropogenic effect) being the major contributor from a multi-component group of effects, one of which is methane emissions. However, sound policies must be in place to make certain that natural gas is used to replace coal and minimize methane emissions.

Note:

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COMPUTER SIMULATION FOR SELECTION OF THE ORDER FOR THE LAYERS FROM THE WALL OF INDUSTRIAL COOLERS

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Abstract: In this paper a mathematical model and computer software for calculating the thickness of the insulation layers (panels) from the walls of the industrial coolers based on the order of their installation was developed. A numerical example is given that is tested on an existing industrial cooler in Bitola, Macedonia. In order to calculate the thickness of the thermal insulation it is necessary to consider a multilayer barrier (wall) where for each layer the thickness is known, except for the insulation material which should be calculated. With the determined geometric and physical characteristics of the wall, it is necessary to determine the temperature at each point of the construction. By connecting these points, the temperature change through the construction creates dependency with its thickness. After calculating the actual specific heat flux, the temperatures between each layer of the wall are calculated. For improved monitoring of the change in the partial pressure of the saturated water vapor through the layers of the wall, the thickness of the insulating material is divided into approximately five parts, and then a table of temperature changes and the corresponding value of the partial pressure of the saturated aqueous vapor is created. In order to avoid condensation of the water vapor when it passes through the wall, a certain condition must be fulfilled. With certain measurements adopted, a computer simulation was created and measurements calculated. The computer simulation enables swift and accurate calculation of thickness of the insulation at multilayer bulkheads found at industrial coolers, and allows selection of the location for the insulation and steam barrier in the bulkhead.

Keywords: Insulation coolers, industrial cold storage, panels, multilayer bulkheads, steam barrier

CALCULATION OF THICKNESS OF THE HEATING INSULATION

A multilayer wall is considered, where for each layer the thickness is already known, except for the insulating material. The insulating material thickness is calculated by Equation (1),

$$\delta_{iz} = \lambda_{iz} \cdot \left[\frac{t_n - t_v}{q} - \left(\frac{1}{\alpha_n} + \sum \frac{\delta_i}{\lambda_i} + \frac{1}{\alpha_v}\right)\right] \quad m \qquad (1)$$

where,

λ_{iz} [W/mK] - coefficient of thermal conductivity of the insulation,

α_n [W/m^{2}K] - coefficient of passage of heat from the external air to the outer side of the compartment,

α_v [W/m^{2}K] - coefficient of heat transfer from the inner side of the barrier of the internal air.

The recommended value for the specific heat flux is: q=11 W/m^2, [1].

CHANGE OF TEMPERATURE

With the determined geometric and physical characteristics of the compartment, it is necessary to determine the temperature at each point of the construction. By connecting these points we determine the change of temperature through the construction depending on its thickness, Figure 2. If we use the heat resistance of each junction instead of the thickness of the construction, then the change in temperature is a straight line.

The designed temperature of the external air is Equation (2),

$$t_{sp} = 0{,}4 \cdot t_{sm} + 0{,}6 \cdot t_{mm} \quad ^oC, \qquad (2)$$

where,

t_{sp} [°C] - average monthly temperature for the warmest month of the last 10 years,

t_{mm} [°C] - the average value of the maximum temperatures of the warmest month of the last 10 years.

The external air temperature are:

$\mathbf{t_n = t_{sp} + 6}$ [°C] - for outer bulkheads on the south side,

$\mathbf{t_n = t_{sp} + 15}$ [°C] - for ceilings with a flat roof,

$\mathbf{t_n = t_{sp} + 10}$ [°C] - for ceilings under roof with ceiling space,

$\mathbf{t_n = t_{sp} + 15}$ [°C] - for floors on the ground.

After calculating the thickness of the isolation, it is adopted and then the true specific thermal flux is calculated by Equation (3),

$$q = \frac{t_n - t_v}{\frac{1}{\alpha_n} + \sum \frac{\delta_i}{\lambda_i} + \frac{\delta_{iz}}{\lambda_{iz}} + \frac{1}{\alpha_v}} \quad W/m^2, \qquad (3)$$

After calculating the actual specific heat flux, the temperatures between each layer in the compartment are calculated by Equation (3),

$$t_x = t_n - q \cdot R_x \quad ^oC, \qquad (4)$$

where, R_x [m^{2}K/W] - heat resistance for each layer of the compartment.

CHANGE OF PARTIAL PRESSURE OF SATURATED WATER STEAM

To better monitor the change in the partial pressure of saturated water steam through the layers of the compartment, the thickness of the insulating material is divided into approximately five parts. A table of temperature changes and the corresponding value of the partial pressure of saturated steam is then made [2].

The specific water vapor flux is Equation (5),

$$W = \frac{p_n - p_v}{H_v} \quad kg/m^2 \cdot K, \qquad (5)$$

where,

p_n Pa - the partial pressure of the water steam of the external air,

p_v Pa - the partial pressure of the water steam of the internal air,

H_v m^2sPa/kg - resistance to diffusion of water steam through the barrier.

The resistance of water steam diffusion through the compartment is calculated by Equation (6),

$$H_v = \sum \frac{\delta_i}{\mu_i} \quad m^2sPa/kg, \qquad (6)$$

where,

μ_i kg/msPa - coefficient of steam permeability of the layer.

The partial pressure of the water steam between each layer in the compartment is calculated by Equation (7),

$$p_x = p_n - W \cdot H_x \quad Pa, \qquad (7)$$

In order not to condense the water steam, when passing through the barrier, the dependency must be fulfilled,

$$p_x < p_{\ddot{x}}(t_x) \quad \text{i.e.,} \quad t_x < t_{\ddot{x}}(p_x),$$

For a stationary heat flux through a multilayer barrier it is calculation by Equation (8),

$$q = k \cdot (t_{sp} - t_v) = k' \cdot (t_{sp} - t_x) \quad W/m^2, \qquad (8)$$

where,

$$k = k' \cdot \frac{t_{sp} - t_x}{t_{sp} - t_v} \quad W/m^2K, \qquad (9)$$

In order not to condensate the water steam, to the contact of the steam barrier and the compartment, the temperature t_x, which is at that place, must be greater than the amplitude of saturation t_x'', for the partial pressure that governs in that place,

$$k < c \cdot k' \cdot \frac{t_{sp} - t_x}{t_{sp} - t_v} \quad W/m^2K, \qquad (10)$$

where,

c = 0,95 - coefficient of safety.

NUMERIC EXAMPLE

According to the mathematical model, a computer program was created, which was tested on an existing industrial refrigerator in Bitola.

The thickness of the insulation on the southern outer wall composed of several layers is calculated, figure 1, with the following features.

- the insulation material which is going to be used is polystyrene and it is going to be installed after the bituminous steam boiler. its features are given in table 1.
- average monthly temperature of the warmest month of the last 10 years, [4], $t_{sm} = 25$ °C.
- average value of the maximum temperatures of the warmest month of the last 10 years, [4], $t_{mm} = 30$ °C.
- coefficient of passage of heat from the external air on the outside side of the compartment, [1], $\alpha_n = 30$ W/m²K.
- coefficient of heat transfer on the inside of the internal air compartment, [1], $\alpha_v = 8$ W/m²K.
- inner temperature, $t_v = 20$ °C.
- relative humidity of the external air, [4], $\varphi_n = 40$ %.
- relative humidity of the internal air, [4], $\varphi_v = 70$ %.

Table 1. Characteristics of the compartment [1].

Type of layer	δ mm	λ W/mK	μ·10¹² kg/msPa
1. facade plaster	20	0,870	37,500
2. brick wall	250	0,870	29,200
3. cementene mortar	20	1,280	25,000
4. bituminous steam barrier	5	0,760	0,012
5. insulating material		0,041	3,000
6. intertwined network			
7. cement mortar	20	1,280	25,000

Table 2. Change the temperature across the barrier

Starting layer number	δ m	R mK/W	t °C
1	0,000	0,000	34,660
2	0,020	0,023	34,425
3	0,270	0,310	34,490
4	0,290	0,326	34,330
iz	0,295	0,333	34,263
6	0,495	5,211	-18,564
7	0,515	5,226	-18,723

Comparison of the calculated and accepted sizes,

- Calculated outdoor temperature, $t_n = 34$ °C.
- Accepted external temperature, $t_n = 35$ °C.
- Calculated insulation thickness, $\delta_{iz} = 184$ mm.
- Accepted insulation thickness, $\delta_{iz} = 200$ mm.
- True specific heat flux, q = 10,2 W/m.

The thickness of the isolation is divided into five equal parts, and the temperature change through the insulating layers is shown in Table 3.

Table 3. Change of the temperature through the insulation layer

Serial Number	δ m	t °C
1	0,000	31,263
2	0,040	21,297
3	0,080	11,332
4	0,120	1,376
5	0,160	-8,598
6	0,200	-18,564

Table 4. Penetration of moisture through the compartment

Starting layer number	δ m	$H_v \cdot 10^{-9}$ m^2sPa/kg	p Pa	p" Pa
1	0,000	0,000	2251	5522
2	0,020	0,533	2249	5450
3	0,270	9,095	2211	4619
4	0,290	9,895	2207	4577
iz	0,295	426,562	370	4559
6	0,495	493,228	76	118
7	0,515	494,028	72	116

Table 5. Moisture penetration through the insulating layer

Starting layer number	δ m	$H_v \cdot 10^{-9}$ m^2sPa/kg	p Pa	p" Pa
1	0,000	426,562	370	4559
2	0,040	439,895	311	2534
3	0,080	453,228	252	1342
4	0,120	466,562	193	674
5	0,160	479,895	134	294
6	0,200	493228	76	110

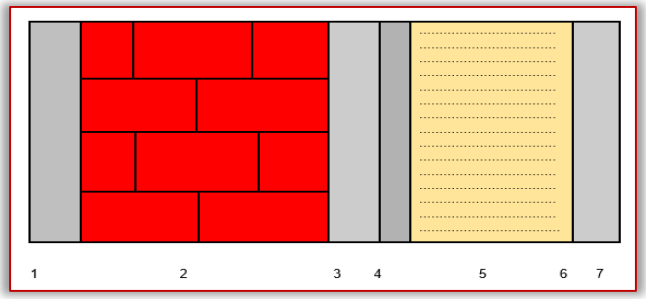

Figure 1. Construction of an external wall

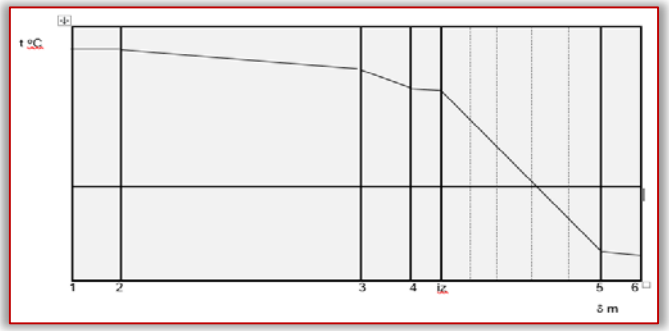

Figure 2. Change in temperature depending on the thickness of the compartment

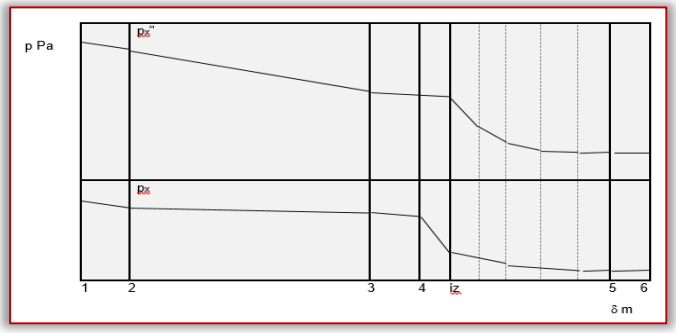

Figure 3. Change in the pressure depending on the thickness of the compartment

CONCLUSION

The aim of the paper is to provide a quick and accurate calculation of the insulation thickness at industrial coolers with multi- layered compartments. In addition it allows selecting the location of the insulation and the steam barrier in the compartment, in order to prevent the condensation of the steam somewhere between the layers of the compartment.

Note:

This paper is based on the paper presented at VIII International Conference Industrial Engineering and Environmental Protection – IIZS 2018, organized by University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin, SERBIA, in Zrenjanin, SERBIA, October 11-12th, 2018.

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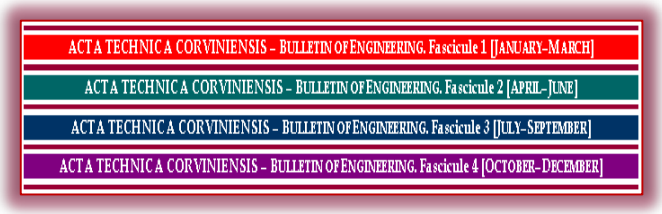

Now, when we celebrate the tenth years anniversary of ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, we are extremely grateful and heartily acknowledge the kind of support and encouragement from all contributors and all collaborators!

On behalf of the Editorial Board and Scientific Committees of ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, we would like to thank the many people who helped make this journal successful. We thank all authors who submitted their work to ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering.

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