ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome VI (Year 2013) – FASCICULE 4 [October–December]
ISSN 2067–3809

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MOTOR-CAR INDUSTRY AS THE MAIN MOTIVATION OF PLASTIC-INNOVATION

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ABSTRACT: New technologies and high quality materials are developed by manufacturers and molders of plastic to comply the emerging requirements. Applying developed technologies complex shaped plastic elements can be produced easily. The production of similar elements from steel needs more steps and more time as well. Besides these possibilities the new technologies increased the freedom of designers in the motor-car industry. This is the other important aspect of application of different type of plastics. This paper gives a brief summary about the development of application of plastic mountings in motor-cars moreover about its motivation and expectable trends. It shows the effect of international environment protection standards on design of motor-cars and construction of cars besides the plastic-industrial developments motivated by emerging demands and requirements.
KEYWORDS: CO_2 emissions, composites, fuel economy, lightweight design, organic sheets, plastics, recycling

INTRODUCTION

The ratio of plastic built in motor-cars is higher and higher year by year. The main goal is the reduction of mass of motor-cars in order to reduce the fuel consumption and CO_2 emission. There are two fields of motivation for manufacturers: thinking and habit of customers and international environment-protection standards. Steel as traditional constructional material has to be replaced by different types of plastic having the demanded mechanical properties. By application of plastics special possibilities of design and manufacturing can be utilized.

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Nowadays the plastic-innovation is motivated by motor-car industry because the main part of plastic element needs high quality materials and manufacturing technologies. For this reason newer and newer technologies have to be carried out [1].

In the frame of this paper a short overview will be presented about the environment protection aspects of application of plastic moreover the motivation of developments and results and possibilities of different engineering developments in this field.

CONSUMPTION AND ENVIRONMENT PROTECTION ASPECTS

There is an important part in environmental protection strategy of European Union to reduce the CO_2 emission of motor-cars. The CO_2 emission of motor-cars is significantly responsible for the climate change, especially in industrialized countries. Because the CO_2 emission is proportional to the fuel consumption, the CO_2 emission and the cost can be reduced by reduction of the fuel consumption of motor-cars.

According to the EU regulation for motor-car industry the CO_2 emission has to be reached 130 g/km until 2015 and 95 g/km until 2020 what correspond to 4,5 l/100 km fuel oil consumption and 5 l/100 km petrol consumption. The average value of the CO_2 emission of motor-cars was in 2010 approximately 140 g/km [2,3,4] (Figure 1).

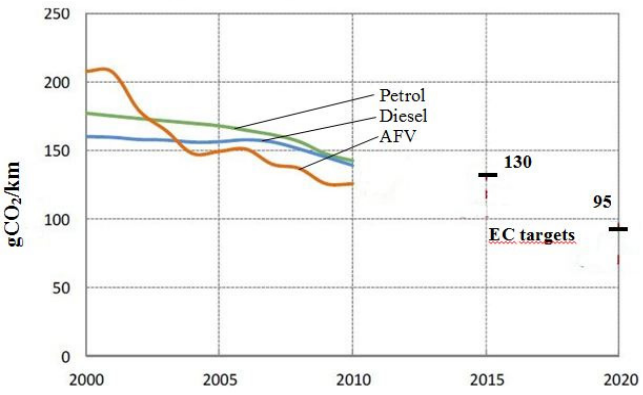

Figure 1 [5]. Evolution and EC targets CO_2 emissions from new passenger car by fuel (AFV: Alternative fuel vehicles)

The association of European, Japanese and Korean car manufacturers produced 98 percents of sold motor-cars undertook the fulfillment of emission target numbers concerning the new motor-cars. They want to reach the target numbers by different technical innovations.

TRENDS OF TECHNICAL INNOVATIONS TO MASS REDUCTION

The most important technical innovations to reduce the fuel consumption of motor-cars [6]:

- *Engine Downsizing With Power- Boosting Technologies;*
- *Hybrid & Electric Power trains;*
- *Downsize Vehicles;*
- *Lightweight Structural Materials;*
- *Fuel Cells.*

The subject of our investigation is at present the application of underweight constructional elements. The most of manufacturers have been changing the compound of material of car body to reduce the mass and the fuel consumption (Figure 2).

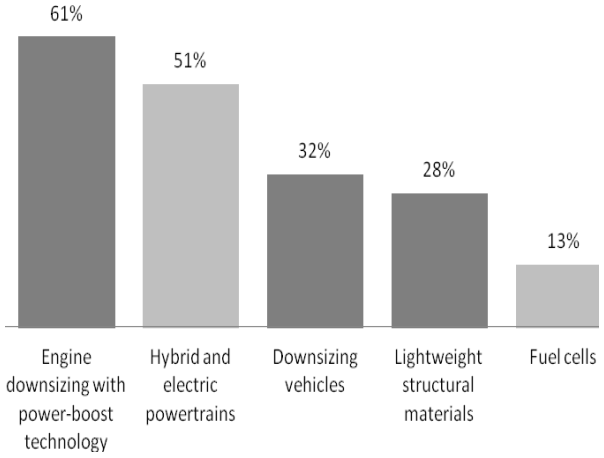

Figure 2 [6]. How will automakers meet emerging regulations

The mass reduction can be achieved by application of high-strength steel, light metal and plastic composites. The compound of materials used to motor-cars has changed considerably and this process will go on in the future (Figure 3).

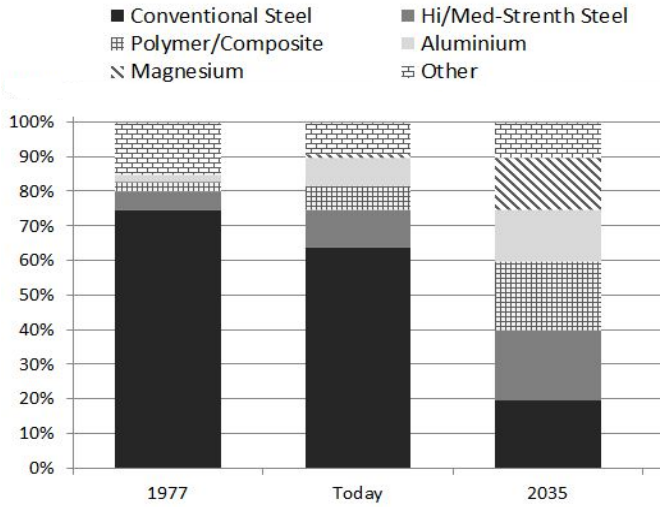

Figure 3 [7]. Typical composition of past and present cars versus a future light weight vehicle

Nowadays a medium size car contains averagely 100 kg elements made of plastic. Application of many kinds can be seen in Figure 4.

The application of thermoplastics in the motor-car industry is traditional. In spite of this fact until the last time it seemed to be suitable purely for low-load constructional elements. Due to the requirements to mass reduction the light metal alloys and reinforced-fiber plastic composites became real alternatives of steel.

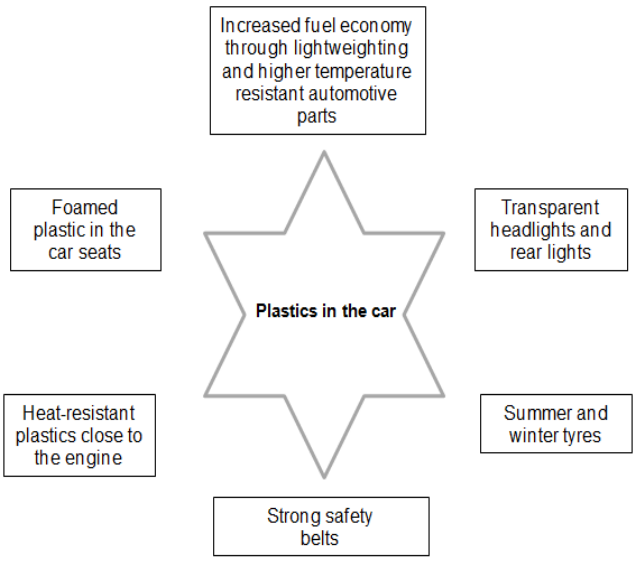

Figure 4. [13]. The use of plastics in cars

The plastic industrial innovations enable the application of plastic not only for decorating elements but also for loaded car-body elements and high heat and mechanical loaded elements in the engine space. The technical innovation will be demonstrated by several especial applications [6,8,9].

☐ ***Body structure and Components**; specific polymers: PP, ABS, PA, PC, „organic sheets"*

For manufacturers mass reduction can be reached by application of high-strength steel and light metal elements moreover complex base material including plastic as well.

- *The low beam of front part of Audi A8 is made of hybrid base material (metal/plastic). The bracing of metal can be reached by plastic plates made of thermo matrix containing reinforced-fiber plastic polymers (organic sheets).*
- *Elements having big surfaces can be produced successfully from reinforced-fiber plastic. For example the voluminous hybrid (plastic/ aluminum) plate of spare-wheel compartment of Audi A8 made from reinforced-fiber at a length of 6 mm plastic PA 6 (Durethan DP BKV60 H2.0 EF) [14, 16].*
- *The mechanical features of bumper bar can be ensured by application of ordinary kenaf hybrid KLFRT, twisted kenaf hybrid TKLFRT base material [17].*

☐ ***Under the hood***

Oil pans are exposed to many kind of loading: lubricants, high temperature, continuous and

dynamical load. The temperature of motor-oil can be reached from -40 °C until +150 °C.

- DuPont Automotive Company decided for the base material of oil pans of Mercedes C-class in 2009 the PA66 (Zytel 70G35 HSLR) reinforced-fiber plastic polymer.
- The solution of BASF Corp. was PA composite containing 35 percents reinforced-fiber plastic.
- According to Ticona Company two own products are suitable for similar application: Vectra LCP polymers and Fortron linear PPS [10].

Applied polymers in engine blocks: PPS, PBT, Long Fiber Reinforced Polymers (LFT). Mass reduction results reached by du Pont Company for 2011 applying high quality technical plastics are the followings [11, 12]:

- Rear camshaft retainer - 0.2 kg
- Manifold- 1 kg
- Charge air cooler - 1 kg
- Turbo charger duct, hose- 0.5 kg
- Oil pan - 1 kg
- Engine cooling system - 0.8 kg
- Rocker cover - 0.5 kg
- Engine cover - 1 kg
- Cylinder head - 4.5 kg
- Pumps, throttle body, small components - 0.5 kg

Other fields of application: [6, 8]

- Interior trim; specific polymers: PP, ABS, PET, POM, PVC
- Seats; specific polymers: PUR, PP, PVC, ABS, PA
- Hood; specific polymers: Nylon/PPE blend
- Door liners; specific polymers: PP, ABS, PET, POM, PVC
- Load floors; specific polymers: composites
- Fuel tanks; specific polymers: HDPE, PVDF
- Consoles; specific polymers: ABS
- Instrument panel; specific polymers: ABS, ABS/PC alloys, PC, PP, modified PPE, SMA.
- Automobile glazing: PC

CONCLUSIONS - SUMMARY

The fuel consumption and CO_2 emission depend on not only the efficient utilization of fuel but also the driving style and other no technical aspects. But yet the greatest effect on the fuel consumption is the own mass of the motor-car. For example the result of 100 kg mass reduction on a motor-car (self-mass 1500 kg) is ~0,3-0,4 l/100km reduction of fuel consumption [15].

In spite of continuous increasing of ratio of built in plastics in motor-cars there are still possibilities to reduce the self-mass of the cars in the future. At present the ratio of plastic in self-mass of small- and medium-size is ~ 15 - 17 %. According to experts there are further possibilities to replace metals in case of systematic application of light structural design.

For this purpose the most suitable material are the reinforced-fiber plastic polymers and composites but the recycling of these materials seem to be difficult. At present there is no effective technology for recycling or destruction of reinforced-fiber plastic composites. This is a quite important aspect because the manufacturers have to comply with the EU directive (End of Life Vehicle - ELV) about used cars.

The aim of this directive is to reduce the waste material coming out from used cars and to enhance the recycling of the elements of them. In order to achieve this coupled aims the EU directive prescribe new requirements for manufacturers. According to this regulation they should apply recycling or at the end of its life degradable materials [18, 19].

These coupled requirements give the motivation for manufacturers of plastic base materials to replace the generally applied artificially created reinforced-fiber by natural materials (flax, kenaf).

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ACTA TECHNICA CORVINIENSIS - BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]