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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.

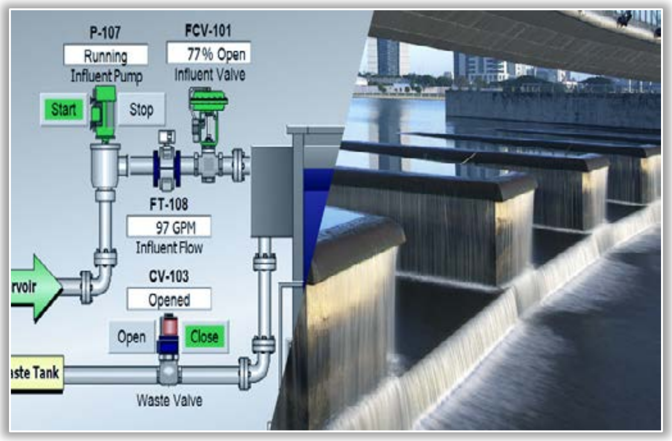

Figure 4. Monitoring the operation of the filter fields via the SCADA

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.

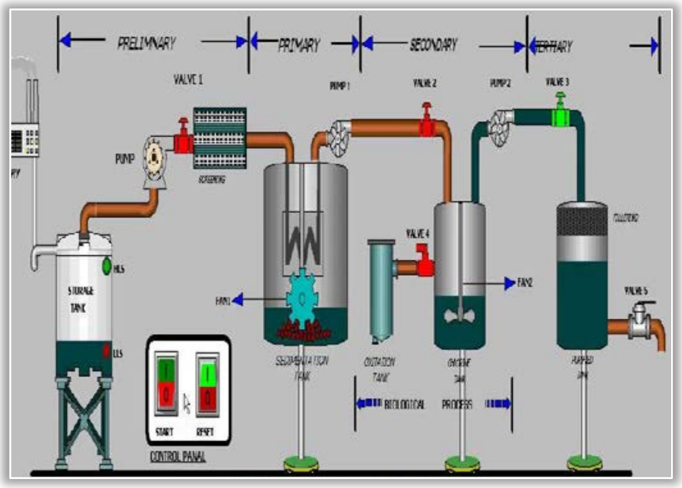

Figure 5. Water processing technology using SCADA

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.

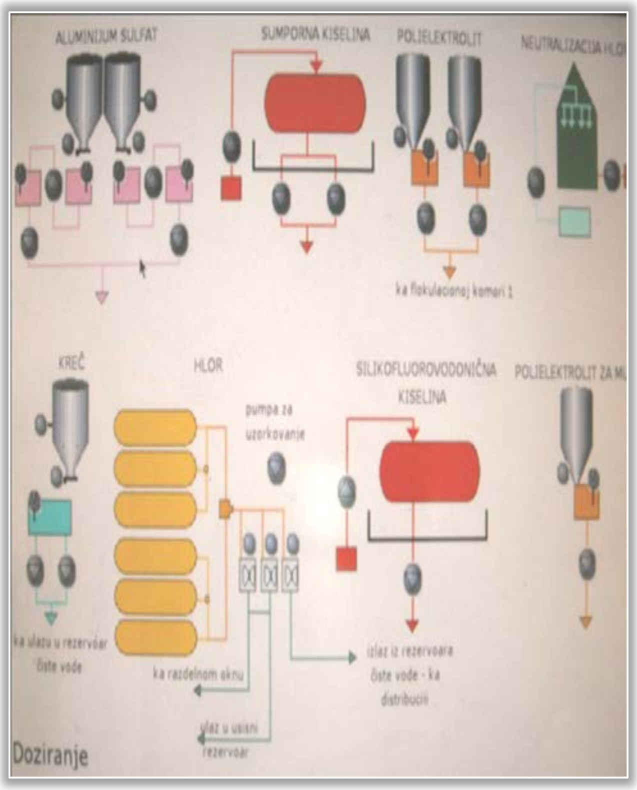

Figure 6. Technological process of water treatment using SCADA

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.

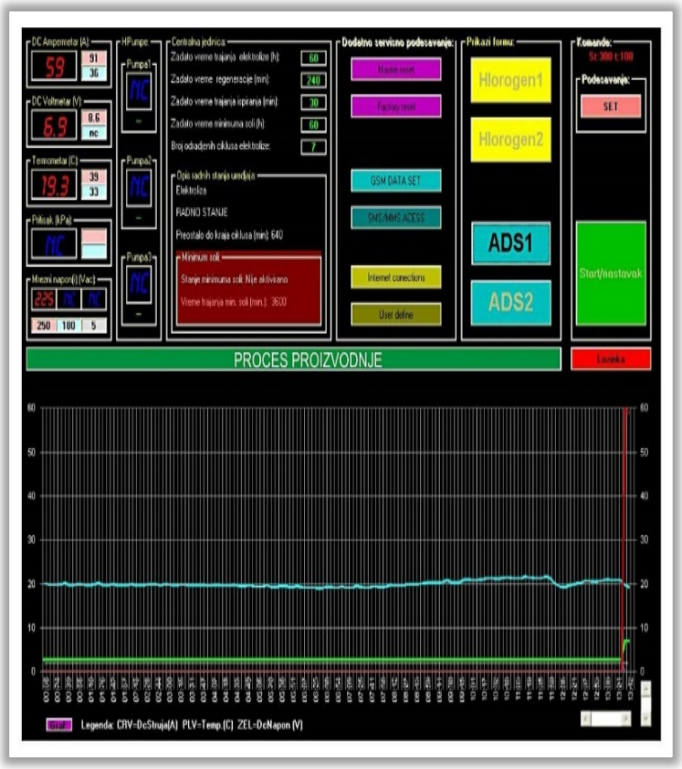

Figure 7. Process of chlorine production by electrolysis of salt

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.

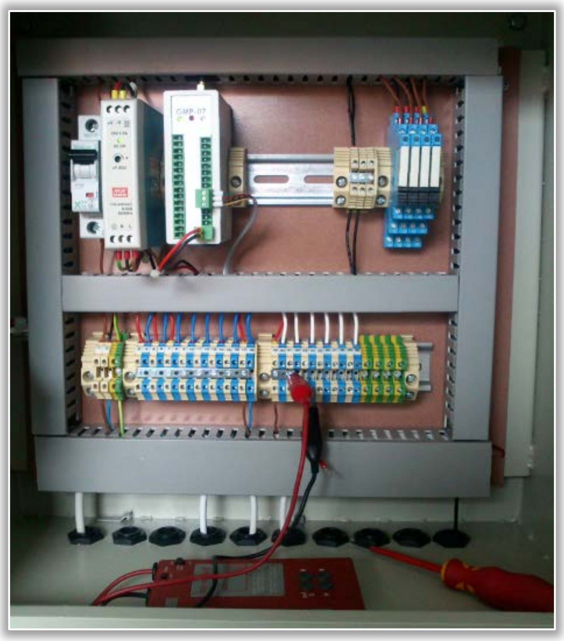

Figure 8. Electrical cabinet with a GPRS modem

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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