XV INTERNATIONAL SCIENTIFIC CONGRESS

SUMMER SESSION

12 - 15.09.2018, VARNA, BULGARIA

MACHINES TECHNOLOGIES MATERIALS 2018

PROCEEDINGS

VOLUME II

MACHINES
INDUSTRIAL INFORMATIC & MATHEMATICAL MODELING
MANAGEMENT

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BULGARIA

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ORGANIZER:

SCIENTIFIC-TECHNICAL UNION OF MECHANICAL ENGINEERING

12.09 – 15.09. 2018
Varna, BULGARIA

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time for presentation 10-12 minutes,
questions after each presentation

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time for presentation 10-12 minutes,
questions after each presentation

EMBEDDED MICROPROCESSORY SCADA SYSTEM FOR SUPERVISORY, CONTROL AND DATA ACQUISITION IN THE PROCESS OF PURIFICATION OF GASSES IN FERRO-NICKEL FACTORY.

Engineer Iliev Dejan.[1] Ph.D Goce Stefanov[2]
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Abstract: *In this paper is presented development and implementation of embedded microprocessory SCADA system in factory for production of Ferro-Nickel. In the process of refining of the molten metal are released huge amount of hot gasses that should be purified before letting them to the atmosphere. The project is to change old system of rellay logic and separately located indicators and controllers with centralised SCADA system with PLC and HMI interface, to monitor and control the work of gas Scrubbers and venting system. The paper presents SCADA system functionality and the advantages from the new digital over the old analog equipment.*

Keywords: SCADA, SUPERVISORY, CONTROL, DATA LOGGING, PLC, OPTIMISATION

1. Introduction

With the development of industry and more complex manufacturing processes, management of modern industrial plants is unthinkable without the help of modern monitoring systems or SCADA (Supervisory Control and Data Acquisition) designed for full supervision, better control and greater reliability in the production processes. These systems are present in all branches of the economy, but mostly in the process industry, energy, telecommunications, oil and gas industry, transportation, etc. Surveillance or monitoring of the plants, as the basic function of SCADA systems, uses communication protocols and a graphical user bond to present data for the state of the system to the end users or operators and provide a clearer image of the process.

Nickel-refining plant is the place of Ferro-Nickel factories where the final processing of the metal or refining is performed until the required parameters of the customers are reached. The metal in the plant arrives in a liquid state with a temperature around 1600 degrees Celsius. Upon receiving, the liquid metal is poured into huge vessels called Converters. In them, the metal is additionally heated by oxygen and air, adding limestone for reducing the unwanted elements such as sulfur, iron, etc. During this process, a lot of gases are produced which are further treated in the gas system and released into the atmosphere after their purification. The gas exiting the Converters passes through several aggregates for cooling and cleaning. First pass through the Hood where they are cooled down, then through the Quencher or primary Scrubber, which also cools them and removes the larger particles. From Quencher, they continue along through Scrubber, which also removes the tiny particles and finally the gas continues through a fan that sucks the gases from the Converter itself through the purification units to the exhaust chimney and the atmosphere.

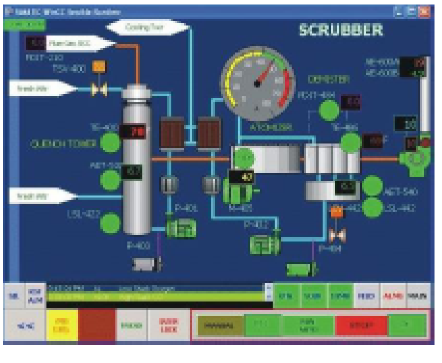

Fig. 1 Example of SCADA for gas cleaning process.

For all this to function impeccably it is necessary to constantly observe and monitor the properties of gas and water in the system. For this purpose, there are measuring instruments of different type: flow transmitters, pressure, differential pressure, level, position, temperature, PID controllers etc. Due to the durability of the equipment, the lack of spare parts and the need for more reliable and safe operation of the process, it was necessary to develop a project for replacing the existing equipment with new sophisticated equipment that would have a full visualization of the process.

The purpose of this paper is to present the design of a centralized SCADA system in which all process values with graphic display and the aggregates themselves with their physical position in the plant will be displayed on few screens for safer and more efficient work of the plant. The implementation of this project significantly improves the operation of the plant. Through this system, operators from one place can observe the entire process. In addition to real-time values, the program saves important data and draws up trends for past process conditions, thus avoiding defects even before they occur. An example of that is the fan vibration chart, when vibrations increase workers can take precaucons like balancing so as can be avoided serious damages to the bearings. With the early warning itself, stalls are avoided, making huge savings for the company.

2. Hardware configuration

The project uses a standard PC for the SCADA program and PLC Siemens from the family S7-300 model 314C-2DP with analogue cards SM331 AI8x13bit.

Figure 2: *PLC Siemens with analogue cards*

The PLC itself, besides the processing unit, has both built-in input/output analogue and digital cards as well as a memory SD card where the program is stored. The I/O are physically divided into two cards. The first has 8 digital inputs, 5 analog inputs and 2 analog outputs, and the second 16 digital inputs and 16 digital outputs. Channels for analog inputs and outputs can be used as current or voltage depending of the configuration in the software and the appropriate wiring connection.

Since we have multiple measurement points, to cover every of them, the PLC allows us to extend it with additional analogue cards. In this project, 5 cards per PLC are additionally connected, in total 10 analogue cards SM331 AI8 * 13bit. Analog cards as well as PLCs use a 24VDC power supply. They have 8 channels that can be used as current or voltage inputs, and on some of the inputs can be connected both directly thermocouples or RTD temperature probes.

The power supply of the PLC and I/O cards is from the same manufacturer Siemens model PS307 with the following technical characteristics:

Input voltage:	220VAC 50Hz
Input current:	1.3A
Output voltage:	24VDC
Output current:	5A

Table 1: Technical specifications of the power supply

During the elaboration of the project for visualization and control of the gas purification process, some of the existing measuring instruments, transmitters, actuators, controllers were used, and where needed new were installed and calibrated.

For measurement of pressure, differential pressure, water flow and level were used Endress&Hausser PMD75 and PMD 70 transmitters. These are multifunctional proven transmitters that can be quickly parameterized and calibrated to measure the required medium and the required value. As an output, they provide an analog signal 4-20mA and digital impulses through transistor outputs.

Figure 3: Pressure, flow, temperature transmiters used in the project

Temperature measurement is done with PT100 RTD probes of platinum, which give 0.38 Ω per degree of Celsius. In measuring places where there are higher temperatures, the measurements are performed using thermocouples type J. They are connected to PRETOP 5333 transmitters, which turn the ohm signal into a current 4-20mA and send it to the current input on the PLC.

For regulating the flow of the cooling water and gas through the system are used actuators and valves. The water flow is regulated with pneumatic valves which are controlled by the SCADA system and Siemens controllers. Operator sets needed flow so the controllers via 4-20mA signal and 3-15psi air pressure puts the valve in the needed position for the given flow. Air flow and the differential pressure is regulated with louver-dampers equipped with Andco actuators. They are also controlled from the SCADA or controllers with 4-20mA signal. SCADA program check feedback signal from potentiometers if the set position is reached.

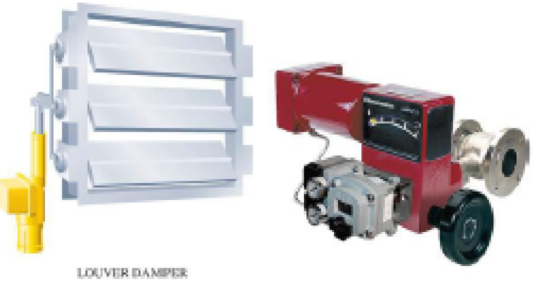

Figure 4: Actuator and valve controlling water and air flow

For setting and calibrating the equipment were used Fluke 179 multimeter and 717 Pressure calibrator. Calibrating of the temperature transmitters was made with Chauvin Arnaux calibrators.

3. Software configuration

For the development and implementation of the software in this project were used Siemens software packages. SCADA was programmed with WinCC Flexible and PLC programming was in Step 7 Simatic Manager 5.5.

SIMATIC Manager is software from the company Siemens that allows to provide detailed network configuration (with basic network and subnets), monitoring of the variables, their "forced activation" and more. We can program in one of the offered languages: STL-assembler which is low-level language, higher-level language SCL similar to Pascal, LADDER programming or graphically oriented and similar to relay patterns. FBD is also a graphic language that is very suitable for streaming the signal path and the S7-GRAPH language being the basis to draw a process flow chart, suitable for technological engineers. Simatic Manager is the part of the program where is done the all the math work. The raw signal from the I/O cards is scaled, and converted in format understandable for the final user. Programming starts with opening new project and setting of the hardware. It is very important to set all the equipment and the communication type between them. In this project we use Profibus communication that uses special communication cards, cable and connectors. Program is divided in several block with one main OB1 from are called all other blocks and functions. In the block we make all the connections between input raw values, scaling and calculations and the output values. All this is done with using of databases and symbols. Use of symbols make this program more flexible and with little changing in the programming it would be useable in lots of other processes and applications.

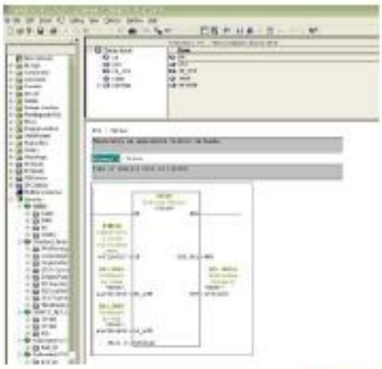

***Figure 5**:Part of a Function Block in Simatic Manager*

Scada software SIMATIC WinCC flexible is powerful HMI software for controling, monitoring and data collection in automated systems that use personal computers. In addition, it enables the defining and displaying the alarm conditions in the system, displaying trends, i.e. displaying changes in the system variables in time, forming alarm reports, trends and operators activities, and their archiving or permanent data storage. The process is displayed graphically on the screen, through a whole set of graphic elements to which they are associated with process tags or labels. Process or external tags allow communication between the components of the automated process, for example, HMI devices and PLCs (in our case, the computer and S7-300 PLC), or provide communication and direct connection between the operator and the process. The external tag is an image of a particular memory location in the PLC. The operator can read and adjust the values of process values through the HMI device, using process tags via a memory location in the PLC. There are also internal tags that are stored in the memory of the HMI device and serve to perform internal (local) calculations. These labels have no connection to the PLCs.

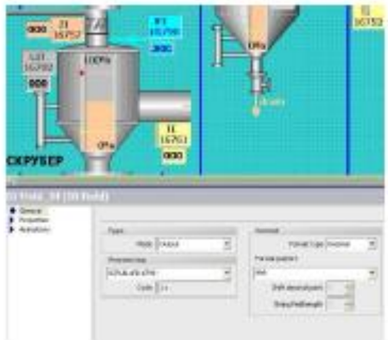

***Figure 6**:Configuring I/O field in Simatic WinCC Flexible*

4. Results of SCADA configuration

As a result of the software and hardware configuration, making measurement, calibration and parameterization of the instruments, in this paper is made SCADA project showing the process variables divided in three screens: Main screen, Admin, Scrubber and Motor & Ventilator.

The main screen displays the process values from all measurement points in the plant in real time. For that purpose we use digital indicator fields and visualization with a bar graphs. They are arranged in the display screen just as they are distributed across the aggregates through the plant, thus providing the operator with a clear picture of the state of the process for cooling and purifying the gases, the condition of the aggregates themselves, critical conditions, etc. Each alarm state is displayed on the screen in yellow and red color, so it's easy to see in which part of the process is the problem. For each kind of measurement, such as pressure, flow, temperature, etc., there are different colors of indicators that are of great importance for the delineation of the displayed values. Also with selecting the I/O field we can set desired value that we need for the process.

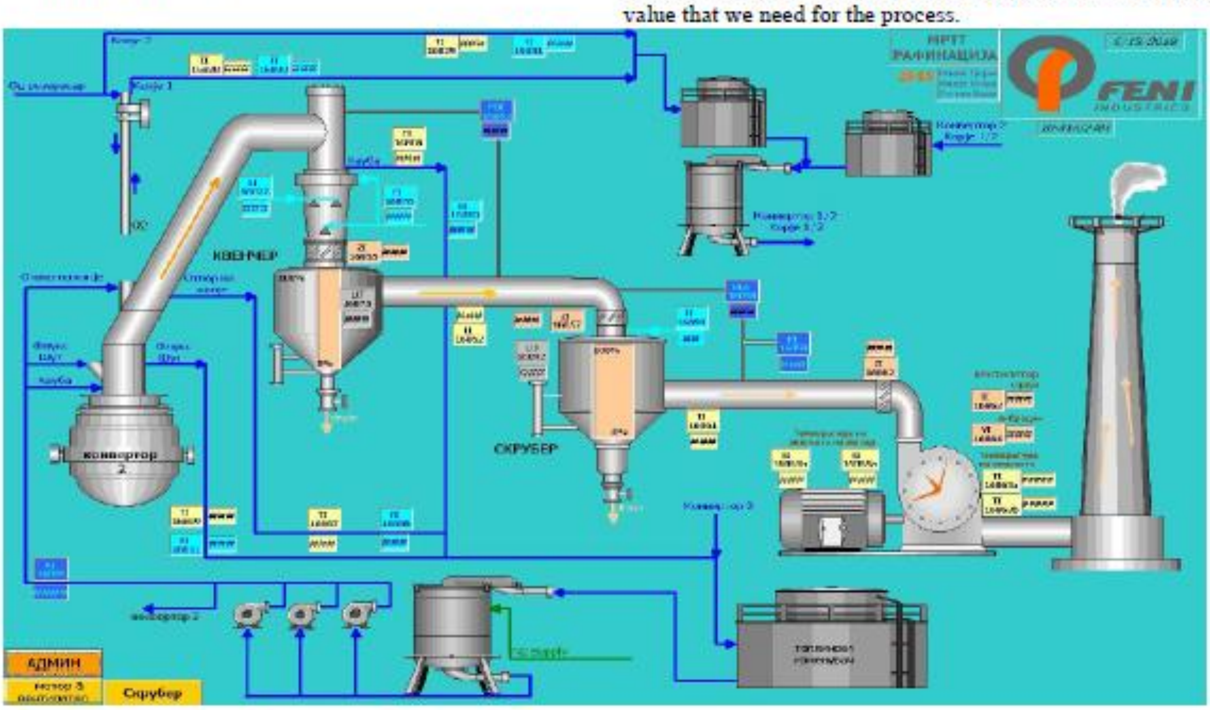

***Figure 7**: SCADA main screen with process values*

On the screen Motor & & Ventilator are displayed values of the measuring points of these aggregates. On the screen also are added trends or graphs about past system conditions. It monitors the currents of the engines that also serve us to regulate the flow of air through the system, the engine and vent bearing temperatures as well as the engine vibration. This is of great importance because with the help of trends we can track changes in values in the past, in case of defects, we can find out what caused the defect and thus avoid similar situations in the future. The SCADA system is a great tool for diagnosing problems and their future avoidance.

***Figure 8:** Motor & Ventilator screen showing values and trends*

The Admin Screen or Admin serves to set up the system by the technical staff. There are settings of the last scaling of the values in a form understandable to the operator. For each measurement point, the threshold of scaling range is assigned for operator to obtain the value in digital understandable form. The thresholds for the alarm and critical state of the system are also given so that new alarm values can be added for each point or, if necessary, and even more measuring points.

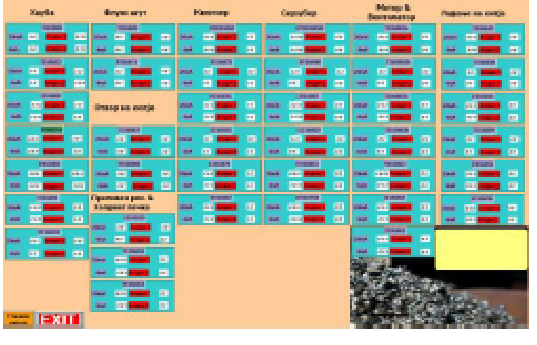

***Figure 9:** Admin screen for setting the system thresholds*

5. Conclusion

In this paper is presented embedded microprocessor SCADA system for Supervisory, Control and Data Acquisition in a process of purification of Gasses in Ferro-Nickel factory. There is a short view of the hardware and software setting in the system. The system is build to replace and old system with lots of separate indicators, controllers, alarm cards and paper recorders. From an economic aspect, there is an initial investment, but the total amount of the system is far cheaper and more cost-effective than the cost of only a few process indicators. The work done by 80 indicators, the same number of alarm cards and annunciators, and paper recorders or data loggers is now only performed by two processor units, 10 input analogue cards and two personal computers, which saves at least half the value of the old system. Hardware equipment is from the company Siemens leading in the world of automation and the software solution is made also in Simatic Manager Step 7 and WinCC Flexible 2008 products of Siemens. Any future upgrade or modification in the system will be programmable with a small additional wiring and little or no cost at all. Programming is made on a separate computer and in the end only need to copy on the process computer, with minimal or no stopping of the process.

6. Literature

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