PROCESS SURVEILLANCE SYSTEM FOR SILICON-CARBID PRODUCTION

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Abstract:
This paper presents a process control system for the carborundum manufacturing, based on a low, cost-effective energy management solution.
The application provides: a graphic editor for technological diagram generation, real time plotting for active power used in the process control, digital and graphical viewer for active and reactive power or energy and power factor, designed for energies management system component. The program application has a friendly human machine interface. The operative alarms and event signals enable the system to maintain predicted energy according to the process demands. During the manufacturing process, the automation system informs the operator when the process power limits are reached, guiding his action, and helps him avoid the critical power limits, in order to comply with standard energy regulations. The software provides a system configuration and estimate for the electric power consumption in furnaces for programmable manufacturing periods.

Keywords: smart power meter, industrial electric distribution control system, carborundum manufacturing overall process control.

1. INTRODUCTION

The carborundum is a synthetic abrasive manufactured through fusion of high grade silica sand and finely ground carbon in an electric furnace at 2400 degrees C.

The automation architecture is used for monitoring and controlling the manufacturing process based on carborundum technological receipts. Because this process is a big energy consumer, the system provides tools for measuring electric energy consumption and estimation of energy load trend.

The carborundum manufacturing process must answers to strict requirements for each product type. These rules are technological prescripts, called receipts. The carborundum manufacturing technology consists in product chemical structure modification through a thermic treatment. The embedded electric energy is an imposed process parameter and its time evolution consists in a power-time diagram. The characteristic diagram shows more inflexions points along the curve. Between those points the characteristic curve is linear ascending or maintained at constant power level.

The process is completed after 50 - 120 hours, according to the type of carborundum, and the estimated time depends on the imposed embedded energy.

Until the implementation of the surveillance and control system on the platform, the human operator has to be in permanent alert, chalks out the power value in each process step, to draw the power-time characteristic curve, to stop de process in case of accidental failure and to deal with several other aspects. After the system was installed, the control over the manufacturing process and the energy consumption are supervised more accurately. As a result a decrease in energy losses was noticed.

2. SURVEILLANCE AND CONTROL SYSTEM DESCRIPTION

The carborundum plant consists in 20 furnaces supplied by 8 rectifying units. The rectifying units are assigned to different furnaces. The control system manages the furnace supplying process. Figure 1 shows a synoptic diagram of the plant used in process surveillance.

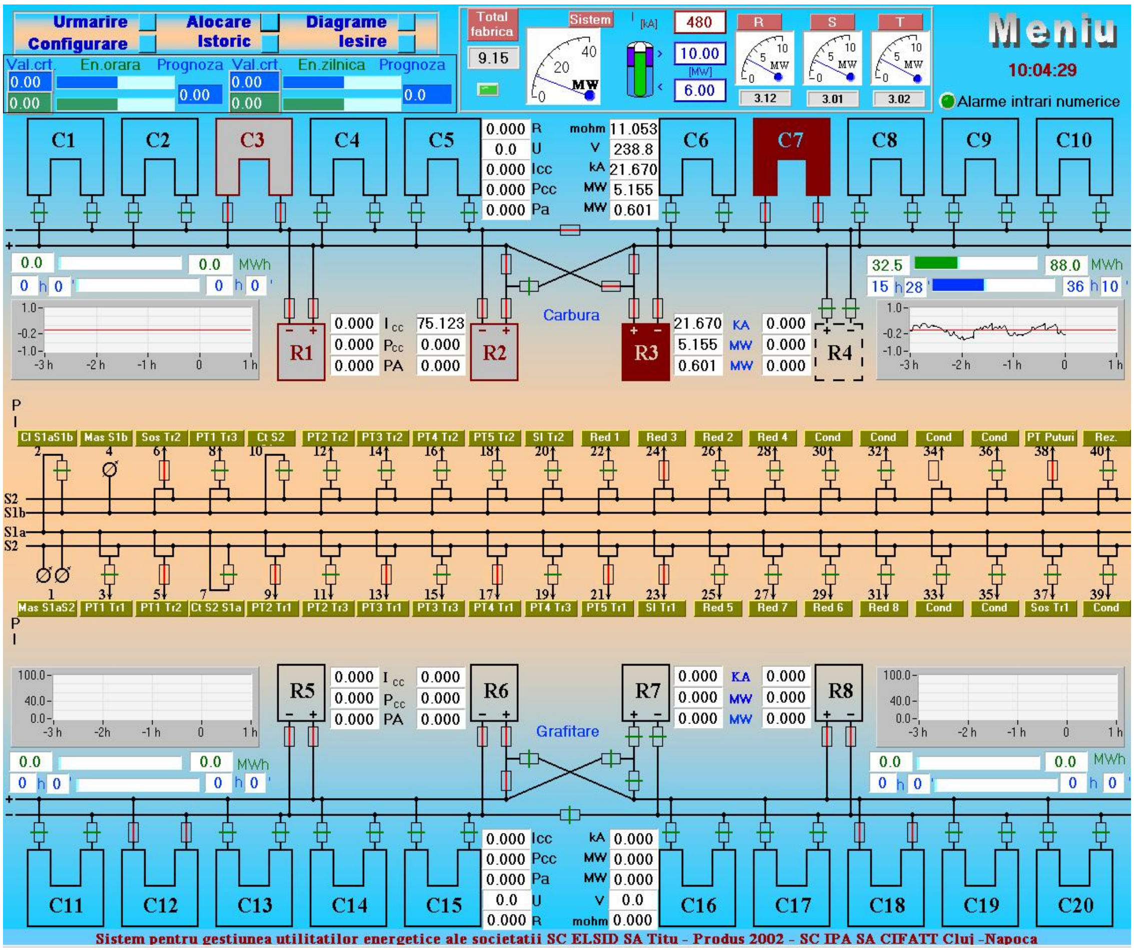


Figure 1. Synoptic diagram of a carborundum manufacturing plant with 20 furnaces and 8 AC/DC rectifying units

The plant furnaces are grouped in four functional entities: C1-C5, C6-C10, C11-C15 and C16-C20. The furnaces of each functional entity work one at a time and can be supplied by one, two or three rectifying unit. The correspondence between furnaces and rectifying units is presented in the next table.

Table no. 1.

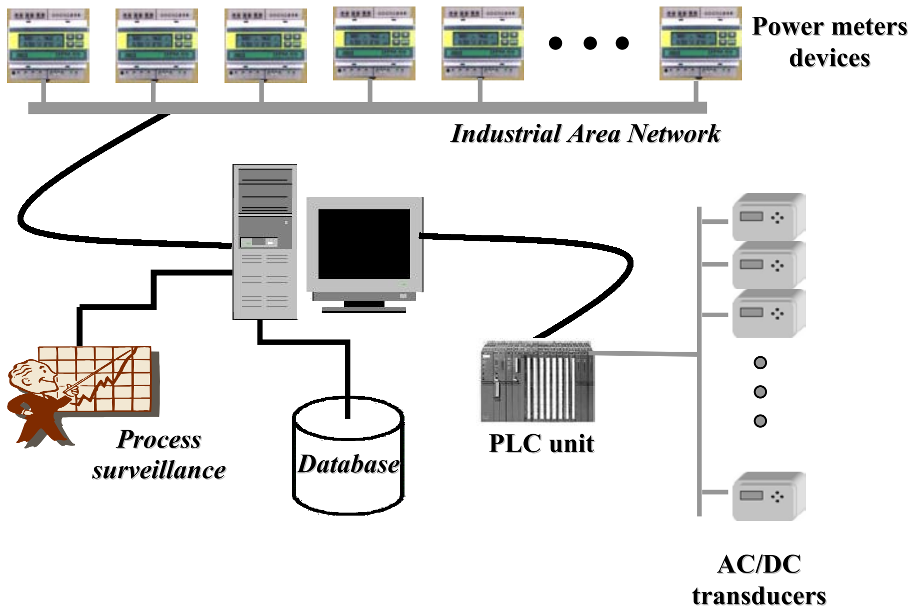
Furnaces	C1, C2, C3, C4, C5	C6, C7, C8, C9, C10	C11, C12, C13, C14, C15	C16, C17, C18, C19, C20
Associated rectifying unit	R1, R2, R3	R3, R4, R5	R6, R7, R8	R8, R9, R10

During the manufacturing process the automation system designates the active connected rectifying units according to instantaneous energy demands.

The computer-controlled system includes specific devices such as smart universal power meters and direct current and voltage transducers (figure 2). The system provides all the measurements for electrical power supply parameters:

- 20 distribution units including 8 rectifying stations are measured in AC with the universal power meters Algodue UPM30, and
- The outputs of the rectifying units are measured in DC by specific current and voltage transducers.

Figure 2. System architecture



The system controls and monitors the plant's electrical power supply network. The power meters are connected to the computer station by an industrial serial data communication network RS485. A PLC unit interfaces the direct current and voltage transducers, it is also connected to the computer by serial interface. The communication equipment uses a RS232/RS485 multiport interface. The serial power meters are dialing by ASCII string using Modbus communication protocol. The direct current and voltage measurements are received from the PLC. The communication between the computer and PLC uses a customized serial protocol. The communication PLC port is programmed in free port mode.

The equipment enables local measurement of the following electric parameters: voltage, current, active, reactive and total electric power and energy, as well as the power factor. All the electric parameters are available to the consumption supervision headquarter.

The most important measured parameter values are stored in a database. In the AC and DC distribution network there are significant electric energy losses. The application provides the possibility of monitoring and recording the power supplied to each production entity. The system allows processing data of the recorded electric measurements (on a daily, weekly, monthly basis and peak hour's consumption, etc.). It also provides acoustic and optical alarms in case of setpoints or preprogrammed limits exceeding and estimates energy cost.

The system informs the operator when the critical power limits are reached in order to comply with standard energy regulations. The software provides a system configuration and an estimate for the electric power consumption in furnaces for programmable periods. The manufacturing plant manager estimates and controls the energy used in the production process in order to optimize the costs.

The real time energy management, according to a specific load diagram, achieves the whole carborundum process control. The software application includes a graphic editor for receipts generating and updating. The carborundum manufacturing process consists in the following steps:

- The operator selects the specific furnace in use
- The operator selects the rectifying unit or units which supplies the active furnace
- The operator selects the product type by its receipt and embedded energy notification – technological parameters
- The computer system sets the thermic treatment duration according to the technological parameters. The process starts by connecting the rectifying unit to the power supply
- On the synoptic process diagram of the plant the operated entity is indicated by a certain color (red color indicates the active equipment – see figure 1)
- In the real time graph of the working entity are indications of the preset power value (in black) and of the measured one (in red)
- The power supply (rectifying units) configuration is modified so that the prescript are reached
- The process parameters: DC voltage, current, power, embedded energy and the event are stored in a process database
- When the estimated duration and energy are reached the automation system perform the process completion procedures.

The evolution of manufacturing process parameters can be displayed in a specific user interface as graphic (see figure 3) or table. This evolution can be also printed and included in the product quality documentation.

3. MAIN FEATURES OF THE SURVEILANCE AND CONTROL SYSTEM

The network power meters are programmable and the main parameters:

- the average power calculated according to programmable integration time value: 1 ÷ 60 minutes
- power and energy investigation rate for single meter device: 270 ms
- parameters measured for each power meter device: 40
- parameters type: voltage, current, power, energy, frequency
- maximum measuring devices on the network: 124 (distributed in groups of 31)
- sample rate for all networked devices: max. 1 min

The system's software package allows two main types of functions:

A. Energy management functions

- remote programming of the power meters: serial communication baud rate, logical number, current and voltage transfer ratio, integration time for the average power, digital outputs parameters (pulse, threshold)
- remote programming of the energy setpoints, management system parameters from the dispatcher (the number of power meters in the network and the investigation rate for the communication session)
- flexible billing according to the power authority requirements regarding integration time for average power, pre-programmed set points
- signaling the exceeding of maximum limits for line currents and power
- local displaying of measurements on the meters' front panel screen
- acquisition and storage of measured values in a database
- graphic or sheet presentation for energy consumption on a daily, weekly, monthly basis.

B. Functions regarding carborundum manufacturing

- technological receipt generating and management using an graphical editor
- carborundum manufacturing process control based on real time control of the DC power according the receipt value
- acquisition and storage of measured DC values and events, in a process database
- process database viewer in graphic form (see figure 3) and in table form.

Figure 3 – Diagram of carborundum manufacturing

4. CONCLUSIONS

The automatic system is a tool for identification of critical points of the manufacturing process. It is useful in order to reduce the losses of power by real time investigation and acquisition (adjust the power supply parameters to the process' power needs).

Database information provides a better estimate for the total time and energy related to the whole carborundum process. The company's manufacturing department and maintenance division avoid penalties by monitoring the load and the power peaks.

Energy consumers can supervise and estimate their power consumption and costs according to the manufacturing process requirements.

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