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A NEW VISION ABOUT OLD TECHNOLOGIES FOR ELECTRODEPOSITION LINES USING PROGRAMMABLE LOGIC CONTROLLER (PLC)

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Abstract: *The purpose of the paper is to create a complex operating modern installation based on a physical model. The model is also useful for upgrading existing installations that have a mechanized or semi-automatic management of the process. The upgrade of the production capacities will be obtained by using its infrastructure to inoculate modern computing technique. Using an Excel developed program to calculate the time required for obtaining a certain thickness of the deposited layer, a calculation program was obtained using WinCC software. Using synoptic this program monitors and controls the maintaining time, temperature, level and movement for the parts that are being electrodeposited during the process. In order to assist the operator, the program has a database associated to the metallic material used for coating, thereby a simple editing of the metal name loads the necessary data to run the program. Given the flexibility of the management diagram, adaptation can be made for all the existing installations, changes can be performed according to needs. The software is designed to improve both the quality of the products and the performance of metal depositions installations.*

Key words: *electrodepositing, automation, monitoring, PLC , optical sensors*.

1. INTRODUCTION

Usually an upgrade means the destruction of the old installation and replacing it with a new, modern and fully automated one. This requires a relatively long time and very high costs.

In addition, the production of the unit will be suspended during this time, and will be started after the installation of the new facility. Like any new product the modern facility will need a trial period that will be tested and adjusted accordingly.

The objective of the research is to modernize old facilities on the following principle: it will maintain the existing infrastructure on which new elements of automation will be installed. Thus diminishing the dead time that would result from the decommissioning of old plants. Costs will also be lower. In addition it will use the existing data that is stored in the already set parameters for obtaining a particular type of processed product. This data has been corrected so as to obtain different deposited layer thicknesses, depending on the time of maintenance.

There is enough production capacity from the small workshops, where operations are conducted primarily by human operators, to the units that have multiple lines for metallic coatings. In some technologic flow is mechanized, but the human operator is still in the same space. As stated above, practical implementation of this approach allows upgrading production capacity so that they correspond to the technical rules required. But, at the same time they must respect the pollution rules, being aware that this industry has a degree of high toxicity.

The software developed for management of complex processes of electrodepositing is designed to improve both the quality of the products and efficiency of metal deposition facilities.

2. ESTABLISHING THE SCHEME GOVERNING THE PROCESS OF ELECTRODEPOSITING

The first step is to monitor the process in real time by means of computer aided technologies and parameters accurate reading due to the accuracy and reliability of the latest generation of sensors.

By comparing the immediate results of laboratory measurements with those obtained theoretically, the necessary corrections will be made so to obtain the maximum performance.

The designed control scheme is flexible so that it can be adapted to existing installations, depending on the existing level of technology. Using the remote control via sensors and data processing using the computer, and programmable logic controller allows isolation and protection of the human personnel from a harmful work space.

Thus, the entire production process is carried out in a closed area, isolated from environment. It made such a first step in the greening process.

The advantage of proposed method is that it uses the existing infrastructure, which is most expensive, with the largest share of the costs chapter (location, facilities, resistant materials to acids and bases used for the floors, vats, electricity supply sources, storage work solutions tanks).

In the case of adopting a program to modernize the electrodepositing lines, the result is the full automation of the process. It will be monitored the process variables and the operating line so the operator is no longer needed in the same room with the electrolysis cells. The operator can monitor and control the entire technological flow

from an isolated room. Process automation and remote control, with sensors, the elements of execution and programmable logic controller allow the isolation of the enclosure where the electrodepositing process takes place. This is considered to be a first step in the greening of electrodepositing.

With the help of the programmable logic controller Festo FC 34 the transport of the pieces in the technological flow was automatically commanded, and also the control of high current intensity power of the electrolysis cell, shaking command and control of warm air dryer will be automatic.

This type of automation is based on the automatic control of two parameters (time and spatial position) and is efficient when the process does not require frequent changes of its parameters, meaning that the technological flow is set for a specific type and number of items subjected to electrodepositing.

The situation changes when on the same line of electrodepositing are processed more types of pieces. The frequent change of the parameters is relatively high. In addition, to increase the accuracy of the entire system is necessary to control with high performance devices the other parameters of the process (temperature, level, pH, concentration).

To resolve this situation the programmable logic controller is connected to a computer so it can monitor the entire system over time. Simultaneously, it can monitor and control in real-time the system variables. Using appropriate software to run on the computer that controls the process, through the use of synoptic in conjunction with the technological flow, snapshots of the values of process variables are made and are compared with the values required so the necessary corrections can be done.

The area that has to be covered and the thickness of the layer to be deposited are introduced by the operator so the computer will automatically set the time of keeping in the vat electrolysis cell the parts to be covered. Because the amount of time taken into account is a theoretical value, the necessary mathematical corrections will be made taking into account the efficiency of the installation.

To achieve the complex management, we will analysis the electrodepositing process on the scheme from Fig. 1.

By scheme analysis is observed that along the sizes of which conversion is made in digital signal (spatial positioning, the solutions levels), we have sizes whose conversion is done in analog signal (temperature).

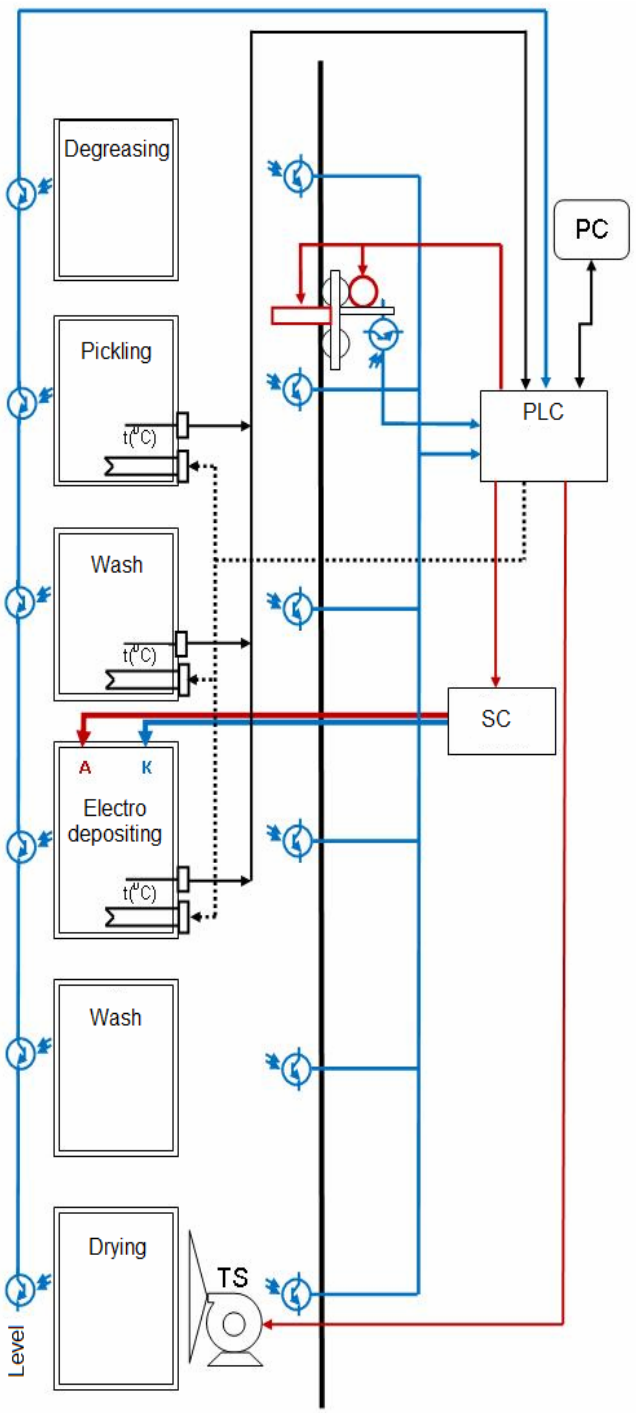

Fig. 1. Schema of complex management for electrodepositing process: PLC – programmable logic controller , PC - computer, SC – current source; TS – warm air drying.

3. SPECIALIZED SOFTWARE FOR MONITORING AND CONTROL ELECTRODEPOSITING

To solve this problem, based on WinCC version 6.2. software, a program was made that can view, modify and control the process parameters. This program entitled "Program Control Electrodepositing Process", noted PCEP. WinCC is similar to C, but allows communication with the field type input / output of programmable logic controller.

Values of input signals corresponding to external variables are called external tags. Besides these tags is allowed the definition and use of internal tags running but only on the local computer. Based on the synoptic, operator introduces the process parameters, the data set for a given flow technology. Also with this synoptic the positions of pieces during the performance process are indicated, and the levels of the solutions in vats are indicated.

When launching the implementation of PCEP the synoptic from Fig. 2 will appear, with Time and Temp (temperature) fields set to zero.

Through its synoptic the operator has the possibility of introducing from the keyboard the time for each box

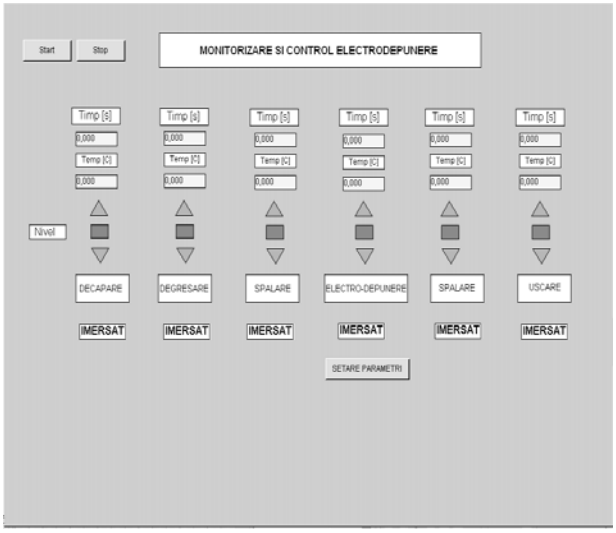

Fig. 2. Synoptic 1 – Electrodepositing monitoring and control.

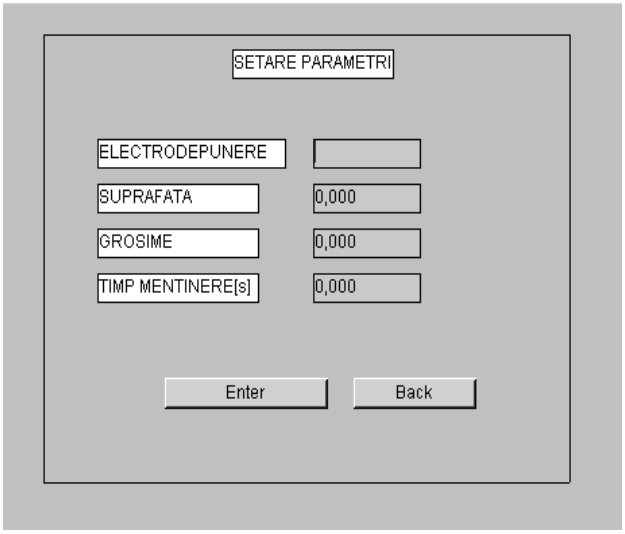

Fig. 3. Synoptic 2 – Parameter settings.

separately, as they were established in the technological flow. There will be no value introduced in the box for the time to electrodepositing tank column. The value in this box results from the calculation based on the mathematical relationship (1).

The time set to washing and drying is chosen as the optimum value from the data obtained from previous experiments.

The time for maintaining in the vats for degreasing and pickling of the parts will be determined empirically, however. It depends very much on the state of surface of the parts and the way of processing them. It is necessary however to take the time so the cover obtained is a perfectly clean surface, free of any traces of grease or oxides.

Similarly the values for temperature are introduced. After entering the appropriate values for time and temperature for the process, synoptic will look like in Fig. 3.

When launching the execution of the window *SETARE PARAMETRI* (parameter setting) for the electrodepositing vat, a function will be created in WinCC. This function initializes the variables of the process that will be subsequently transmitted to programmable logic controller.

It eliminates the risk of errors resulting from the remaining earlier settings. On the monitor screen synoptic in Fig. 3 will appear behind which works the init value program.

Given these fields are ready, the next step is to enter the type of metallic material to be deposited on the surface and the values for the surface to be covered in [mm^2], but also the value to reach of the thickness of the deposited layer in [μm] as shown in Fig. 3. The name of the metallic material has associated in the program also the corresponding density, atomic weight and valence. It thus reduces the time needed for data introduction and ultimately removes the human error factor.

Once the data entered by pressing the *Enter* key in the appropriate field the value of the maintenance time will be shown in seconds (Fig. 3), calculated using the program, based on the mathematical relations, according to the formula:

$$t = \frac{S \cdot \delta \cdot \rho \cdot z \cdot F \cdot \eta}{A \cdot I} \text{ [s]} \quad . \tag{1}$$

Same value will appear in the synoptic shown in Fig. 2, in the appropriate field of the electrodepositing time.

This program operates with the material constants for chromium, nickel, copper, zinc, gold and silver. It can be used for other metallic materials by adding their specific constants. The values of current intensity and efficiency will be updated for each process and are specific to each plant part.

Once the time for maintaining in the vats value calculated we will get back to the *Electrodepositing Monitoring and Control* synoptic (*Back* key), but the difference is that we now have set all the values for time and temperature. At this stage the synoptic which monitors the whole process must have all fields filled with the appropriate values.

With all these parameters set, the next step is to start the process by enabling key *START*. Above each cell is shown the maintenance value, set and calculated properly, and the solution temperature in vats. The position of the parts in the proximity of a certain vats will be indicated by color changes of the tank with associated tags that becomes green, and when the parts are immersed in the solution will be flagged by the color green with the inscription *IMERSAT*. Indications of these positions are based on the signal received by the programmable logic controller from the optical position sensors. It sends to the computer the data and the software will change the color fields.

With the help of this synoptic it indicates also the levels of the solutions in vats. Based on digital signal received from the sensors, it will light one of the three indicators. Normal is when the rectangle becomes green. Activating one of the two red triangles means to overcome or decrease the level. Adjusting the level will still be done through the programmable logic controller who sends simultaneously command signals to the pump and to the electro-valve (digital output).

In Fig. 4 is presented the synoptic of the process in progress in the next stage:

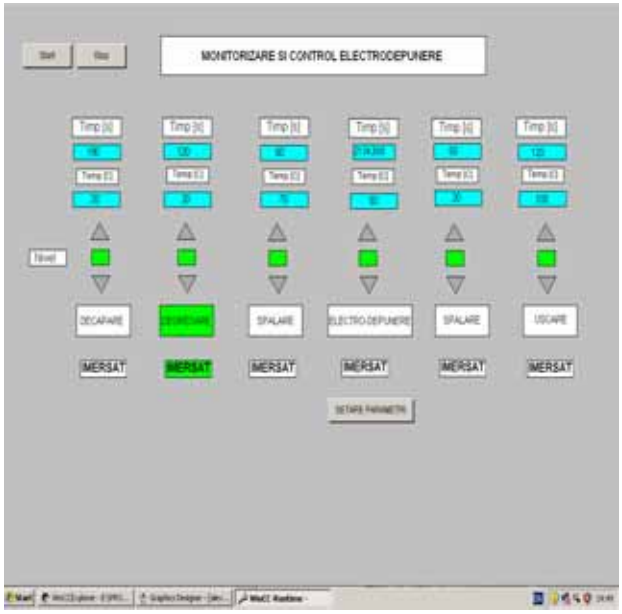

Fig. 4. Synoptic 3 - Electrodepositing monitoring and control.

- We've introduced the values for the time and temperature.
- Solution levels in the vats are at normal rate.
- The parts are in the degreasing tank, immersed in the solution.

The adjustment of the temperature is based on the signal received from the thermal resistance to the analog entry of the programmable logic controller.

The programmable logic controller converts the value of the resistance in digital signal which is transmitted to the process computer.

Using software, this value is compared with the set value.

Command signal in digital form is applied to the execution elements.

The conventional regulator is replaced by programmable logic controller. Reaction time is shorter, regulation is almost linear and continuous with no discontinuities or increases in step as it happens in the conventional regulatory solutions.

The operator can manually stop the process by pressing *STOP* key. This is necessary when damage to the proceedings or when required by the amendment process parameters in order to achieve different thicknesses of the layer of coverage.

4. CONCLUSIONS

The software created can be adapted to any of the processes of electrodepositing metal coating, taking into account existing technological flow, and the technical endowment.

The first step in complex management involves the mechanization of the technological flow on which sensors are installed and the devices that command the existing execution elements are replaced with other more reliable, where appropriate, so that automation is exploited to the fullest.

Using the new PCEP software developed, implemented on a PC which communicates with a programmable logic controller the reading by monitoring process variables, display, processing and their modification are made possible. Storing results in a database will ultimately increase the efficiency by correcting these values to the theoretical ideal.

The software created is designed to improve both quality products and the efficiency of metal deposition facilities.

Starting from a line of classic electrodepositing, mechanized, using the WinCC software a complex process management was created. The software allows, however, by extrapolation, the adaptation to any electrodepositing process using electrolysis vats served by a system of mechanized transport parts.

Ongoing process monitoring, superior performance are obtained in the quality of the metallic material deposited layer and at the same time the products resulting from the process can be control, thus minimizing the negative impact that they would have on the environment.

REFERENCES

[1] Stănescu, A. (2009). *Conducerea complexă a proceselor de protecție anticorozivă prin depuneri metalice* (Management of complex processes by anticorrosive protection of metal deposits), PhD Thesis, Bucharest.

[2] Florea, B., Volintiru, P., Stănescu, A., Vasilescu, P. (2005). *Program de simulare a conducerii proceselor metalurgice* (Soft for simulation of management metallurgical processes), Edit. Fundației Universitare "Dunărea de Jos", Galați, Scientific conference "UgalMat".

[3] Stănescu, A., Florea, B., Stănescu, A. (2009). *Stadiul actual şi necesitatea conducerii complexe a proceselor de acoperiri metalice prin electrodepunere* (Stage and the need for complex management of covering metal processes by electrodepositing), Metalurgia, No. 1, Romania.

[4] Gamburg, I.D. (2006). *Materialov i tehnologhi – Galvaniceschie pocrîtia* (Materials and technologies – galvanic processes), Edit. Tehnosfera, Moscow.

[5] *** *Technical documentation*, Festo, www.festo.com.

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