Optimization of production flow for construction aggregates using modular control systems

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Abstract: - Propose of this paper is to present a practical approach that was imposed due to the need of placing protective foils over the specific construction aggregates products in order for them to keep their properties. The employees who are responsible for placing these protective foils will be replaced with a flexible control system, so that the technological process will be one without interruptions. Changing and improving the process flow led to large labor savings and redeployment of employees to other operations may represent improvements of other processes that are performed in the construction aggregates factories. By implementing the modular control systems, in the production flow for construction aggregates, the production costs can be optimize up to 10%.

Key-Words: - production flow, control systems, graphical program, optimization, construction aggregates

1 Introduction

The construction sector activity is very important, these activities being implemented in the whole sphere of life and industry sectors. The production activity is supported by a lot of industrial manufacturers: construction materials industry, construction equipment, metallurgical industry, etc. Technological processes management involves automatic control, supervision and control of production lines in accordance with specific stages of production of the finished product[1]. Lately there is an increase and diversification of numerical control equipments and control systems used for driving construction aggregates processes due to the complexity of these processes and their performance requirements. These standards led to the development and diversification of technological lines by introducing the automation systems and sequential order of the manufacturing processes and thus increasing productivity.

This paper presents a practical approach that was imposed due to the need of achieving a modular control system of the production order flow for construction aggregates. This was done because of some specific environmental rules imposed that construction material to be stacked on waterproof bags when placed on the euro pallets. These operations were made manually and because of that the production flow was interrupted and led to financial losses [2].

In order to solve this problem we have used a PLC designed for automation of construction aggregates installations and by that ensuring reliability and safety in operation.

2 Production flow for construction aggregates

We present in this part of the paper the realization of a fully automated device for cutting and placing waterproof PVC foil on the euro pallets. In figure 1 is presented a general design of the production flow for construction aggregates starting from the introduction of raw materials in storage places until the transportation of the pallets to the warehouse.

Figure 1. The production flow for construction aggregates design
The phase in which cutting, placing plastic foil at the pallet and placing bags was done manually by two operators per shift and that often create malfunctions in the technological process. In figure 2 is presented the synoptic panel for the classical production flow for construction aggregates, from the loading of raw materials in bags until their processing into a dryer.

Figure 2. The graphical panel of the technological flow

Because the placing bags operation (red arrow from the fig.2) was performed by two employees, all processes flow had to be stopped by for a period of time in which they placed the waterproof foil at the pallet, and this inevitably cause financial loss.

3 Modular control system for production flow

Further is described the modular control system for placing the protective foil over the specific construction aggregates products. The integrated flexible embedded system is based on a programmable logic controller from Moeller, the graphical design of the proposed application is made using EASY SOFT 6.10 software, which is provided by the utility provider MOELLER and allows both simulation and visualization application [3].

2.1 The method flowchart

In figure 3 is presented a brief flowchart of the the placing bags operation, in which the numerical equipment operates sequential starting with checking the if is in the right position; the next step is to check if the foil reel is place in device and after that the pneumatic devices catches and carries the foil to the length determined up to the knife line with cutting speed ($v_1$); in the next step the machine will cut the plastic foil and the transport system will start toward pallet with a certain speed ($v_2$); placing the pallets in to the bags and withdraw the foil transport device in the initial position, with the speed ($v_3$).

Figure 3. The placing bags operation flowchart

The flowchart will repeat cyclically all queries related to placing the protective foil over the construction aggregates application.

2.1 Implementation of the PLC in the modular control system

For solving the problem we chose a programmable controller EASY 719-AB-RC, Moeller having 16 inputs and 12 outputs, like is presented in figure 4.

Figure 4. Running the director EASY Soft 6.1

In figure 5 appear relay contacts consisting of instruments I – Input Basic Unit, Q – Output Basic Unit or M – Marker and time relays, that emulates...
the system operation in accordance with the developed logic algorithm.

An important advantage of implementing PLCs in industrial applications is that they can have online simulation control and automation schemes. The possibility to simulate the industrial application provides flexibility in modifying and adapting the program according to the needs and changes in the process and also, the repair activities are made easier when an abnormal functioning situation occurs. Using programmed simulator facilities can be made all combinational states of the command circuit in order to verify the correct functioning of the developed system [4].

The modular control system was achieved with Moeller PLC, family of 719-AB-RC and for driving the devices motor is speed controllable and is implemented through a Commander SK converter frequency, like is presented in figure 6 and 7.

AC input connection is shown in this figures, the terminals L (Line) and N (Neutral) are connected to an AC source (DRA240). L terminal is protected by fuses over currents. Ac power supplies and contacts from the process connected to the inputs I0.0, I0.1 and I0.2 PLC.

2.2 Equipment for placing the protective foil based on the modular control system

In figure 8 is presented the electrical equipment used for placing the protective foil over the specific construction aggregates products. The developed flexible embedded modular system is used to work based on the presented flowchart, in order to satisfy the imposed environmental requirements.

Using this modular control system, the foil is placed automatically and the major advantage of this method is represented by the fact that the work productivity increases significantly. Compressed air necessary the bagging and wrapping bags installations will be provided by a compressed air consists of a compressor, air dryer and buffer tank. The bags will be carrying from the cement bags loading facility are automatically stacked and
packed with plastic for protection against moisture by plant palletizing and wrapping bags of cement.

2.3 Production monitoring system and data storage
The program for data reporting, displaying monitoring station and storage in the database was done in the graphical program LabVIEW, as is presented in figure 10.

![Figure 10. Graphical interface for preventive](image)

Counter impulses and signal conditioning was done based integrated logic circuits based on the signal received from the optical sensor and processing, acquisition, reporting and data storage was achieved with a data acquisition board from National Instruments NI 6008, like is presented in figure 11.

![Figure 11. Graphical interface for preventive](image)

Using the virtual graphical program and the developed hardware the entire process will be monitored, because the program will calculate the total production of construction aggregates by means of the number and types of protective plastic foils used [8-10].

4 Conclusion
The practical realization of this modular control system was put into function to a construction aggregates company, and its functionality was without faults or interruptions of the production process. By putting into service this flexible system he improved the process flow and removed of dead times due to automatic operation and signaling of any anomalies that could disrupt the technological flow.

By creating this virtual instrument a immediate reporting was developed for production days, weeks and months, which enables statistical processing types and categories.

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