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Eugen Răduca, Marius Schmidt, Dan Ungureanu-Anghel, Mihaela Răduca, Cornel Haţiegan, Nicolina Pop, Florica Novăcescu

The command of the Flour Transport Pumps in a Cereal Mill with PLC Siemens S7-1200

This paper presents pump control with PLC Siemens Simatic S7 - 1200, for transporting flour designed to be implemented in the Pfalzmühle Mannheim. The order was designed to replace the old system made in various traditional contacts and relays. Programming PLC Simatic S7 - 1200, which is a powerful and reliable, a new generation, was conducted in FBD. In order to verify the accuracy and to optimize the operation of the control system was built a functional model.

Keywords: command, PLC, algorithm, FBD, experimental model

1. Introduction

In a mill the grain flour is transported on a conveyor belt by an absorption process using air pump absorption. For this analysis the actual situation in the process, used two pumps, each driven by a 7.5 kW induction motor powered directly from the network. The existing version both pumps working continuously regardless of the amount of flour on conveyors, control and actuation system which is implemented through traditional circuits with contacts and relays [1], which makes the whole system is energy intensive, and its reliability is quite low. In a study it was replaced traditional control system with PLC that performs all the functions of the old system; In addition PLC provides control signals to two static frequency converters for powering two motors so that they work on power and variable speed adapted technological process.

2. The technologic process

The simplified scheme of the technologic installation for flour transport in the cereal mill is presented in Figure 1.

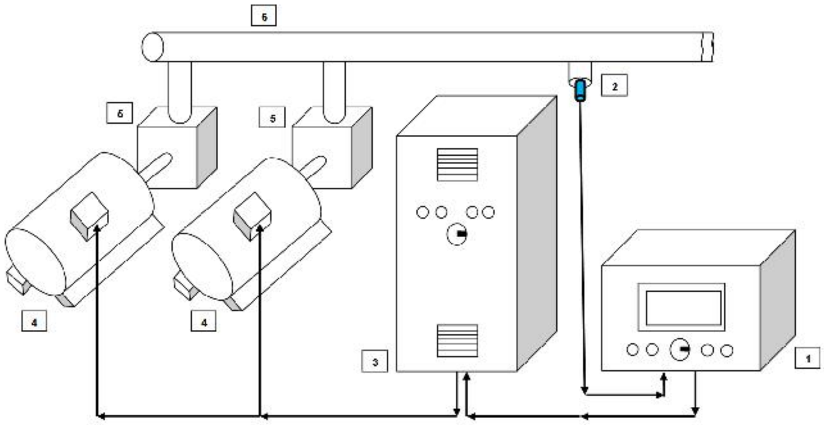

Figure 1. The simplified scheme of the technologic installation for flour transport in the cereal mill

1 – Command and control unit
2 – Pressure sensor
3 – Power and command cupboard
4 – Electric engines for driving the pumps
5 – Air pumps
6 – Air conduits

Pump setting (5), adjust technical parameters of the technological process is by continuous measurement of pressure in the system with pressure sensor (2). The pressure of the TCP process is influenced by the amount of product transported.

Increasing product carried MPT is approximately inversely proportional to the air pressure conveyor. For this reason, the variation amount of the finished product a change in pressure. By observing pressure pumps can be achieved by adjusting the parameters of current requirements.

An increase in pressure above the required implies an increase in speed pump (5), the speed that is set by the PLC provided adequate control frequency inverters which supplies engines power cabinet and control (3); system pressure drop in the engine speed set point requires lowering the drive.

The aim is to maintain the pressure in the system PPT as close to the theoretical value of the time PPR. The pressure sensor provides command and control unit (1) actual value of the pressure, being in the concrete conditions of the technological line between 0.2 and 0.7 bars.

When system pressure drops very quickly below the minimum (0.2 bar), it can be assumed that there was a system failure conveyor, conveyor routes such as blocking, which involves stopping the pumps; an increase in pressure above the 0.7 bar suggests that there is a leak of air into the system and this is also reported.

For the specific absorption pumps are used. If the pump set is used for GM3 Type SG-5 [2] at a pressure differential of 0.9 bar, driven by a 7.5 kW asynchronous motor assembly is shown in Figure 2.

Driving the asynchronous engines is done by frequency converters (inverters).

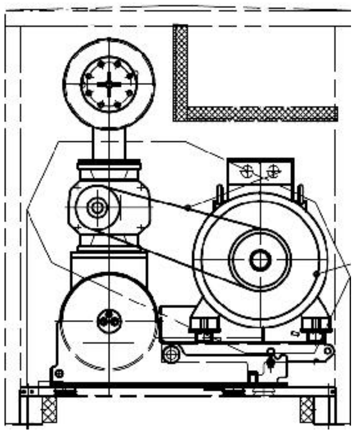

Figure 2. An asynchronous engine ensemble- air pump

3. The command algorithm of the air pumps

The quantity of flour transported on a runway is variable and for this reason the absorption force necessary for the transport is also variable; theoretically a minimum quantity of flour m_{Fmin} there corresponds a minimum absorption force F_m, corresponding to a minimum force furnished by the action engines P_{min}

$$m_{F\min} \rightarrow F_m \rightarrow P_{\min}$$

Whereas to a maximum quantity $m_{Fmax,}$ there corresponds a maximum force F_M, respectively to the maximum power of the starting engines P_{Max}

$$m_{F\max} \rightarrow F_M \rightarrow P_{Max}$$

The technologic process from the analyzed factory, for the maximum quantity of flour transported m_{PTmax} requires the use of a maximum force F_{PTmax} greater than the maximum force developed by a pump, namely:

$$F_{PT\max} \rangle F_M$$

For this reason one has opted for the use of a pump, identical to the first so that:

$$F_{P\max 1} + F_{P\max 2} = 2F_M \rangle F_{PT\max}$$

By using the 2 pumps in parallel, when there is the case, the force used for transporting falls in the field:

$$F_{PT} \in [F_{PT\min}, F_{PT\max}]$$

The present algorithm is given in Figure 3.

When starting the "START" to plant this fall under the "Standby" which signifies that it is ready for work; in this state after power up the building blocks that self-test routine is run. Then select manual mode "MAN" or automatic "AUT".

In manual mode the operator of the two pumps act independently according to information received from the system. In this mode commands are only active fault to not damage the plant.

If the system is set to automatic mode, the pressure Pth is the information which determines the operating parameters of each of the two pumps by means of drive motors thereof in accordance with the algorithm; if the size of the order prescribing MPR pump drive motor is equal to the size required MPTH associated technological pressure existing in the system, it acts as appropriate, according to the algorithm, accelerating or braking actuator motors sequentially. If both engines operating at maximum power PMAX but:

$$M_{\Pr} \neq M_{PTH}$$

One considers that in the installation there exists a flaw and the same one is stopped.

The meaning of the marking from the installation is as follows:

AUT – automat mode

MAN – manual mode

M_{Pr} – set size associated to pressure

M_{PTH} – size associated to the current pressure in the installation

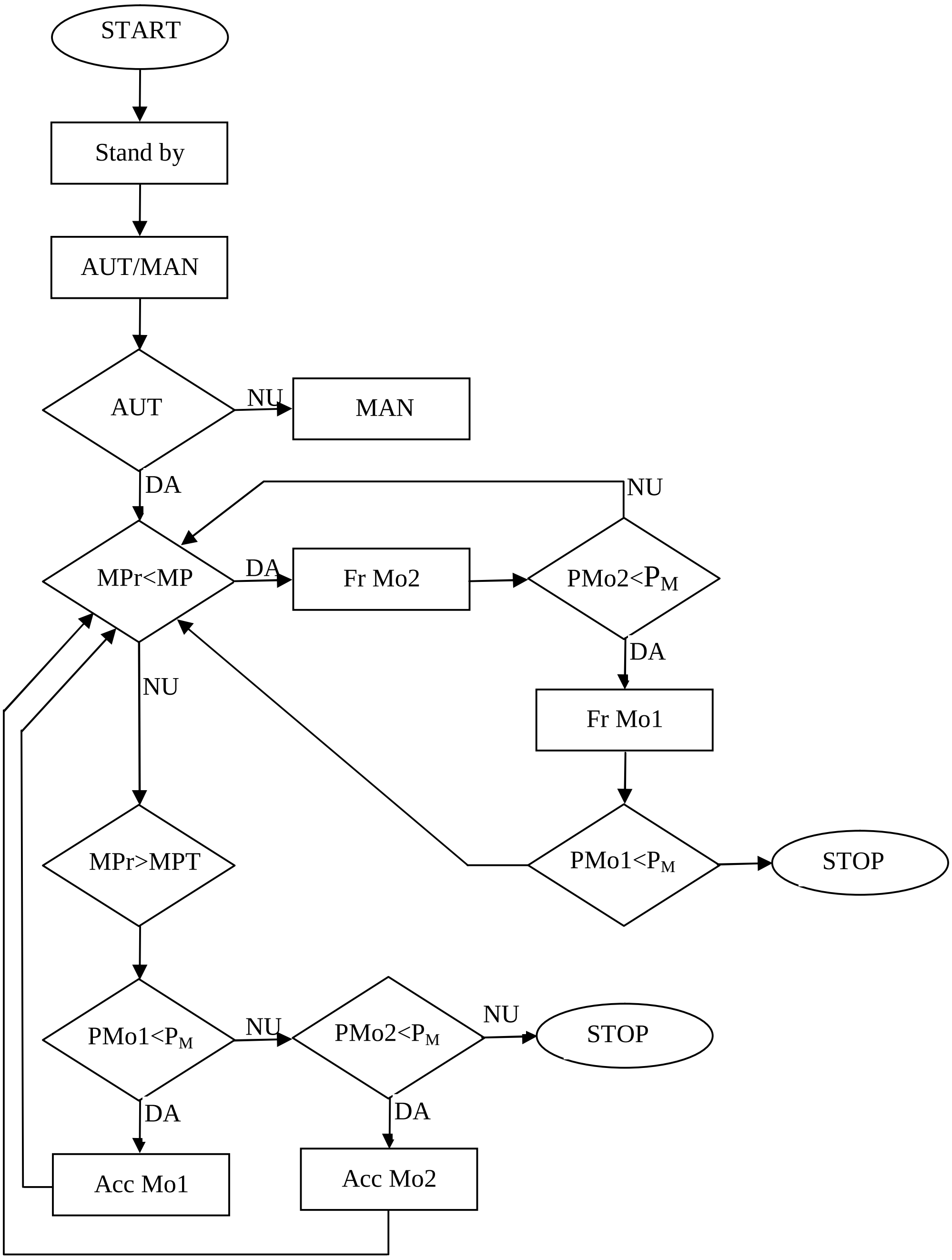

Figure 3. The command algorithm

FrMo1 – breaking mode engine 1
FrMo2 - breaking mode engine 2
AccMo1 – acceleration mode engine 1
AccMo2 - acceleration mode engine 2
PMo1 – current power in the installation of engine 1
PMo2 - current power in the installation of engine 2
P_M – maximum power of an engine (P_{MAX} = 7,5kW for the present case)

4. Implementing the system

PLC Simatic S7-1200 [3] is a product of a new generation of Siemens continues the tradition for use in various industrial applications, complete and complex. Compared to previous versions 7 and Win CC STEP programs were integrated into a common platform, TIA Portal [4]. Thus the interaction between PLC SIMATIC S7-1200 SIMATIC HMI [5] panels range and common STEP 7 programming system enables automation solutions specific class of compact controllers. Therefore it is possible to design easier without weights monitoring and ease of use. The programming window is given in Figure 4.

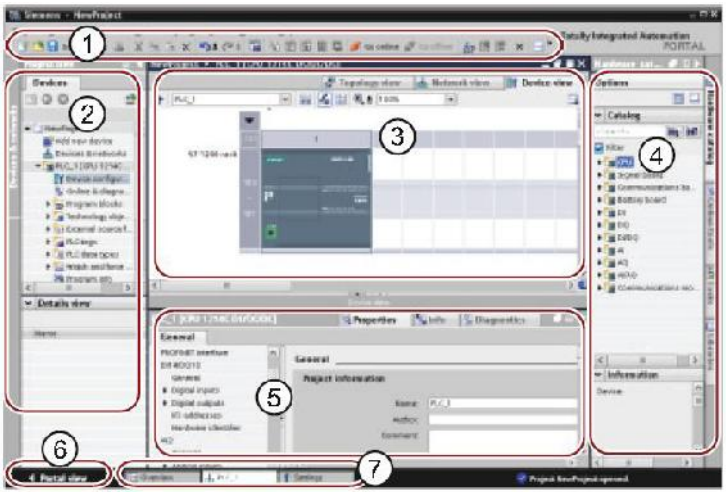

Figure 4. Programming window

1 – Menus and instrument bar
2 – Navigator of the project
3 – Work space
4 – Tasks cards
5 – Inspecting window

6 – Modifications brought to the view of the portal
7 – Editor of the instrument bar

Programming was done using FBD [6]. In Figure 5 - Figure 7 there are given by way of example, compile the program, start / Signaling - Pump 1, signaling a defect, namely a pressure loss created experimental model.

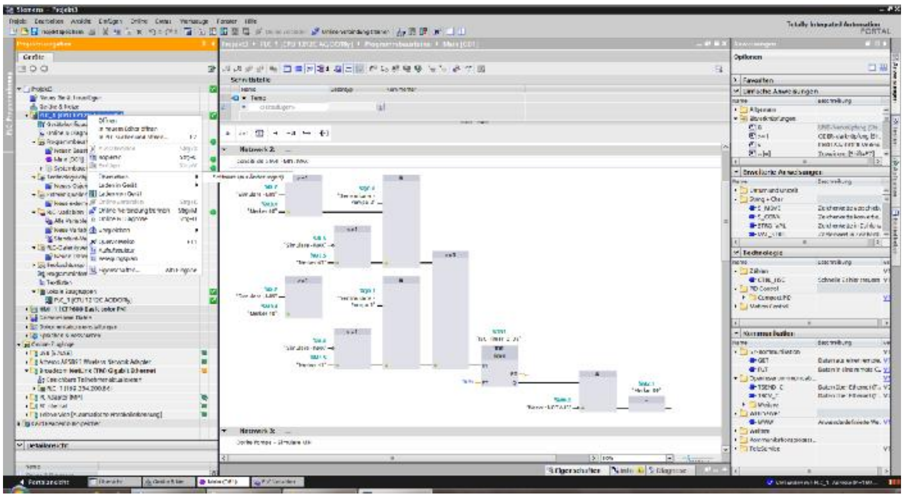

Figure 5. Compiling the program

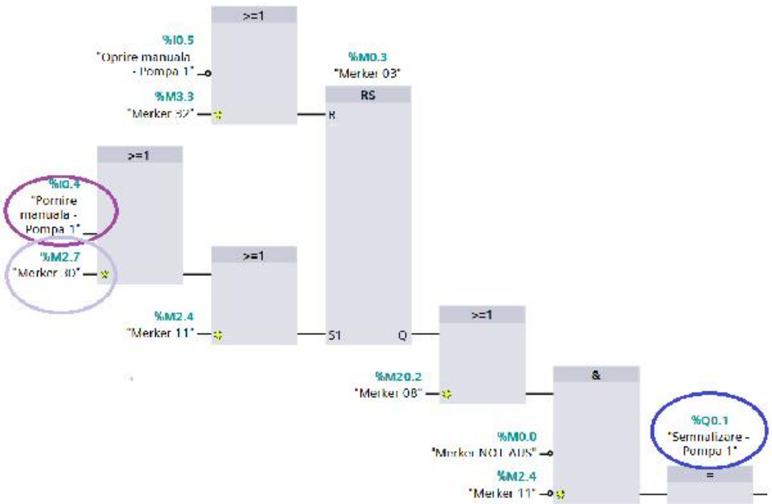

Figure 6. Starting / Signalizing - Pump 1

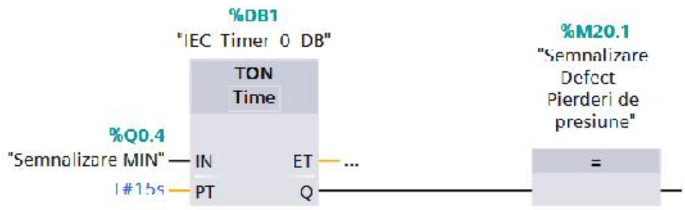

Figure 7. Signalizing al flaw – Loss of pressure

There was used for pump control CPU 1212C [7] which has two 10-bit analog inputs that accept voltage Ui = 0-10 V, 8 digital inputs 24 VDC, 6 digital outputs 24 VDC. The unit has implemented a PID controller and PWM generators that can be ordered value or percentage. Information of the sensor pressure is brought to one of the analog inputs and based on the algorithm described in the previous paragraph, with the implementation of PWM generators are generated from the digital outputs DO1, DO2 respective control signals for the two converters motor drive pumps Simatic type G120 / 7.5 kW [8]; average voltage required to power the inverter control pump motors is obtained by connecting each output of each converter averages simply realized with semiconductor diodes. In this way it can be avoided using an analog output module, as for example SM AO 1232 [9]. Two digital inputs are used as comparator for sensing the system minimum and maximum permissible pressures (pm = 0.2 bar, pM = 0.7 bar) in which case the digital outputs 3 and 4 will show signs of damage signals.

5. Attempts and experiments

For checking the designed system but also for studying in the view of optimizing future technologies and experimental model has been realized, presented in Figure 8.

The model allows the simulation and testing in manual or automatic control and local control or remote bus, a command center.

After the model was performed several tests and trials which included running in manual mode and automatic mode, each pump performed independently and both in parallel. The operation was followed by the display KTP 600 [5]. Similar operation for tracking the production process applied to the sensor input voltage range corresponding continuous PTH = 0.1 to 0.9 bar.

In Figure 9 there is illustrated an order of "Touch" panel HMI.

Figure 8. Frontal panel: Simulating the functioning of a pump at minimum pressure

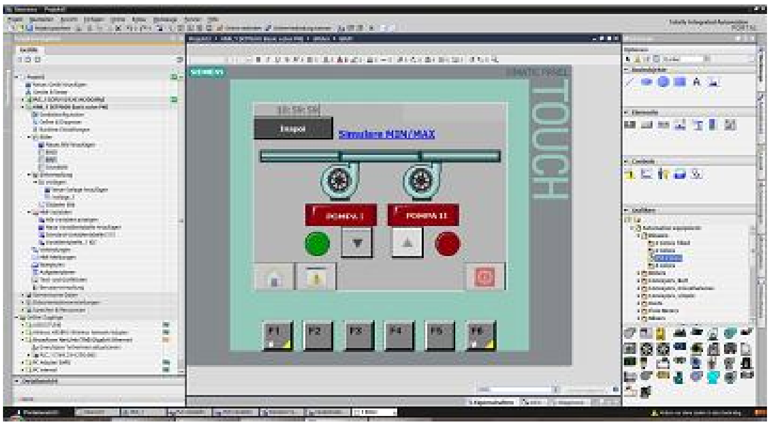

Figure 9. SIMATIC HMI type KTP 600 panel- Simulating functioning: pump 1 started, pump 2 stopped

6. Conclusions

The PLC Control presented for operating pumps with motors powered by inverter drive pumps increase system reliability and reduce electricity consumption

The experimental model built allows the study so that the commissioning of the plant can be upgraded to quickly determine the optimum operating regime The experimental model has high flexibility due to the TIA Portal program inputs and outputs available and the functions implemented by factory settings as PID and PWM generator which makes it useful in other industrial applications.

The system is designed and proposed to upgrade one modular which allows quick and easy maintenance.

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Addresses:

- Prof. Dr. Eng. Eugen Raduca, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, e.raduca@uem.ro
- Eng. Marius Schmidt, Pfalzmühle Mannheim, marius2schmidt@t-online.de
- Lect. Dr. Eng. Dan Ungureanu-Anghel, Polytechnic University of Timisoara, Bd.V.Parvan 2, 300223, Timisoara, dan.ungureanu@aut.upt.ro
- Assoc. Prof. Dr. Eng. Mihaela Raduca, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, m.raduca@uem.ro
- Lect. Dr. Phys. Cornel Hatiegan, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, c.hatiegan@uem.ro
- Lect. Dr. Phys. Nicolina Pop, Polytechnic University of Timisoara, Bd. V. Parvan 2, 300223, Timisoara, nicolina.pop@upt.ro
- Assist. Eng. Florica Novacescu, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, f.novacescu@uem.ro