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EXPERIMENTAL MEASUREMENTS FOR TESTING SOME AUTOMATED MONITORING SYSTEMS OF CONVEYOR BELTS IN THE COMPOUND FEED FACTORIES

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Abstract: The main objective of any compound feed factory is to obtain finished products with a higher quality, in the shortest possible time and at lowest cost price. For this must be endowment with equipments with a high degree of mechanization, automation and computerization, with high productivity and low consumptions. Considering the importance of the raw material transport activities, but also of the finished products obtained, this article proposes an experimental study regarding the possibilities to achieve some dedicated devices for monitoring and automatized control of conveyor belts from a compound feed factory (CFF). The proposed experimental model for implementation involves the use of some magnetic sensors for monitoring the rotational speed of the drums that act on the conveyor belts, which by the measured parameters allow prompt transmission of signals to the control panel of signals to stop the motor operation if a change is detected at the optimal running rhythm established for that work installation.
Keywords: conveyor belts, rotation, magnetic sensors, response time, productivity

1. INTRODUCTION

The increase of animal feed consumption in zootechnical farms has also determinated a diversification of the offers of compound feeds produced by the profile factories, according to the species and the age of animals for which they are intended in the feed process, in accordance with the standards and the rules imposed by the specialists in this field.[1, 7]

The production of compound feed is a high interest activity because they represent an important source of food for animals of the zootechnical farms, thus having a role essential in obtaining large and profitable productions in this field. Farmers who working in this field know that there are different recipes of compound feed, depending on the breed and age of the animals to be fed. In figure 1 it is presented the global-level repartition of the compound feed consumption by different animal species.[2, 6]

All these aspects determined an improvement of the activities in the technological flow in a CFF (compound feed factory), by using modern high-performance machinery and equipment, with a high level of mechanization, automation and computerization, to ensure the achievement of high quality final products with specific costs as low as possible.[3]

The technological flow of obtaining the compound feed involves to carry on of several distinct activities, but each one with its importance. For ensure the proper functioning of the working installations of a compound feed factory, must to take into account also an automation control of the technological flow, which also assumes, among other things, a permanent monitoring of the horizontal and vertical conveyor belts (figure 2), which have the role to transport the raw materials to the storage bunkers and to the other working installations.[8]

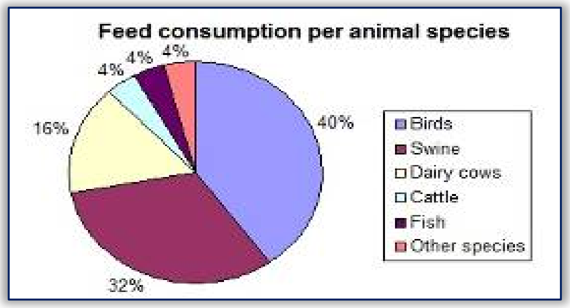

Figure 1 - Global-level repartition of the compound feed consumption for animal species [7]

(a) (b)

Figure 2 - Conveyor belts system from a compound feed factory consisting of horizontal conveyor belts (a) and vertical elevators (b)

Horizontal conveyor belts are electromechanical installations made up of a metal chain linking, which forms a closed chain, over which a rubber band is placed and which are moved in a horizontal motion due to the drums driven by an electric motor, which also has a rotation reducer for controlling the speed of movement of these bands.

Another electromechanical installation is the vertical elevator, which, unlike the previously presented type of conveyor belts, allows the vertical transport of the raw materials and consists of two vertical tubes parallel to a rectangular section, through which is moving a rubber conveyor belt on which are mounted, at equal distances, transport cups. These vertical elevators represent an important installation in tehnological flow in a compound feed factory, because they allow the lifting of raw materials from the level of storage bunkers located on the ground up to heights which can get to several tens of meters.[7, 8]

2. MATERIAL AND METHOD

The experimental researches presented in this article were carried out at an compound feed factory where the transport of necessary raw materials is made up using two successive horizontal conveyor belts and a vertical elevator (figure 3).[8]

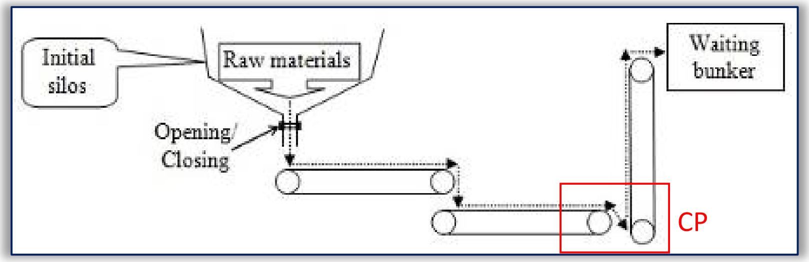

Figure 3 - The system of conveyor belts in a CFF

By analyzing the shifting route of raw materials it can be observed that one critical point of the technological flow is placed at the base of the vertical elevator, meaning in the special marked zone in the figure 3 (CP – critical point). In this place, the horizontal conveyor belts bring out a fairly large quantity of materials that should be taken in the cups of lifting, but because of different reasons may appear problems of functioning: overload with raw materials, unstable functioning of the motors which act the belts etc.

The studies which carried out were aimed precisely at avoiding such undesirable situations, because the rubber bands elongation of the vertical elevator leads to rubbing of the cups against the walls of the installation, possibly causing blockage or even breaking of the conveyor belt. This situation would lead to a stagnation in the technological flow, with time and cost loss.

One of the solutions which allow to avoid these situations is the implementation of a specialized automated control module of the conveyor belts. In order to obtain the optimal implementation variant, a test stand was constructed to determine the functional parameters of the magnetic sensors that ensure the coupling or disconnection of the motors which acting the drums.[4, 7]

The electronic montage that have been used to obtain the experimental results (figure 4), is composed of the following elements:

- rectifier 220Vca-24Vcc
- fan motor 80W/1500 rotations per minute
- magnetic sensor for speed of rotation monitoring
- voltage variator to change the motor speed
- 2 intermediate relays and signaling lamps at 24V

Figure 4 - The electronic montage of the test bench

The sensors functioning is based on the field lines modification principle generated by coils powered by a high-frequency oscillator and allow conversion of an non-electrical input (distance to a metal body) in a output of electrical nature (tension).[4] So, when approaching a metallic body to sensor, the magnetic field lines are changing, thus determining the damping of the oscillations and automatically generating the modification of the inductance of the magnetic circuit. The electronic circuit of demodulation (figure 5) detect this modification and it switches the electric signal in active status "1"(figure 6), which is amplified by the amplifier circuit and then sent to the sensor load, which is an start-stop relay which is part of the automatized projected controling circuit.[5, 9]

A magnetic sensor used for monitoring of motor speed is powered at 24-36 Vcc (according to the electric scheme presented in picture 7) and works as a pulse generator whenever a metallic object passes around it.[8]

For the testing of different types of speed sensors, the experimental measurements have been carried out using a tachometer by type EBRO DT-2236 (Figure 8), which recorded the speed rotation value for the metalic lamella attached to the rotor pallet, thus simulating the rotation movement of the stretching drum of the conveyor belts. The speed variator from this electronic scheme is designed to modify the powering of the rotor drive motor (the drum) with the purpose of generate different movement speeds of the metalic lamella which is attached to the rotor.[5, 9]

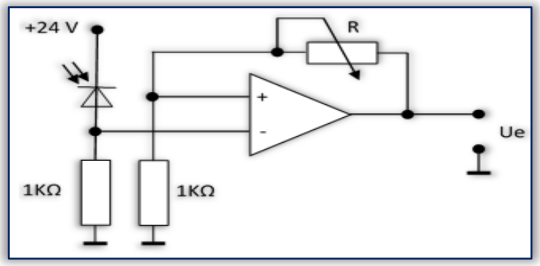

Figure 5 - The electronic circuit used to obtain the electrical output (Ue)

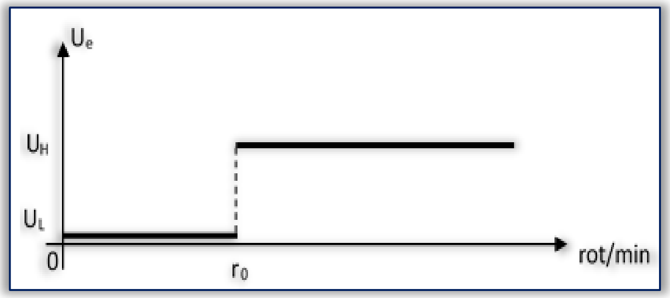

Figure 6 - Electrical output (voltage) of a magnetic sensor

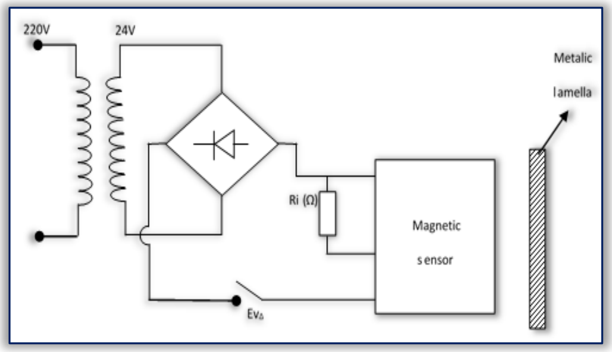

Figure 7 - Electrical powering scheme of a magnetic sensor

Figure 8 - Measuring the speed of rotation of the metallic lamella with the electronic tachometer

3. RESULTS

In the case of the magnetic sensors for speed monitoring which were analysed and tested on the trying stand, was followed the highlight of two essential parameter, which will help the realisation of the automatized monitoring device of the conveyor belts under optimum conditions:

- the distance to which the sensor detects the metallic body attached to the motor drum being in rotation movement;
- the response time of the sensor when modifying the rotation speed, depending on the distance to which that monitored metallic body is situated.

Table 1. The determination of operating parameters for the speed sensor type NXP KMI15

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,4	0,5	0,5	0,6	0,7	0,8	0,8	0,9	1	1,1	1,2	1,3	1,3	1,5	1,7	1,7	1,8	1,9	1,9	2	-

Table 2. The determination of operating parameters for the speed sensor type ATS 653

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,5	0,6	0,6	0,7	0,8	0,9	1	1.1	1.2	1,3	1,4	1,4	1,6	1,7	1,7	1,8	1,9	2	2,1	-	-

Table 3. The determination of operating parameters for the speed sensor type XSA-V11373

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,4	0,4	0,5	0,6	0,6	0,7	0,8	0,8	0.9	1	1,1	1,2	1,3	1,4	1,6	1,7	1,8	1,8	1,8	1,9	-

Table 4. The determination of operating parameters for the speed sensor type SM351LT

Sensor response	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	-
Distance [cm]	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Response time [s]	0,6	0,6	0,7	0,8	0,8	0,9	1	1,1	1,2	1,3	1,5	1,5	1,6	1,7	1,8	1,9	1,9	2	2,2	-	-

The results of the experimental measurements obtained by successive tests on the trying stand are highlighted for each type of magnetic sensor, thus: for the NXP KMI15 type sensor in Table 1, for the ATS 653 sensor in Table 2, for the XSA-V11373 sensor in Table 3, for the SM351LT type sensor in Table 4.

From a graphical point of view, in figure 9 it can be observed very clearly the reaction mode of the magnetic speed sensors that have been analysed in these experiments, according to the distance to which they are located towards the motor drum which activates the conveyor belts. However, considering the operating parameters and the purchase price, for the implementation of the electrical control scheme of the automatized control device, it was chosen to use the speed sensor type XSA-V11373 manufactured by TELEMECANIQUE.

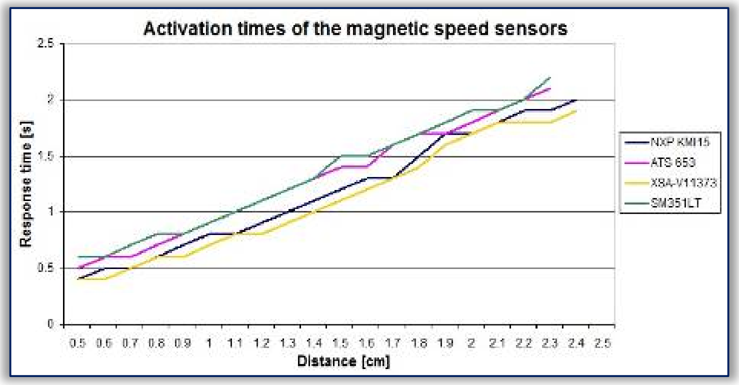

Figure 9 - Activation times of the magnetic speed sensors in function of the location distance against the drum

4. CONCLUSIONS

To resist on the competitive market, but also for compliance with the rules of the European Union on the protection of the environment, all the compound feed factorys have acquired modern installations of work, with a high degree of mechanization, automatization and computerization of all activities in the technological flow.

The conveyor belts ensure the transport of raw materials from the incoming bunkers to the working installations and therefore represents a critical point of the technological flow of a compound feed factory (CFF), because their blocking can cause loss of material, of time and the default financial losses.

In this study was pursued the making some experimental measurements for the implementation some modules of automated control of the rotations of drums which is acting vertical and horizontal conveyor belts.

The implementation some special modules of automated control of the conveyor belts has at basis the use of some sensors, which to emit a signal of warning in the moment when is changing the normal rhythm of running of the displacement of them.

Knowing that exist a lot of types of magnetic sensors of rotation, for the verification of parameters of running them it was builded a stand of tries, which allow the simulation of automatized control for start and for stop of the conveyor belts, such that to analyse all events which can appear during the functioning and thus to eliminate possibles blockages or breaking of them.

By implementation of some automatic control devices of the conveyor belts is eliminated the possibilities of stopping the technological flow and minimizes the loss of raw materials, which causes an increase in working productivity.

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