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CONTRIBUTIONS TO DOSING SYSTEMS OPTIMIZATION

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Abstract: *The paper presents the research on functioning optimization of dosing systems. The main objectives are the optimization of the hardware system and as well as the command structure, which the basic elements are found in modern dosing systems. The optimization of the dosing process has two aspects: hardware system optimization versus the standard ones and the implementation of an intelligent control system. The optimization of the hardware system was introduced in the structure of the experimental standby of two mechanisms: the change of the angle mechanism of the vibrating chute and the mechanism for the rapid stopping of the flow at the end of the dosing process. The optimization of the software contains the implementation of an intelligent command for designing and implementation of an automat control algorithm with feedback response using PID theory algorithm.*

Key words: *Dosing, Mechatronics, Optimization, Control*

1. INTRODUCTION

In the context of technological boom which the industrial production lines had had, especially in terms of increased computing power and automation, the dosing phase plays an important role in industrial processes. In conditions of a full automation of batch processes the aim has been pursuing improvement in terms of time and accuracy of dosing.

The previous studies carried out a need to use a closed loop control to ensure a self-regulation based on the errors that introduce some disturbing factors in the system.

Dosing and packaging can be made continuous either way if the dosing is made in a package priory made, for metal or glass containers, or if the dosing precedes, at a very short time, the package making (for example, products packed in foil or plastic box).

Batching operation isn't independent of manufacturing products; it is integrated into various processes, so the result in the final product result does not have a distinct form but a cumulated one. As a consequence, the quality of dosing directly influences the quality of the final product.

In order to define the operation of dosing there are some requirements: knowledge of the volume to be portioned; establishing a control parameter; transporting of the product.

Dosage problem is solved only if these three requirements are met (Fig. 1) (Asch, 2006). During the construction of dosing systems an important step consists of choosing technical solutions that will be used: devices, sensors, operating principles of functioning and methods of manufacture.

2. THEORETICAL ASPECTS

Optimization of the process, in terms of speed and accuracy of dosing, is achieved by controlling the vibration and gutter flow angle depending on the material remaining to be dosed. To ensure a controlled flow of the material in the weighing bucket a PID algorithm for flow control depending on the material weighed at a time was used.

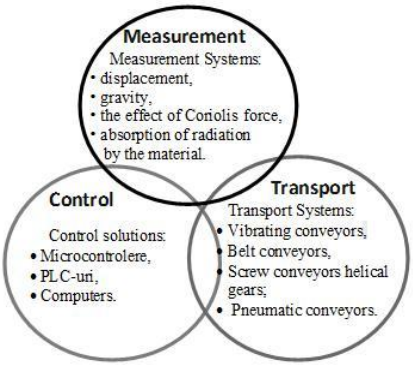

Fig. 1. Dosing system requirements

The controller commands actuators (engine vibration and engine generator that changes the angle jolt) to maintain the flow of material at the desired value during the dosing process.

Closed loop control consists of three steps: Measuring the size of output using a sensor connected to the process; Generating and implementing the decisions of the control unit; Actuation actuator for control process.

The controller reads a sensor, it reduces the value obtained from measurement from the set value (desired value) thus determining the error. He uses the error in order to calculate the input value into the process (how it works) so that is the reason why the correction will remove the output measured error.

In a batch system, the actuator element doses the material until the amount of dosed material reaches the desired value. The problem of optimizing this process arises in terms of speed without losing accuracy of dosing. The solution is to have a variable rate dose because high-speed dosing of material lead to problems affecting the accuracy of dosing.

A sensor will measure the quantity of the dosage and will continuously send data to the controller. The controller has set a desired dose point (set point). Controller output is connected to the metering actuator that actually pushes the material. The controller will use a measured value of the quantity of material dosed to calculate how the actuator must be commanded to reach precisely the dosage amount in a short time.

In order to better highlight the behaviour of the PID algorithm in the case considered, it is necessary to analyze each parameter of its operation. The description of algorithms that are to be executed using a computing system cannot be achieved using a natural language, primarily due to the fact that natural language is not rigorous - various formulations of this type of language may have the same meanings (Manescu &Cristea, 2008).

Commonly used methods of representing algorithms are logical schemes and pseudo language.

As their main quality is the ability of clearly showing the sequence of operations.

3. EXPERIMENTAL ASPECTS

The experimental stand is equipped with a data processing module which has as the central unit the microcontroller Atmega8535 (fig.2.). It communicates through the serial interface such as SPI (Serial Interface Peripherical) with the AD7730 circuit. AD7730 circuit is specialized for the conversion of analog signal received from the tensiometric mark PW6CC3MR. The main advantages of this circuit are: better accuracy due to internal microprocessor which is able to generate 24-bit operations, registers of signal filtering and low cost. The main disadvantage is given by the sensitivity to disruptive external factors such as: industrial frequency, vibration, electromagnetic wave sources.

The operating diagram was made based on the following conditions that the system must meet: Establishing a protocol for communication with the computer; Commanding actuators to generate vibrations, changing the angle of shutter vibration and throttle control; Set digital analogue conversion; Closed loop to control flow metering.

Through the graphical interface of the PC application, the user can set certain parameters of dosing and controlling its phases: start, stop, reset batch process. The scheme includes several modules: The module to change the angle of inclination of the tank includes blocks for amplifying signal from the microcontroller to control a unipolar stepper motor, which through a nut screw transmission changes the angle of the vibrating jolt. Microcontroller sends signals to these blocks, the transmission signals are unidirectional.

Optimization of the process, in terms of speed and accuracy of dosing is achieved by controlling the vibration and gutter flow angle depending on the material still to be dosed. Vibrations of the transport system cause errors in digital analogue conversion process, which is the most important cause of errors in a weighing system (Cristea et al., 2009). Removing these errors can be made taking the following measures: application of electronic filters to signal transducer; finding the optimal amount of filtering register of Sigma Delta converter that is included in the AD7730 specialised circuit. Microcontroller receives the SPI interface (Serial Peripheral Interface) the result of an analog-digital conversion (ADC). Tests were conducted to optimize the conversion by removing errors caused by disturbances in the power amplifier floors. To highlight errors there were performed several tests in the following identical conditions: food cup filled with 613 g of material; food chute is empty and remains empty during the tests.

The quality of the dosing process can be characterized by two parameters: speed and accuracy of dosing. In the standard process is a known fact that dose rate adversely affects accuracy

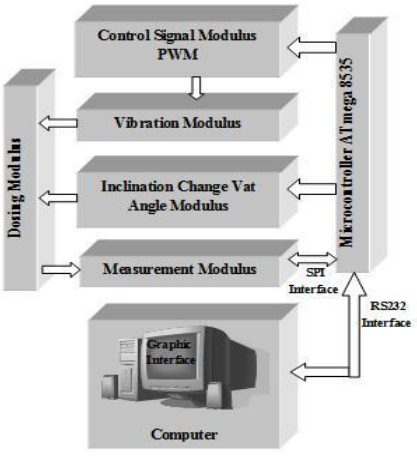

Fig. 2. Block chart of automatic dosing system

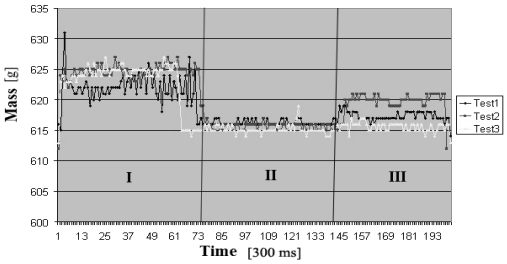

Fig. 3. Test chart

Each test consisted of three phases: first stage, the vibrating engine is started, the second stage, the vibrating engine is stopped mechanically; third stage vibrating engine is disconnected electrically after amplifying floor.

In figure 3 there are represented the signals from the AD7730 during the three stages for the three tests considered most significant. Differences between the last two digital analog conversions are:-3g,-9g,-3G. (the three tests shown).

4. CONCLUSION

Vibrations of the transport system cause errors in digital analogue conversion process, which is the cause of errors in a weighing system. Removing these errors can be made taking the following measures: Reduce vibration to end strength; Application of electronic filters to signal transducer; Good filtering configuration registers Sigma Delta converter circuit included in specialized AD7730.

After the theoretical analysis of material flow in the dosing process there have been established parameters for determining the flow section, natural slope angle, the theoretical resolution of the metering system for weighing bulk materials to be used in experiments. Solids metering devices should consider bulk flow properties and bulk material flow. These properties go through many changes since the bunker fuel storage tank and dosing device outlet end section of the dosage unit.

It is essential to avoid any interruptions in the flow of material or status changes of flow which can be often seen as phenomena such as vaulting material effect because small sections of exhaust flow or avalanche due to poor fluidity.

The shape of particles can be approximated by analyzing the diameter of the particles forming the mass of material. Since this size is less than 100 mm, the increase compressibility and particle cohesion. Because of uncontrollable factors that influence the process of determination is recommended in closed loop control of actuators based on dosed flow during the process. Due to uncontrollable factors that influence the process of determination it is recommended a closed loop control of actuators based on dosed flow during process.

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