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PRECISION FILLING CONTROL APPLICATION WITH PLC FOR BIG BAG SCALE AUTOMATION

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Abstract

In this study, we designed a big bag scaling machine. Control of the designed machine is provided by PLC (Programmable Logic Controller). With the developed software, the weighing function is provided precisely and quickly. The weight information was sent to the PLC via modbus in the weighing using three load cells. The filling speed is controlled by the data processed on the PLC. Filling is slowed by the amount of weight. PI control method is used for fill control. In tests made for 1000 kg filling, a more precise filling is made to the conventional filling method. Also the filling time is reduced by 35s from 50s.

Keywords: Automation, PLC Control, Big Bag Scaling

INTRODUCTION

The storage of powder, granules or particulate matter was preceded by stacking. In this case, stock information must be kept in order to detect the remaining product when using the products. In addition, storage in the form of stacks can be reduced due to environmental factors (wind, rain, etc.). Due to the constant increase in costs, the follow up, protection and hiding of the product from production to consumption has become important. For this reason, many factory products are not clearly stacked. They are stored in packets of known weight [1-2]. This makes it very convenient for the products to be ordered and shipped. This makes it very convenient for the products to be ordered and shipped. In this context, large sack weighing machines are produced in the sector [3]. These machines are a variety of products to fill sacks weighing the desired weight. Examples are shown in Figures 1 big bag agricultural machinery.

Fig. 1. Big Bag Scale Machines Examples

The working principle of the two machines shown in FIG. 1 is based on measuring the weight of the suspended sacks. At the same time when the product is fed from the top of the machines, the bag hanging on the arms is weighed and when the desired mass is reached, the entrance of the bag is cut off [4-5]. Similar to these machines, they are available in machines that pre-weigh the product and empty the bag when desired.

In this study, a machine that pre-weighed was designed and automated [6]. The weighing machine to be designed is used for rice weighing and obtained for the rice brine product. The product mass of 200-1500 kg entered by the user through the touch panel (HMI) is weighed in the bunker and transferred to the bag when desired. It is also developed various mechanisms for sack transport according to the factory environment. Sack weighing machines are not in contact with the ground. For this reason sack lifting and lowering mechanism is necessary. In the pre-weighing machines, product entry and product output are controlled [7-9]. In Chapter 2, we will refer to the hardware used in machine automation. The software and control algorithms developed in Chapter 3 are discussed. Finally, section 4 gives the results.

WEIGHING AUTOMATION HARDWARE

Big bags weighing automation is planned in two parts. Delta DVP14SS211R PLC was used as hardware to run software in the system and to control other hardware. Delta DOP-B07S410 HMI touch panel is used for user input. [10] These enhancements have been programmed for proper operation. Product flow control during filling is provided by pneumatic pistons. Two double acting pneumatic pistons with a diameter of 40mm and a distance of 300mm were used. The designed filling system is shown in figure 2.

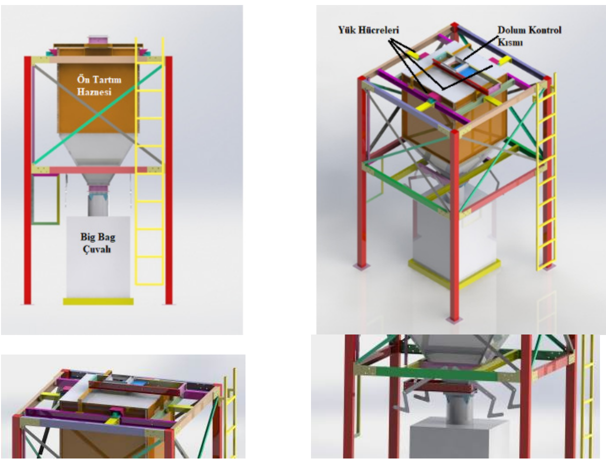

Fig. 2. Design of Big Bag Scale Machine

One of the pistons is located in the unloading section. This piston movement is provided by a 3 way 2 position spring return valve. Control is turned on and off. When requested, discharge is provided by outputting by PLC. When the output signal is interrupted, it is closed again. A proportional 5/3 valve of MPOE model of Festo with 0-10V input voltage for fill control was used [11].

The piston clearance was measured by placing a linear ruler on the piston. It is back-controlled by an in-field flow plunger with a 30x30cm square cross-section. The rice grains flowing from a section with a cross-section of 900 cm2 are quickly filled into the reservoir located on the bottom. The upper filling part and the bag discharging parts are as shown in fig2.

The filling is measured by three load cells attached to the body and weighing the pre-weighing chamber. The analog value from the load cells is converted to mass data. An internal converter is used. The converter communicates on the Modbus communication protocol with the PLC and transfers the mass information instantaneously.

SOFTWARE AND CONTROL ALGORITHMS

The mechanical structure of the sack weighing machine and the equipment used are explained in chapter 2. The software is encoded on a programmable logic controller (PLC) that provides control of the machine. Two pieces of information are received from the machine for the control function. These are mass knowledge. The mass is measured from three load cells connected to the pre-weighing chamber. The resistance generated by the displacement of the load cells is converted to weight or mass information by a value transformer. Then the information is transferred PLC via, Modbus. The information obtained is the raw mass information. The second information is the level of openness of the filling section. The 30x30cm wide area is controlled by a pneumatic piston. The forward movement of the piston reduces the span. Therefore, the amount of mass entering the pre-weighing chamber is also decreasing.

Clearance information was obtained with a linear ruler placed on the piston for aperture control. This information is read as 0-10V for 0-30cm. The general control block diagram of the system is given in Fig 3.

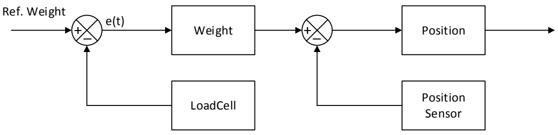

***Fig. 3.** Control Block Diagram without PI*

In the control process, firstly a double-stage control method, which is found in many machines available, has been tried. In this method, filling is achieved with a 100% clearance up to a predefined threshold mass level, but when the level is reached, the piston clearance is reduced by about 90%. This level is to be filled until the final mass value is reached after shrinking. Once the target is reached, it is completely closed. This process is done with two separate pistons to offer a more economical cost. In this study, first experiments were carried out by the double stage filling method. When the brass machine in the storage bin (bunker) is commanded, it fills the pre-weighing chamber and when reaching 950 kg, the opening is narrowed to 27 cm. After that, full filling of 1000 kg is stopped and the sack is emptied. This process takes 50 seconds.

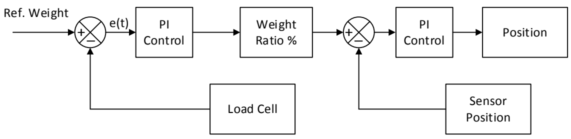

***Fig. 4.** PI Control Block Diagram*

In order to find a dynamic ratio according to the error value instead of the pre-defined ratio, a PI-inspected control model was created. For the control function, two separate PI controls have been applied for both filling rate assignment and piston position control.

The PI supervised block diagram developed for the control of the soil is shown in Fig 4. The coefficients for two separate PI controls are given separately. The complete state of the system is shown in Fig 5.

***Fig. 5.** Big Bag Scale Automation*

CONCLUSION

In this study, design, production and application of large sack weighing automation have been realized. The PI controller is used for the system to be able to work fast and precise filling. System control is provided by means of a program developed on a programmable logic controller (PLC). Touch human machine interface (HMI) has been used to enable users to enter data and to track values. The PI controlled filling control developed by the classical and widely used double stage filling control has been tested separately. The data for rice weighing was also filled in 50 seconds for 1000 kg with the double stage filling method, whereas the filling was carried out in PI for 35 seconds.

Because the mechanical properties of the machine are the same, the PI-controlled filling time is faster. Only the control method has been changed by keeping the mechanical factors affecting the filling speed (product type, dimensions of filling chamber etc.) constant. In the dual stage system, the fill mass is weighed properly because there is very little mass transit when the predefined section is reached. This increases the fill time.

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