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## Research of Control System of Packaging Machine on PLC

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### Abstract

*An automatic control system of sampling package for sample coal is designed according to the realities of sample coal powdery materials which are based on controller (PLC). The system can realize the functions of random sampling, auto-weighting, auto-packaging, and auto-sealing off. It also can adjust waste less, control convenient, zero point self-tuning and dynamics weighing measurement. It can be used in sampling weighing package of sample coal. Various performance indicators can be stably and reliably used in field.*

**Keywords:** checking sample coal, auto-quantitative packaging, dynamics control, PLC

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### 1. Introduction

The rapid development of modern mechanization and automation of packaging technology with each passing day, the quantitative packaging of various items is accurate direct impact on the survival and economic benefits, most manufacturers have adopted a highly automated production line to complete [1]. In contrast, coal rarely used the packing of the products, the study also few, and how to improve in coal washing industry of coal samples packaging precision. It has been a major enterprise problem. In this paper, according to the characteristics of coal samples collected developed coal sample quantitative packaging control system.

#### Related Technology Introduced

In the coal washing or coal processing production, the national requirements for the finished products of coal quality of the sampling testing, such as smelting with plant, need to test the moisture, ash and all the sulfur. Coal samples sampling machine should meet the following requirements: a) the sampler opening size should be not less than be sampled coal of the largest size 2.5 times; B) mobile the coal flow sampler should be able to intercept a coal flow cross-section as a sub-sample, Static coal in the sample quality should be consistent with the requirements of GB/475- 1996 [2]; C) by a qualified departments identified sampling system errors, precision achieves GB475, 1996. The basic requirements of sampling sites: coal samples should be selective examination unit sales or be in coal, coal flow in mobile or the train, automobile load taken in coal, generally not directly in the coal and the ship carrying taken in coal, and should in the pile of (pack) coal and coal unloading process, from coal transport flow or small transport tools such as automobile load in the coal to take. In exceptional circumstances, can be layered from the top of the coals taken can also be taken directly from a height of less than 2m of the coals. The sampling base checks coal sampling base is generally shipped 100t or a batch. Sampling base in less than or equal to 100t, at least should be a homework class of the production, stockpiling or traffic volume. The more common method is manual bagging sampling of coal products, past operator randomly installed in the coal pile in 2000 bags per bag of 50-80 kg, sent to the various testing agencies. In this case, bagging and weighing measurement imprecision, the human factors also have important to sampling quality, and with big waste.

## 2. Total Solutions

Coal products produced, sent to the conveyance by the conveyor belt. In the transport of coal product conveyor belt set up a separate acquisition bagging institutions. The users only need to set the sampling on the console cycle and the total number of bags. The control unit is responsible for the collection of coal product random, and using a set of bagged way for volume coal bagging. After bagging, give some hints to complete the entire signal the sample collection of coal. Whole process without manual intervention, make sampling more objective. Experiments show the effect is very good.

## 3. System Design

### 3.1. System Architecture

The automatic acquisition bags system mainly by the control unit, the coal thickness tester, intercept paddles, and the coal loading spin measures, the heavy equipment, Sealing device and touch screen components. The main control unit [3] is performed by the programmable logic controller (PLC) and its corresponding control circuit components. The system uses Mitsubishi FX2N series PLC, the main achievement of the quantitative packaging control system for all phases of automatic control functions. Through the inverter to adjust control with coal scuttle, rotational speed and into the coal amounts decide the size of the rotation speed, intercept the paddle and coal to intercept time also the throughput, thickness of coal seam is increased, the interception time is short. Weighing transducer and the corresponding instruments formed electronic weighing measurement unit, realize the coal samples of bagging measurement, bag number digital display. Material transfer unit is mainly composed of chain transmission system; the transmission system adopts the motor control, to achieve the transfer of packaging products. According to the requirements of the sealing element set to complete automatic packing seal action. The system basic composition is shown in Figure 1.

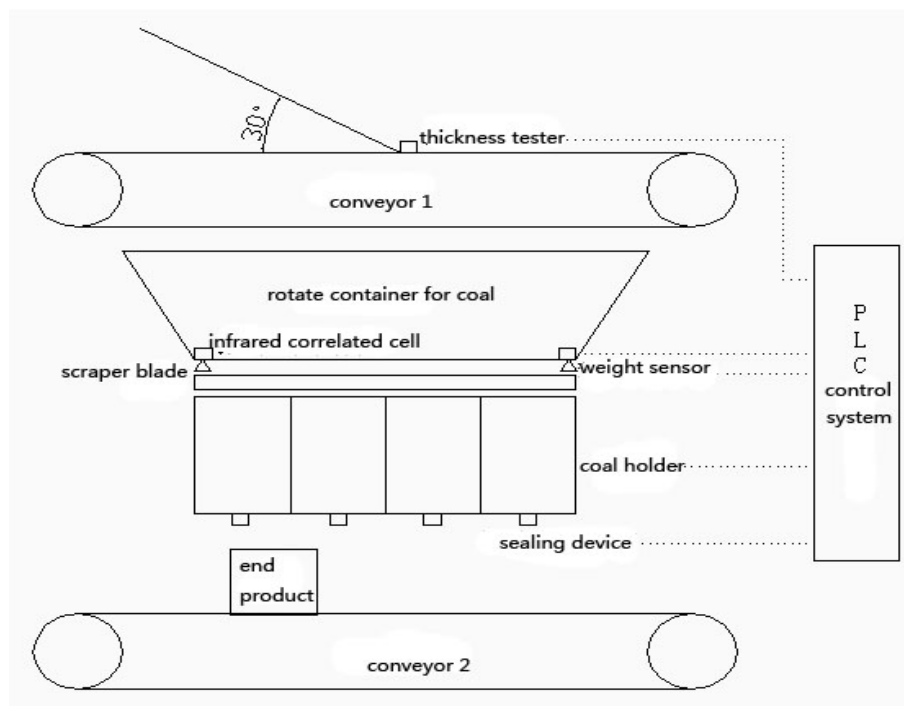


Figure 1. Composition Diagram of the System

### 3.2. System Working Principle

The system first asks the user to set on the touch screen sample coal collection amount and several bags, and then start the acquisition order. The system began to work is the premise

of the tests measure the thickness of coal seam thickness of coal seam reach a set requirement and coal seam in stable flow on the conveyor belt. So there is no coal scuttle cavity too much or too little phenomenon, to ensure effective follow-up bagging error control in less than 5%. Systematic random wait time for a period of time after the start of acquisition. Using hardware filter [4] and software smooth, through the AD module input system. Start collecting, put down the block coal baffle, coal particles in the paddle stopped, next to the coal to collect slot movement and in the force of gravity, pulverized coal fall into is spinning the coal loading a spin, continuous fall into total K pulverized coal.

$$K = A * S * T * H$$

A: the width of pulverized coal (the width is made up of the sieve institution decision, normally unchanged, but through the manual correction)

S: transfer speed, (stable running of little change, can be manually modified )

T: baffle coal blocking time

H: The coal seam thickness (it measured by the sensor, the stable range is small)

Rotating coal scuttle has four coal loading of the chamber, the capacity of the chamber

K1,

$$K1=K/4;$$

Coal scuttle the rotational speed is determined by the thickness of the coal seams, coal seam thickness, the faster and the rotation speed of the coal scuttle. In the upper part of the coal scuttle, the installation of a fixed scraper, when coal scuttle rotation, it has the function of pulverized coal scrape flat, through the infrared radio tube to judge whether the pulverized coal scrape flat. Because the total amount of coal is stable, after get flat pulverized coal, four coal scuttle cavity all can fill up, then open the feeding device realize automatic packaging material of coal, and then realize weighing, labeling, etc. The basic work measurement process is divided into coal thickness, coal, coal block rotates cartridge measures, discharging sealing, weighing 5 stages. System production process shown in Figure 2.

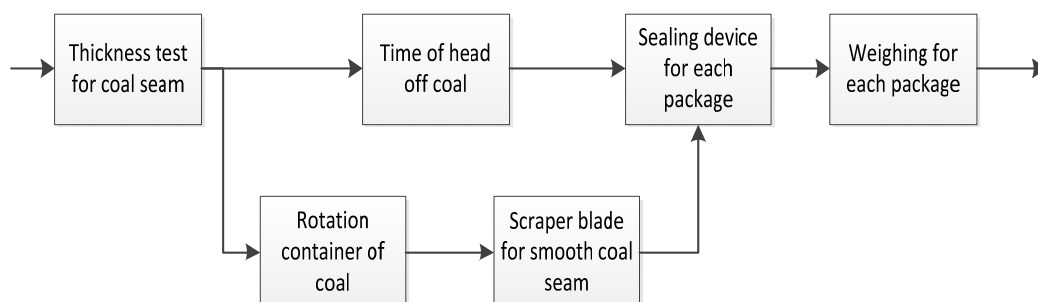


Figure 2. The Flow of Manufacture Process

### 3.3. Hardware Level of Design

The system hardware circuit is mainly composed of the test, control and implementation of 3 parts. The movable connecting rod drives the angular displacement sensor to realize the measurement of the thickness of coal seam. The lower end of the connecting rod has a wheel, rely on linkage gravity and pressure in coal seam. Through the angular displacement sensor for coal bed thickness into electrical signals are transmitted to the AD module. The motor is utilized to drive the gear rack, high-speed baffle rises drop control. In order to achieve the requirements of the coal flow section, design a rapid reciprocating motion of a motor. Through the vibration [5] method to ensure the requirement of whole section, meets the requirements of the whole section. A displacement sensor detects the position; the second is through the motor current detection. The weighing part, in the weighing hopper side force supporting point and the installation of a weighing sensor, weighing hopper used to measure each weighing samples of coal quality. And convert it into a current signal output signal through the A/D converter module. The measured analog to digital signal, input PLC. Each bag samples can be obtained by conversion of coal quality, through the touch screen display. Touch screen would communicate via RS422 and PLC.

#### 4. Software Level of Design

The system software is developed by SFC [6]. In program the LAD module includes a digital signal processing, stable initialization processing, frequency converter to read and write, etc. Routing module mainly realizes process control, etc.

The initialization process can rely on the M8002 is an initialization pulse completion, pulse to complete the system self-test and the external module testing. Taking into account the serious interference of the environment of the scene, especially on the input signal into an adjustable 5ms to 10ms temporal filtering, experiments show that the effect is good.

In order to real-time control of the inverter, high frequency of data exchange and inverter speed value setting [7] is inevitable. How to guarantee the read command, the write command, data loopback command, orders confirm command not disorder, Work timing signal is very important. In order to ensure that there is a sufficient amount of time for speed decreases, the set value of 0 to properly in advance. The introduction of a sequence control pulse used to realize the PLC real-time control charging rotary bucket speed. The PLC read and write control sequence is shown in Figure 3.

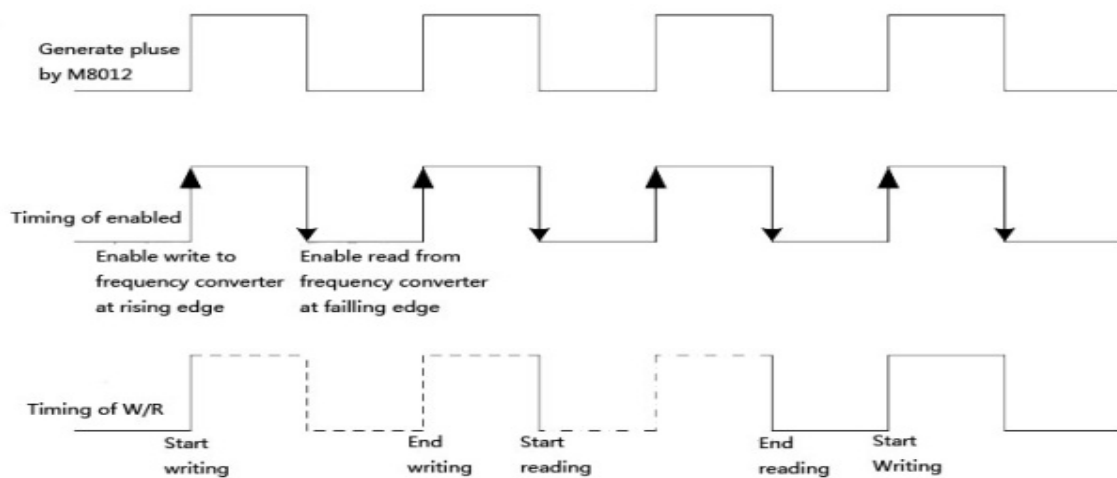


Figure 3. Timing of the W/R Control System

Considering the program interfere with communication and time delay of random effects, Specifically the introduction of a 10Hz the stable pulse generated by the M8012. In the pulse rising edge detection can write transducer. On the trailing edge of the pulse detecting whether can read transducer. Reading and writing prerequisite for the transducer is ready, the PLC data has been processed, the last communication has been completed. Through the field experiment proved that communication delay is really serious, almost a time needs 40ms to complete. If it don't use this work mode, always to cause the communication chaos. System software of the control flow shown in Figure 4.

The whole control process, a crucial content is determined the baffle block time. In order to improve the baffle insertion speed, the panel is set to and vertical plane into 30 degrees tilt angle way inserted. In the course of transmission using a rack and pinion, the speed and power can be guaranteed and test the motor armature current size. When the sensor does not reach the set value and the current value is larger than the threshold, the baffle high-speed reciprocating lifting. Within 1ms cannot be full cut coal flow, enhance the baffle to wait sometime after the re-implementation of the block of coal.

For weighing link, coal scuttle wall adhesion of pulverized coal weighing have certain effect. This system uses the stainless steel wall structure that can be attenuated this effect. In the weighing measurement process, the system will produce some error on the weighing of coal products. Corrected this error of weighing, before each feed, empty bucket mass  $m_0$  controlled by PLC automatic weighing and  $m_0$  as the next coal product quality of feed weighing ( $m_1$ ) Reference zero. The actual quality of the materials of the  $m_2$  through the system operation can

be got,  $m_2 = m_1 - m_0$ . External factors caused by drift phenomenon will make the actual feed value affected [8].

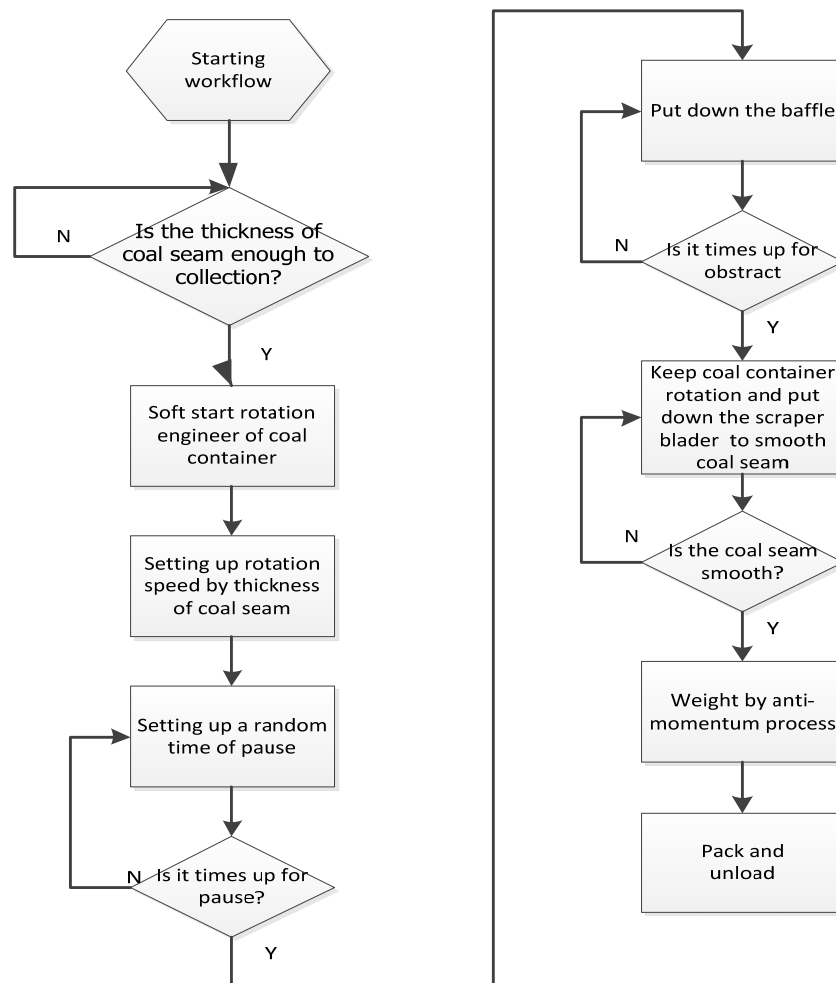


Figure 4. Flow Chart of Control

In the packaging incoming link, in order to make the feeding speed and the accuracy of the measurement packaging assured that the system uses the incoming material and fine tune fast the way of the combination of the feed. Usually the rapid feeding threshold is set for the target value of 80% [9], so that the feed speed. The accuracy of the feeding can be remedied by slight feeding to improve. Fine-tuning the quality of incoming material value is equal to the target and threshold impulse difference.

Fine-tune the feed valve will automatically close when the system feeding reaches the set value. Some distance from the weighing hopper feeding exported coal products, can cause some materials may fall into the bag. System settings will be less than the actual packaging value. At the same time in the process of pulverized coal feeding and bagging, shock, vibration, will cause the packaging quality transiently increase and arouse overshoot phenomenon. Actual feeding quantity is equal to the fine-tuning the feed with the overshoot. In order to make the overshoot automatic correction, this system uses a negative feedback bias control technology. The basic principle is based on the last bagging error to adjust the weighing measurement process resulting in overshoot. In order to improve the precision of the quantitative packaging, weighing deviation value and target value switch time to adjust by micro feed valve [10].

## 5. Conclusion

By the above discussion, the samples of coal quantitative packing control system design is completed. The utility model is characterized in that, has the advantages of simple structure, convenient maintenance, can improve the sampling of random, accurate measurement, good to meet the requirement of coal samples for quantitative packaging. PLC and its related instruments as execution-driven devices, the system can be run automatically. And realize efficient implementation of the PLC and inverter communication, zero drift self-tuning and overshoot self-adjusting functions. To all sorts of powdered or granular items has the reference value and promotion. The maximum satisfy the users of different process requirements. In a year of field test, each performance index of the system is stable and reliable.

## References

- [1] WU Wen jun. PLC Control of Feed Weight Measurement and Automatic Packaging. *Packaging Engineering*. 2006; 29(3): 87-89.
- [2] GB/475—1996. Commercial coal sampling methods.
- [3] LIU Cheng, LI Xiaogang. Application of PLC in Packaging Machine. *Packaging Engineering*. 2004; 25(2): 51- 53.
- [4] Jiang Qing. Design of Quantificational Weighing Controller of Powdery Materials Based on STC89 Microcomputer. *Packaging and Food Machinery*. 2008; 26(1): 24-27.
- [5] ZHENG Yuezhen. Vibration Monitoring and Analysis for Rotating Machinery. *Gas Turbine Technology*. 2010; 23(1): 39-44.
- [6] Zhang Wangui. *Electric machine control technology*. Peking University Press. 2006.
- [7] ZHU Shunqiang, WANG Liang. A Simple Method of Packing Crushed Slat Rationally. *Journal of Salt and Chemical Industry*. 2007; 36(2): 46-47.
- [8] SUN Huer. Design of Automatic Control System of Quantitative Packaging for Miscellaneous Crops. *Packaging Engineering*. 2008; 29(12): 81-82.
- [9] Mao Qianmin. A Single chip Microcomputer based Quantitative package System China Institute of Metrology. *Packaging Engineering*. 1999; 20(03): 53-55.
- [10] FAN Bin. Tracing zero point automatically in application of infrared transducer. *Journal of Transducer Technology*. 2001; 20(10): 22-23.