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The design of the control system of pneumatic conveying for coal ash based on PLC

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Abstract. According to the transport characteristics of coal ash and dust, a pneumatic conveying equipment control system for coal ash is designed in this paper. The automatic control of pneumatic conveying equipment is realized. The structure of mechanical system, control system hardware, system software and man-machine interface are introduced. The project practice shows that the ash conveying system based on this control function is reliable and easy to operate. It not only safeguards the safety and stability of the production equipment and the economic operation. It also protects the civilized environment.

Keywords: Pneumatic conveying, Ash conveying, PLC.

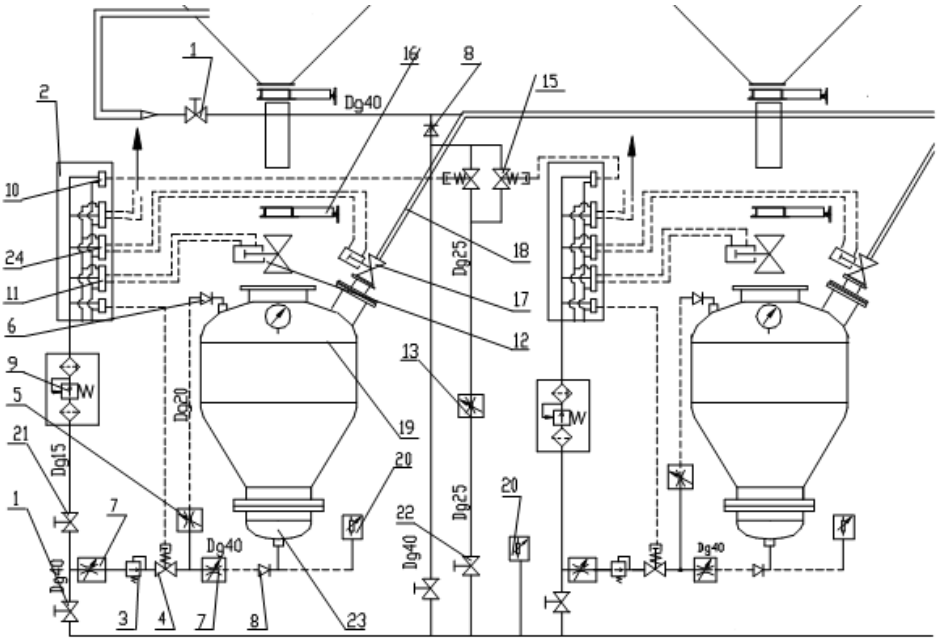
Introduction

Thermal power plant produces a lot of coal ash and dust in the process of production. Because of the characteristics of small coal ash and fine particles, it is easy to leak, generate dust and pollute the environment when using general mobile transport equipment, which seriously endangering the health of operators. Ash and dust transfers in the closed pneumatic conveying system to achieve the purpose of no dust pollution, flexible pipe layout, long transportation distance, easy to centralize transportation and recycling. Pneumatic conveying control system based on PLC is safe, reliable and highly automated.

Hardware design of control system for pneumatic ash pump

Composition of a storehouse pneumatic ash pump. Composition of a storehouse pneumatic ash pump is shown in Figure 1.The pneumatic conveying system is mainly composed of the storage type pump, the transmission line, the compressed air and the control equipment. The power source comes from the compressed air and uses compressed air to transport the dust through the pipeline to the ash pool or the next industrial process. The dust storage pump is mainly composed of feed valve, pressure valve, delivery valve, anti blocking valve, warehouse type pump body and pipeline. The pneumatic control is adopted to control the gas source, and the compressed gas source for transportation is adopted. Its equipment is composed of 1 Diagram, which is a conveying system diagram composed of two warehouse pumps. The compressed air from the valve (No. 1) to enter and divided into two ways: the way of air connection by air source treatment (No. 9) into the local control cabinet, control of the valve under the control of PLC, in which the valves are for pneumatic valve, controlled by the electromagnetic valve to open or close the other way; flow through the throttle valve and pressure relief valve (No. 7) (No. 3) as the source of dust conveying. In the control system, the pressure of the gas source, the material position and pressure of the material in the pump are transmitted through the corresponding sensor to the PLC program control cabinet. The inlet valve is arranged on the upper part of the sump pump (No. 12), delivery valve (No. 17) and the material level meter, are used to control the charging and discharging and material level measurement; the gasification device is arranged on the lower pump (No. 23), to improve the air pressure inside the pump and discharge ready; the pressure

transmitter set (No. 20), for monitoring air pressure. The ball valve (serial number 22), throttle valve (serial number 13), check valve (serial number 8) and ball valve (serial 1) pipeline and so on constitute a blockage and plugging system, which is used to further purge the dust in the pipeline and prevent pipe blockage.



1. Valve 2. Local control box 3. Pressure regulating valve 4. Pressure valve 5.Throttle valve 6. Check valve 7. Throttle valve 8. Check valve 9. Gas source processing unit 10. Two - position three - way solenoid valve 11. Two - position five - way solenoid valve 12. Feed valve 13. Throttle valve 14. Gas supply hose 15. Plugging valve 16. Barn pump overhaul valve 17. Delivery valve 18. Conveyer elbow 19. Storehouse pump body 20. Pressure transmitter 21. Globe valve 22. Globe valve 23. Gasifier 24. Two - position five - way solenoid valve

Fig.1 Schematic diagram of a storehouse pump

The composition of the storage pump control system. The composition of the storage pump control system is shown in Figure 2.It includes PLC system, man-machine interface system, intelligent digital display instrument, pneumatic system, pneumatic system solenoid valve, pressure sensor, various control switches, acousto-optic alarm system and so on. Among them, the intelligent digital display instrument is used to deal with the analog signals of the output of pressure sensors and to do further processing and output.

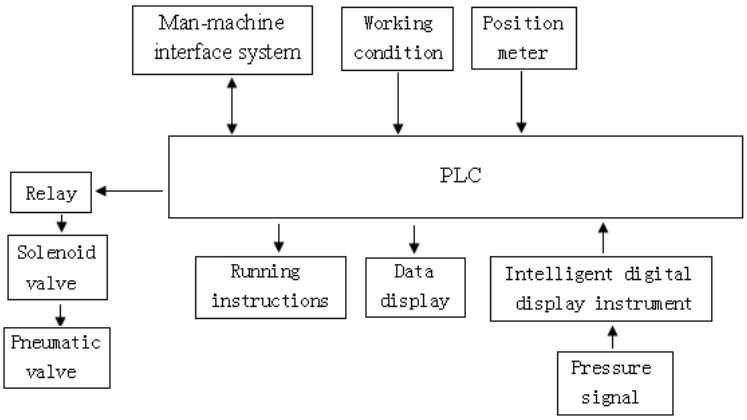


Fig 2 The composition of the storage pump control system

Tnput / output module address allocation. The system uses SIEMENS PLC S7-300 PLC. According to the process and control requirements, the input module includes input button, exit button, automatic manual switch button, fault protection, variable signal and so on. The distribution of PLC digital input points is shown in Table 1.

Table 1 Input point allocation

address	function	address	function	address	function
I0.0	1# Pump input	I2.4	3#Low pressure of bin pump	I5.0	6# Pump input
I0.1	1# Storehouse pump exit	I2.5	3# Bin pump automatic	I5.1	6# Storehouse pump exit
I0.2	1# Silo pump plugging pipe	I2.6	3# Storehouse pump is full	I5.2	6# Silo pump plugging pipe
I0.3	1# Pump pressure high	I2.7	3# Storage pump reset	I5.3	6# High pressure of bin pump
I0.4	1#Low pressure of bin pump	I3.0	4# Pump input	I5.4	6#Low pressure of bin pump
I0.5	1# Bin pump automatic	I3.1	4# Storehouse pump exit	I5.5	6# Bin pump automatic
I0.6	1# Storehouse pump is full	I3.2	4#Silo pump plugging pipe	I5.6	6# Storehouse pump is full
I0.7	1# Storage pump reset	I3.3	4#High pressure of bin pump	I5.7	6# Storage pump reset
I1.0	2# Pump input	I3.4	4# Low pressure of bin pump	I6.0	1#Feed time of bin pump
I1.1	2#Storehouse pump exit	I3.5	4# bin pump automatic	I6.1	2#Feed time of bin pump
I1.2	2# Silo pump plugging pipe	I3.6	4# Storehouse pump is full	I6.2	3# Feed time of bin pump
I1.3	2#High pressure of bin pump	I3.7	4# Storage pump reset	I6.3	4#Feed time of bin pump
I1.4	2#Low pressure of bin pump	I4.0	5# Pump input	I6.4	5#Feed time of bin pump
I1.5	2# Bin pump automatic	I4.1	5# Storehouse pump exit	I6.5	6#Feed time of bin pump
I1.6	2# Storehouse pump is full	I4.2	5# Silo pump plugging pipe	I7.0	Low pressure of gas source
I1.7	2# Storage pump reset	I4.3	High pressure of 5# bin pump	I7.1	Normal pressure of gas source
I2.0	3# Pump input	I4.4	5#Low pressure of bin pump	I7.2	Alarm silence
I2.1	3# Storehouse pump exit	I4.5	5#bin pump automatic	I7.3	Alarm reset
I2.2	3# Silo pump plugging pipe	I4.6	5# Full storehouse pump l	I7.4	System input
I2.3	3#High pressure of bin pump	I4.7	5# Storage pump reset		

The output module includes feed valve, pressure valve, anti blocking valve, delivery valve, discharge valve, exhaust valve, fault output and other switch instructions and corresponding indicator lights. The distribution of digital output points is shown in Table 2.

Table 2 Output point allocation table

address	function	address	function
Q8.0	The action of the feed valve of the 1# bin pump	Q20.0	1# Pump pressure valve indication (pressure timeout)
Q8.1	1# pump pressure valve action	Q20.1	1# Pump delivery valve indication (delivery timeout)
Q8.2	Anti blocking valve action of an electric field	Q20.2	1# Pump position indication (failure alarm)
Q8.3	1# Pump delivery valve movement	Q20.3	1# Pump operation indication (in-situ manual)
Q8.4	1# Pump automatic (failure) output	Q20.4	1# Pump local box manual
Q8.5	The action of the feed valve of the 2# bin pump	Q20.5	2# Pump pressure valve indication (pressure timeout)
Q8.6	2# Pump pressure valve action	Q20.6	2# Pump delivery valve indication (delivery timeout)
Q9.0	2# Pump delivery valve movement	Q20.7	2# Pump position indication (failure alarm)
Q9.1	2# Pump automatic (failure) output	Q21.0	2# Pump operation indication (in-situ manual)
Q9.2	The action of the feed valve of the 3# bin pump	Q21.1	2# Pump local box manual
Q9.3	3# Pump pressure valve action	Q21.2	3# Pump pressure valve indication (pressure timeout)
Q9.4	Two electric field anti blocking valve action	Q21.3	3# Pump delivery valve indication (delivery timeout)
Q9.5	3# Pump delivery valve movement	Q21.4	3# Pump position indication (failure alarm)
Q9.6	3# Pump automatic (failure) output	Q21.5	3# Pump operation indication (in-situ manual)
Q12.0	The action of the feed valve of the 4# bin pump	Q21.6	3# Pump local box manual
Q12.1	4# Pump pressure valve action	Q22.0	4# Pump pressure valve indication (pressure timeout)
Q12.2	Two electric field discharge valve action	Q22.1	4# Pump delivery valve indication (delivery timeout)
Q12.3	4# Pump delivery valve movement	Q22.2	4# Pump position indication (failure alarm)
Q12.4	4# Pump automatic (failure) output	Q22.3	4# Pump operation indication (in-situ manual)

Q12.5	The action of the feed valve of the 5# bin pump	Q22.4	4# pump local box manual
Q12.6	5# pump pressure valve action	Q22.5	5# Pump pressure valve indication (pressure timeout)
Q12.7	Three electric field anti blocking valve action	Q22.6	5# Pump delivery valve indication (delivery timeout)
Q13.0	5# Pump delivery valve movement	Q22.7	5# Pump position indication (failure alarm)
Q13.1	5# Pump automatic (failure) output	Q23.0	5# Pump operation indication (in-situ manual)
Q13.2	The action of the feed valve of the 6# bin pump	Q23.1	5# Pump local box manual
Q13.3	6# Pump pressure valve action	Q23.2	6# Pump pressure valve indication (pressure timeout)
Q13.4	Three electric field discharge valve action	Q23.3	6# Pump delivery valve indication (delivery timeout)
Q13.5	6# Pump delivery valve movement	Q23.4	6#Pump position indication (failure alarm)
Q13.6	6# Pump automatic (failure) output	Q23.5	6# Pump operation indication (in-situ manual)
Q16.0	1# Pump exhaust valve action	Q23.6	6# Pump local box manual
Q16.1	2# Pump exhaust valve action	Q24.0	Overpressure of 1# ash pipe
Q16.2	3# Pump exhaust valve action	Q24.1	Overpressure of 2# ash pipe
Q16.3	4# Pump exhaust valve action	Q24.2	Normal gas source
Q16.4	5# Pump exhaust valve action	Q24.3	PLCBattery failure
Q16.5	6# Pump exhaust valve acti	Q24.4	Alarm sound

Software design of pneumatic conveying control system for storehouse pump

The process flow of the storage pump mainly includes feed, pressure flow, transportation, blowing and so on, and analyzes the process flow of the bin pump to design its control mode. In the control mode of the storage pump, it includes two modes of operation, manual and automatic. Manual operation is applied in the commissioning, failure or automatic failure of the storage pump. The valves can be freely moved to facilitate debugging or operation, and operate automatically in normal situations. Its working process is shown in Figure 3

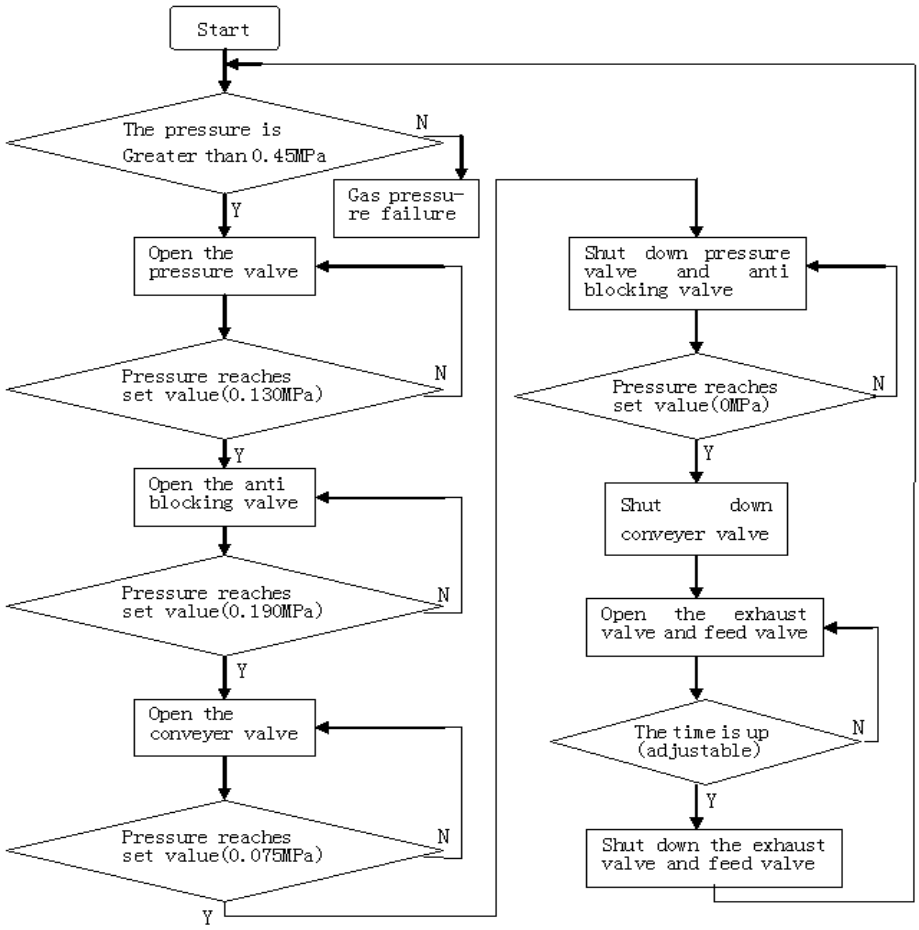


Fig 3 Its working process

Human-computer interaction system

The human-computer interaction system is responsible for monitoring the running state of the pneumatic ash transportation system. Through human-computer interaction system can control the production process, can realize a few stations, pump or the entire system input and exit operation,can set feeding time, work pressure and other process signals; when a fault occurs, it will give an alarm signal, and the indication of fault location, and can achieve the corresponding alarm silence, alarm reset operation.

The system can adjust the sensitivity of material level gauge, various pressure values, the action time of various programs and the opening of valves according to the characteristics of the materials such as coal ash and dust, so as to adapt to the transportation of different dust and to use flexibly and conveniently.

Conclusion

In this paper, the control system of pneumatic ash transportation is designed by using PLC. The control system is superior in the equipment debugging, maintenance, fault diagnosis, alarm and flexible use, etc. The automatic control of pneumatic conveying equipment is realized. It is proved by the application in the thermal power plant. The system is safe, reliable, easy to operate, transportation without dust pollution,and Improves economic and environmental benefits. It has good application value and market prospect.

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