ISSN: 2414-1895 DOI: 10.6919/ICJE.202103_7(3).0023

Design of Silica Drying Control System based on Heterogeneous Communication

Fei Han[1,*], Zongguang Hu[1], Mingzhi Cheng[1], Peng Wang[1], Weidong Cheng[1]

[1]School of Shandong University of Technology, Zibo 255000, China.

*han080610@163.com

Abstract

As the demand for silica functional materials increases, it becomes inevitable to transform the traditional production process control method into an integrated silica drying control system. Based on the existing equipment of a traditional silica drying control system, with the adoption of some of the original sensors, instruments and power, heterogeneous communication between the equipment and the system is carried out to build a communication network of the drying control system compatible with RS-485 and tcp/ip communication protocols, and flexible configuration of PLC and DCS equipment parameters and inter-network protocol converters to realize the integrated control of the drying control system. The error range between the moisture measured by the microwave moisture sensor and the set moisture is 0.5%, which provides a feasible solution for the integration of plant control using fluidized bed drying.

Keywords

Drying Systems; DCS; Plant Control Integration; Moisture Sensors; Heterogeneous Communication.

1. Introduction

Silica is an environmentally friendly and high performance functional material, which enables it to be widely used in several kinds of production fields, as an additive in feed; as a carrier or diluent in pesticides and highly effective spray fertilizers; and as a reinforcing agent in rubber. Forty percent of the Asian market is occupied by China, which has become the largest silica trade market in the world [1]. At this stage, it is necessary to carry out technical transformation of the production equipment that has been put into production, such as energy saving and potential tapping, and upgrading the level of automation control of silica drying is the technical key. According to the existing equipment base of the silica production base, the automatic control of feed pumps, spray tower air closers, fluidized bed air closers, hot air blowers and induced air blowers, fluidized bed pressure and temperature measurement and control, fluidized bed inlet and outlet moisture measurement and control are carried out using Modbus RTU communication protocol, intelligent moisture sensor Mobdus free port communication protocol and PLC and touch screen tcp/ip communication. The heterogeneous communication network of Modbus RTU protocol, Mobdus free port communication protocol of intelligent moisture sensor and PLC and touch screen tcp/ip communication protocol is used for hard and software configuration. In the control system, the traditional control system is integrated into the DCS control system for design research, and the RS-485 Modbus and tcp/ip communication protocols are used to connect each decentralized system, and the heterogeneous communication configuration between each decentralized system is used to form an integrated system for control and management [2, 3], which not only greatly reduces the downtime for transformation

ISSN: 2414-1895 DOI: 10.6919/ICJE.202103_7(3).0023

and makes full use of the original equipment, but also realizes operation control and remote monitoring functions.

2. Drying process flow

2.1 Spray tower drying

Spray drying tower is the preparation of silica with precipitation, through the mud pumps to spray centrifugal spray tower, with the centrifugal spray materials from centrifugal atomizing spray tower, atomization of white carbon black particles into the spray tower hopper, the silica atomized spray, by spraying mouth bottom into the combustion exhaust gas heating, water was carried out on the centrifugal atomization after silica exchange and heat exchange, after the exchange is lighter and more dry white carbon black from export after dust removal fan into fluidized bed, the heavier silica powder into the spray tower at the bottom of the hopper, through closed wind device adjusting material into the lower the speed of the fluidized bed.

2.2 Fluidized bed drying

Fluidized bed drying is the main control flow in the whole control flow, after the first spray tower drying, through the closure of the air into the fluidized bed for two drying. The fluidized bed is divided into several chambers by baffle, and the silica comes into contact with the hot gas flow in the lower layer, which causes the silica particles to be suspended in the airflow, and causes the heat transfer and water transfer between the material and the gas. Each chamber is divided into upper and lower chambers. The upper and lower chambers are respectively equipped with pressure sensors, which are used to alarm blockage in fluidized bed boiling and drying.

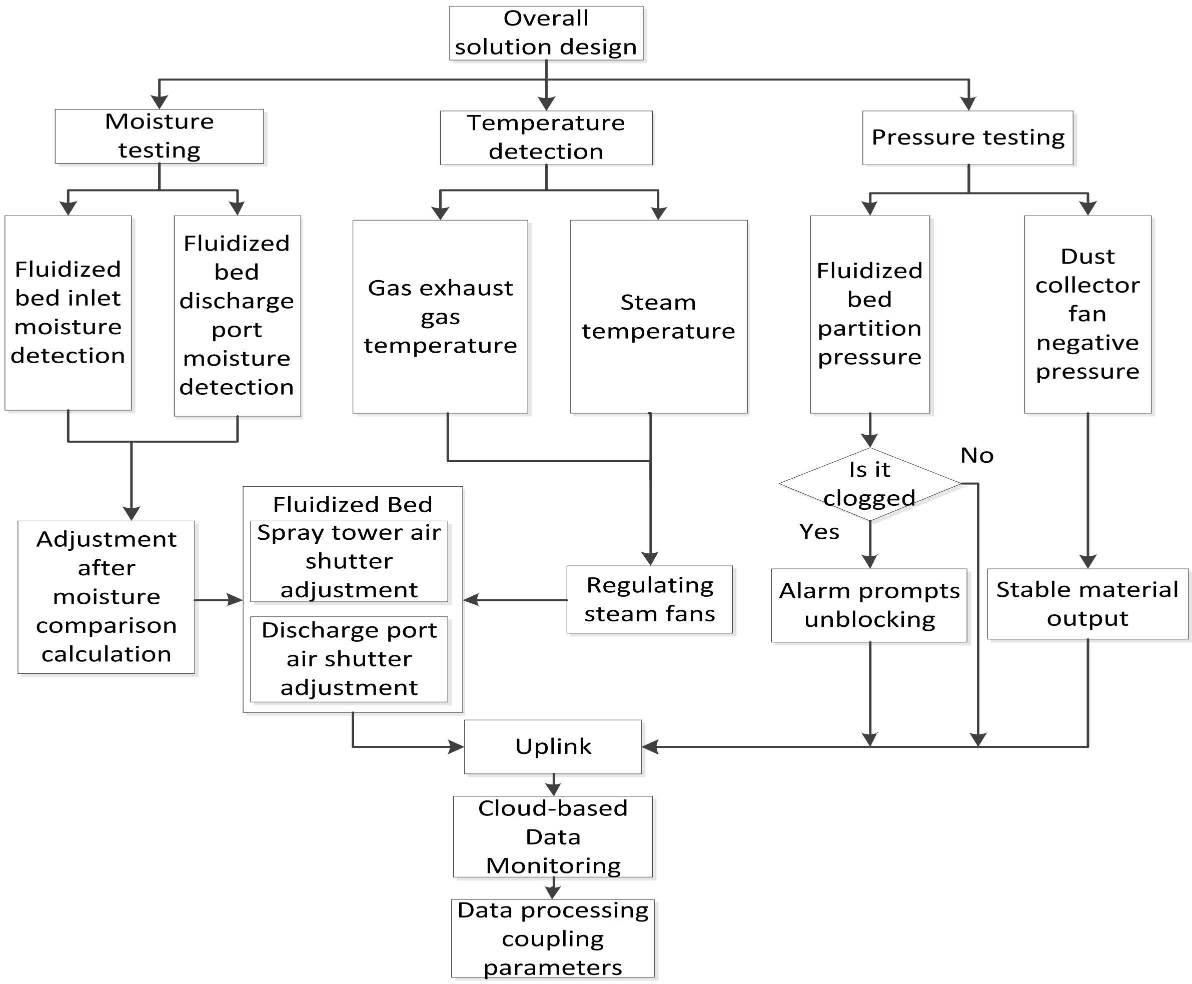

Figure 1. Drying system control flow chart

ISSN: 2414-1895 DOI: 10.6919/ICJE.202103_7(3).0023

From fluidized bed inlet into the fluidized bed much indoors, and the lower qualities of hot mix, boiling shaped in the fluidized bed, in each indoor boiling, after boiling drying a finer particles through the induced draft fan of negative pressure bag filter for extracting, fine discharging discharging mouth, white carbon black particles coarser of discharging mouth after moisture sensors from coarse discharging closed wind discharge. The control flow of the drying system, see Figure 1.

3. Overall design of drying control system

The drying control system of a silica production plant is controlled by PLC equipment produced by Siemens of Germany. S7-200 SMART PLC supports Modbus communication protocol. Drying control hardware devices include: power supply power cabinet, terminal 2 blocks and differential analog input module, PC, a programmable controller PLC2 set, kunlun pass Thai TPC150Gi touch screen 1 piece, 1 set of Siemens PLC and remote data transmission unit, work station, moisture sensors, temperature sensors, pressure sensors, the British witten inverter, etc. PLC adopts redundant system setting, and the configuration of host and standby machine is exactly the same, that is, two PLC, dual power supply, dual CPU, dual communication module, and dual-machine spotless switching time is less than or equal to 48 ms. The production PLC system is connected with the superlayer redundant Ethernet and the monitoring computer to form an integrated system of PLC and computer [4]. The upper computer has the authority to process data, write and modify programs, set target water, monitor data and other aspects, but does not collect the underlying data. The communication between PLC and the upper computer is connected through the asynchronous transmission of RS-232 interface. The communication mode is serial data receiving and sending. PLC preliminarily summarizes the collected data for processing and control, sends the parameters measured by the underlying equipment and alarm prompts to the upper computer, and analyzes and monitors the running state of the system.

4. Integrated system configuration

MCGS configuration, data transmission unit configuration and PLC configuration constitute an integrated system.

4.1 MCGS configuration

The upper monitoring PC configurates the Kunlun Tongtai system and builds a bridge between the controller and the upper computer, which consists of three parts: hardware configuration, program configuration and network configuration. Hardware configuration: using twisted-pair cable to connect the controller, the MCGS screen, the upper machine, process configuration, through reading and writing frequency converter, temperature sensor, pressure sensor, moisture sensor data storage register and I/O address, follow the Modbus communication protocol of RS - 485 data transmission [5], the physical in the kunlun pass ty add TCP/IP subnet Siemens 200 SMART, it is set to cycle and communication delay, set the corresponding query of communication address, make it can be stable and the controller and PC to exchange data. Network configuration: Configure the properties of PLC communication port module SB CM01, establish communication network with PLC, set IP address and related parameters; Configure the properties of the CPU module, set up a network that can communicate, specify the address of the touch screen master station, and add the address of the data transmission unit according to the address reading set by kunlun Tongtai touch screen panel.

4.2 Data Transfer unit configuration (DTU)

DTU (Data Transfer Unit) is a wireless terminal device specially used to convert serial Data into IP Data or convert IP Data into serial Data for transmission through wireless communication network . Set data transfer unit slave station parameters: Set the address of the data transfer unit to the PLC address. Set data transmission system parameters, adjust the address to set the address of the server, which is consistent with the address of the remote monitoring website; The remaining data formats are adjusted, that is, parameters such as unified baud rate, check bit, data bit, stop bit, communication

ISSN: 2414-1895
DOI: 10.6919/ICJE.202103_7(3).0023

transmission mode, etc., and the data transmission unit is taken as the Modbus master station to send the data in the form of heartbeat packet with 4G signal. Taking Siemens 200 SMART as slave station, Modbus slave station node and its address are added into the configuration software of data transmission unit to connect PLC. Modbus command is added to the Modbus slave station node to establish the mapping relationship between the transport unit storage area and the Modbus communication protocol address. The scanning mode is configured to facilitate the gateway to read and write real-time data of Siemens PLC.

4.3 Siemens PLC system configuration

The configuration of Siemens PLC system is carried out through on-site monitoring PC, and the program editing and hardware setting connection are carried out on Siemens PLC. First, Siemens PLC system software MODBUS-Master was used to create the target project. Set the station address under the target project, set the high baud rate to spread the serial data quickly, and establish a topological network with MCGS touch screen, upper computer and underlying infrastructure according to the Modbus protocol. Set data transmission instructions between the data transmission unit and Siemens PLC [6, 7]; Adjust the communication parameters between devices, and connect the address number of Modbus PLC system port and the IP address number of Ethernet port; And the communication port module is separated to specify the corresponding communication port. MCGSPro software is used to create the monitoring configuration screen of the system, and the channel between device data is established through the device serial port configuration, and then the real-time database channel is connected with variables. Variables in the user window are connected with the monitoring dynamic table, so as to realize the parameter monitoring of the configuration device to the field control subsystem and the remote start-stop control. The remote device reads and writes the specified register through the data transmission unit, so as to gain the ability to read parameters remotely and control the start and stop of the frequency converter remotely,see Figure 2.

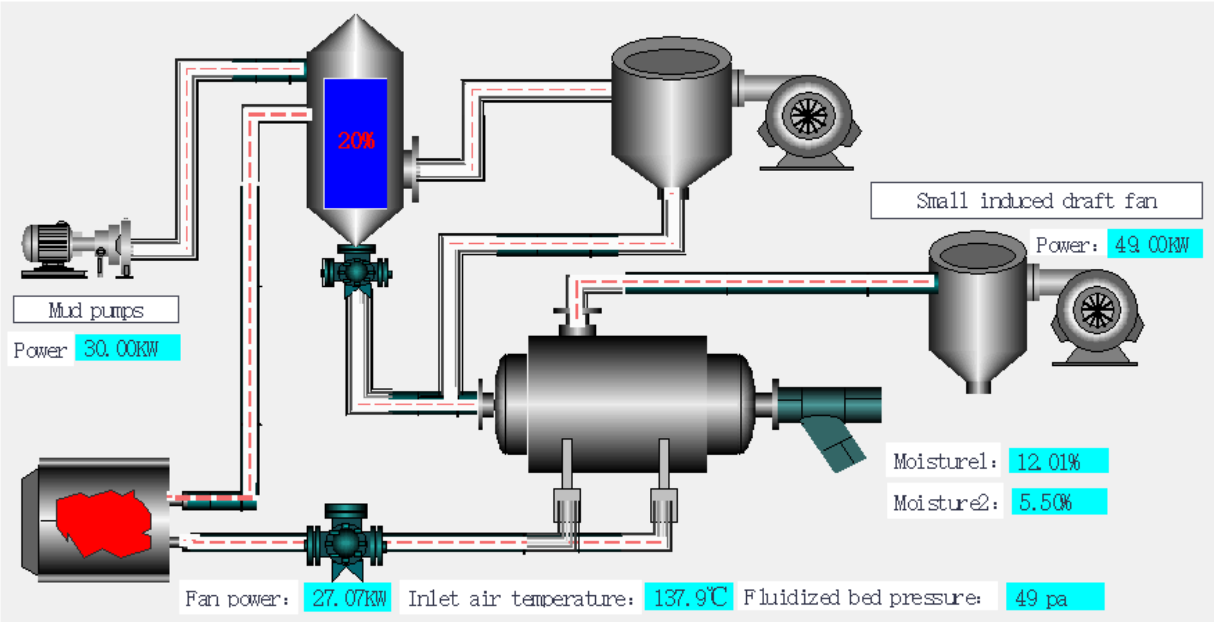

Figure 2. Drying system configuration screen

5. Experimental results

The water content from silica spray tower to fluidized bed is stable, and the water content in the inlet is about 12%. After using the fluidized bed drying control system, the outlet water was set to be 5.5%. The measured comparison data before and after adding the silica water at the outlet of the fluidized bed into the control system,see Table 1

ISSN: 2414-1895 DOI: 10.6919/ICJE.202103_7(3).0023

Table 1. Fluidized bed parameters table

Inlet water (%)	Fluidized bed temperature (℃)	Pressure in fluidized bed (Pa)	Outlet water before transformation (%)	Outlet moisture after transformation (%)
12.00	136.3	-54	6.23	5.50
11.96	134.3	-57	5.38	5.73
12.13	137.9	-49	5.44	5.65
12.03	137.5	-53	5.18	5.39
11.81	146.2	-51	4.82	5.56
12.05	135.2	-60	5.94	5.47
11.97	145.7	-67	5.4	5.93
12.19	139.8	-71	5.49	5.43

Export the difference before and after can be seen from the Table 1, white carbon black water export the whole system is relatively stable before modification, and dynamic performance index of the control system also wait to improved, export water stable at between 5% and 6%, and 5.5% error value is 0.5%, at the same time, the jamming signal, appeared in the process of production system can quickly adjust self parameter setting, rapidly to stabilize the system.

6. Conclusion

In view of the production process with fluidized bed, devised a silica drying system based on heterogeneous communication, by Siemens PLC system, kunlun pass ty system and data transmission system in the conversion of the read/write register variables and heterogeneous data communication transmission, make establish the process monitoring and remote parameter monitoring picture.

Each sensor, touch screen and PC between the realization of information transmission or sharing. During the operation of the system, the inverter can be adjusted in real time to control the motor to precisely adjust the moisture of silica after drying, and the error between the moisture of silica produced and the target moisture can be controlled at about 0.5%, which greatly reduces the error, more accurately meets the needs of customers, and increases the profit for the factory.

Through the integration of the drying system access can reduce the operator, rapid transformation, economic benefits increased; Can be remotely monitored; It can provide reference for the integrated construction of secondary drying of silica in the existing fluidized bed.

Acknowledgments

"Talent Team Cultivation Plan for Superior Disciplines in Shandong Universities" project (2016-2020).

References

[1] J.Yin: Crane Design Manual (China Electric Power Press, China 2004), p.83-85. (In Chinese)

[2] Z.M. Sun, Q. Wang, S.G.Hu, et al. Modern Electronics Technique, vol. 42 (2019), 6-10.

[3] O Rholam, M Tabaa, Fabrice Monteiro et Abbas Dandache. Smart Device for Multi-band Industrial IoT Communications[J]. Procedia Computer Science,2019(155): 660-665..

[4] J. Liu, E.L. Chen and Z.T. He: Defense Manufacturing Technology, Vol. 3 (2018), p.34-36.

[5] W Dong. Application Analysis of PLC Technology in Electrical Automatic Control. 2020, 1533(2).

[6] C Zou. Motion Automation Control System of Ship Assembly Robot Based on PLC. 2019, 93(sp1):1006-1012.

[7] Information on http://new.siemens.com.