Research and Design of Coal PLC Control System in Coal-fired Power Plants

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Abstract

Coal handling system in thermal power plant is the important component of the auxiliary system of power plant, it takes on the power plant's power to produce fuel supply missions with other corresponding mechanical and electrical equipments. During the operation of thermal power plants, the improvement of working efficiency of coal handling system is the key factor to improve the work efficiency of the whole power plant, the whole process of remote monitoring of coal is also put forward higher requirements on the design of automatic control system, so we choose the most widely used PLC control system in coal handling system, it makes the dream a reality.

Keywords: thermal power plant; coal handling system; control system; PLC

1. Introduction

Coal handling system of thermal power plant is an important part of auxiliary system, it is one of the important factors to ensure the stable and reliable operation of the power plant. A fuel delivery system with high reliability and flexibility is the important guarantee to run stably of the crew or the whole plant, its operation directly affects the safe operation of the power plant[1-2].

The traditional coal conveying control system takes the relay as control equipment, it is semi automation system which adding manual operation. As coal field in appalling conditions, it is very bad for the health of the workers. Also, workers' manual operation has many uncertainties, and it often has the problems of belt deviation, belt tearing, coal tube blockage and inefficiency, it has a very negative impact to the stable operation of power plant [3]. So, using PLC to replace the traditional relay to control the coal handing system of power plant, using PLC to complete the control of coal handling system, it optimizes the working pressure and environment of the workers, and it improves the operation efficiency of power plant. So transforming the coal handling control system in thermal power plant and it is imperative to replace the original relay control system with PLC control system with high automation level.

2. Introduction of Coal Handling System in Thermal Power Plant

Coal handling system is complex, at present, it still uses the conventional belt conveyor. The controlling objects are more, such as belt conveyor, coal breaker, sifting machine, ring type coal feeder, impeller coal feeder, belt feeder, vibration feeder, bucket wheel stacker reclaimed portal, three way electric baffle, coal distributor, belt type disc separator, electronic belt, sampler, dust wiper, coal car, and so on. The protective or measuring devices of coal handling system are relatively complete, measuring the deviation, slip, speed, coal flow, coal blockage, pull rope, tripping operation, dilacerations, elongation of belt, measuring the over temperature, super vibration, overload of the equipment, measuring the high and low coal level signal, coal weighing signal, bunker, control signals

of equipment are start-up, halt, lift, fall and sound and light alarm. Vast majority of control and protection monitoring signals are switching signal to these equipments, a 4 * 300MW power plant coal handling system, general input and output switch at around 1000 points according to the calculation of the most basic control requirements[4-6].

Coal is transported by train, the dumper will unload coal or coal into the coal scuttle, then load the coal on the belt to transport to the coal bunker using coal feeder or bucket wheel. General belts are fitted with dual, one is running and one is spare, it can be two-way running at the same time. It can be cross running through two-way communication between the baffle, it can also take coal with a belt to assign to the two belts to different places through coal distributor. The coal often has various metals or large foreign bodies, which bring the damage to the belt, crusher and the coal mill, so using magnet separator and separator to remove metal and large things, it needs multiple iron removal which with high requirements. In order to reduce the output of coal mill, the coal often separates coarse coal to coal breaker through sifting machine, and the small coal can be directly into the next level of belt through the screening machine.

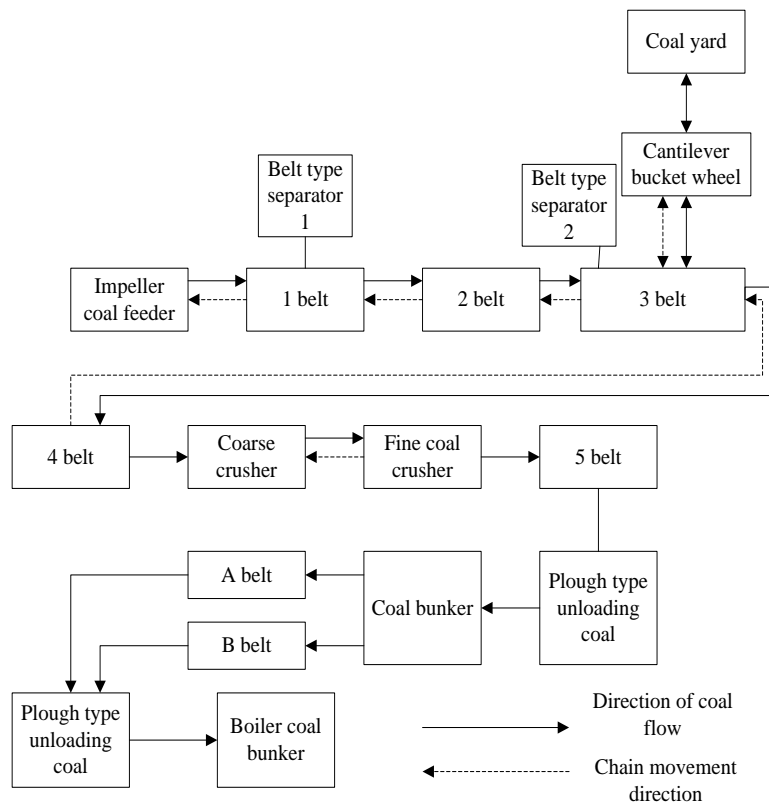Figure 1 is the operation process chart of coal handing system in thermal power plant.

Figure 1. Operation Process Chart of Coal Handing System in Thermal Power Plant

In order to guarantee the boiler coal, power plant has the coal storage yard or dry coal shed, it can be used for boiler 10-15 days. The coal are storage in the coal yard through the belt, then taking the coal to coal bunker from coal yard when using them, and some power plants build large coal bunker to increase the amount of coal storage or consider mixed coal, they can store 1-2 days of coal consumption. Coal is transported by belt, finally to the coal bunker. Generally, a boiler corresponds 2-3 bunkers, there are two belts in the warehouse, there are 2-4 coal plough on the two belts of each warehouse, using coal plough to distinguish the coal which on the belts to each bunker according to the requirements.

3. Realized Functions of the Coal Conveying Control System

Coal conveying control system usually adopts centralized control room mode, the normal operation mode in control room takes automatic program control, and manual control is complementary, operating personnel in control room can monitor and control all the major coal handling equipments through CRT, keyboard and mouse.

(1) Upper coal control function

Upper coal control function includes automatic control, program control manual and local manual. All operations of automatic control realize through software of program control room, program control manual includes programmable interlock manual and program control manual.

(2) Program control start and stop operation and manual control operation

Before starting the device, we should choose coal supply, coal and coal blending devices to determine initialization routine of the whole system. Then according to the program running mode, start the instructions, to determine whether the program is correct or wrong through monitoring program flow or analog screen display before starting, if there are errors, it can be changed in time. When it needs to stop the operation of the device, taking the control switch to stop location. After a certain delay in the operation of the device, to stop them in the direction of coal flow.

(3) Coal blending program and manual operation

Blending control function includes automatic coal blending, remote manual blending and local manual blending, coal blending system has perfect function of measuring shunt. Program control jump warehouse automatically according to the function of jumping warehouse when boiler maintenance, coal handling equipment maintenance and individual warehouse outage, coal plough lift and stop coal blending automatically.

(4) Equipment condition monitoring

Monitoring the running state of belt and monitoring the state of coal bunker and coal plough, recording the historical process of equipment.

(5) Sound alarm

CRT program fault alarm signal when belt deviation, coal blocking coal, bunker coal level low, belt tearing, motor fault tripping and site fault shutdown, the corresponding equipment on simulation system diagram sends out a flash, electric whistle sends fault acoustic signal at the same time.

(6) Bunker coal level measurement and display recording function

Coal handling system has functions of computer management, it can automatically collect operating conditions and relevant data, to realize real-time flow preparation, modification and status display, printing all kinds of reports and records, it also can query and call the relevant data on the CRT.

(7) Accident recall function

All important warning signals, chain protection signals and equipment fault trip signals record and storage according to the sequence, it can also call and print at any time.

(8) Coal and blending mode selection function

System logic should be based on the characteristics of process system, to set a variety of coal and coal blending modes. The operating personnel can choose different coal and coal blending modes according to the status of coal handling system equipment.

4. Software Design of Control System for Coal Transportation

There are two coals in this design, coal bunker and coal screen. No matter which coal is used, coal will eventually fall to A and B belts. Coal move to the third section of the coal frame through zero section, section one and section two. The region of the coal frame is boiler coal bunker, each boiler coal bunker has respective electric coal plough. The coal on the coal frame is sent to the corresponding coal bunker when coal plough down, the corresponding coal bunker obtains the coal. Each boiler is equipped with 2 coal bunker,

each bunker has 4 coal exports. To control the coal fall into the coal bunker according to the coal level of each coal bunker export.

4.1. Upper Coal Control

Upper coal control includes automatic, manual and local mode.

1. Automatic mode

All operations of the automatic mode can be operated by the PC keyboard, operating personnel can call out the pre selection process menu on LCD according to process requirements, when the program chooses correct menu and form a complete process, it will appear effective signal on LCD, when the baffle and the plow are all in place, sending out the signal to start the signal after 20s, the selected belt start the equipment in the direction of the coal flow, the alarm bell issues 20s alarms before each belt starts, the alarm lifted after belt starts, stopping it according to the direction of the coal flow when program stops. When emergency stops, running equipment immediately shut down, only coal breaker delay stops, the delay time is 30min.

2. Manual mode

Manual mode is divided into interlocking manual and unlock manual. Interlocking manual is the operator complete the missions through PLC on the upper computer. Operating personnel call out the corresponding picture according to the operation requirements on upper computer, the devices that select processes boot device through interlocking mode and reverse coal flow, stopping the devices through coal flow direction. Unlock manual operation is also operated on upper computer, there is no interlocking relationship at this point, we can start and stop any equipment.

3. Local mode

Local mode is operated on the local control box and switch cabinet, the control room is not controlled for the device at this point. Upper coal system only provides equipment maintenance, start stop button and emergency stop switch on the spot.

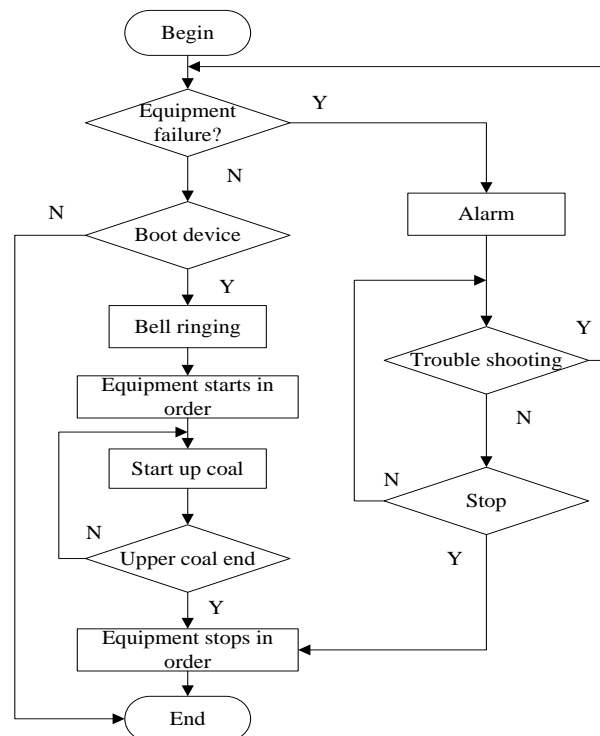Automatic coal control process is shown in Figure 2.

Figure 2. Automatic Coal Control Flow Chart

4.2. Blending Control

Blending control function is divided into coal blending and manual control. We can control to add gallon neatly through controlling blending mode.

Operator inputs related instruction through the keyboard and mouse according to the requirements of the opening of the boiler, to realize the automatic opening of coal blending, principles should be followed as below:

(1) A gallon of coal: coal blending should be given to low-low-order warehouse in order before gallon, until eliminating low-low-order signal.

(2) Circular opening time: add a storehouse at a certain time to each bunker in order after low-low-order signal disappears. The time to add a warehouse can be set on upper computer, you can also set the bunker to high order coal and turn to the next bunker.

(3) Automatic cross function: it can automatically skip the high coal level, super high coal bunker and maintenance positions in the coal blending process.

(4) Setting tail storehouse and maintenance warehouse: we can set tail storehouse, maintenance warehouse, tail storehouse and bunker wouldn't configure coal any more when adding the warehouse.

(5) Uniform coal function: upper coal program will stop automatically and configure the rest coal to tail storehouse or each warehouse after all of the coal bunkers appear full coal bit signal.

(6) Ultra high coal level alarm: any coal bunker appear ultra high coal level in the process of coal blending, give an alarm offhandedly and change the blending bin.

Concrete processes are as follows:

(1) Configure coal to low-low-order bunker and give an alarm in order before adding a warehouse, with a certain amount of coal, eliminating low-low-order state.

(2) Configure coal to low-order bunker in order, eliminating all low-order signals.

(3) Configure coal in order after all low-order signals disappear, turn to next coal bunker to configure coal in order when the coal is full, until all the coal bunkers are full.

(4) If appearing low-low-order coal and low-order coal during configuring coal, stop the opening program, configuring the low-low-order coal and then to low-order coal, turning to the opening sequence of program with a certain amount of coal.

(5) Program stops automatically and configure the rest coal to each bunker on the belt after all the bunkers appear full coal bit signal.

(6) Skip high coal level positions in the coal blending process automatically.

(7) Tail storehouse of the coal blending can be set on the upper computer, tail storehouse and the after bunker can't configure any coal when adding a warehouse.

(8) Coal blending can be controlled through the operating equipment on control cabinet.

According to control requirements, the automatic coal blending process is shown in Figure 3.
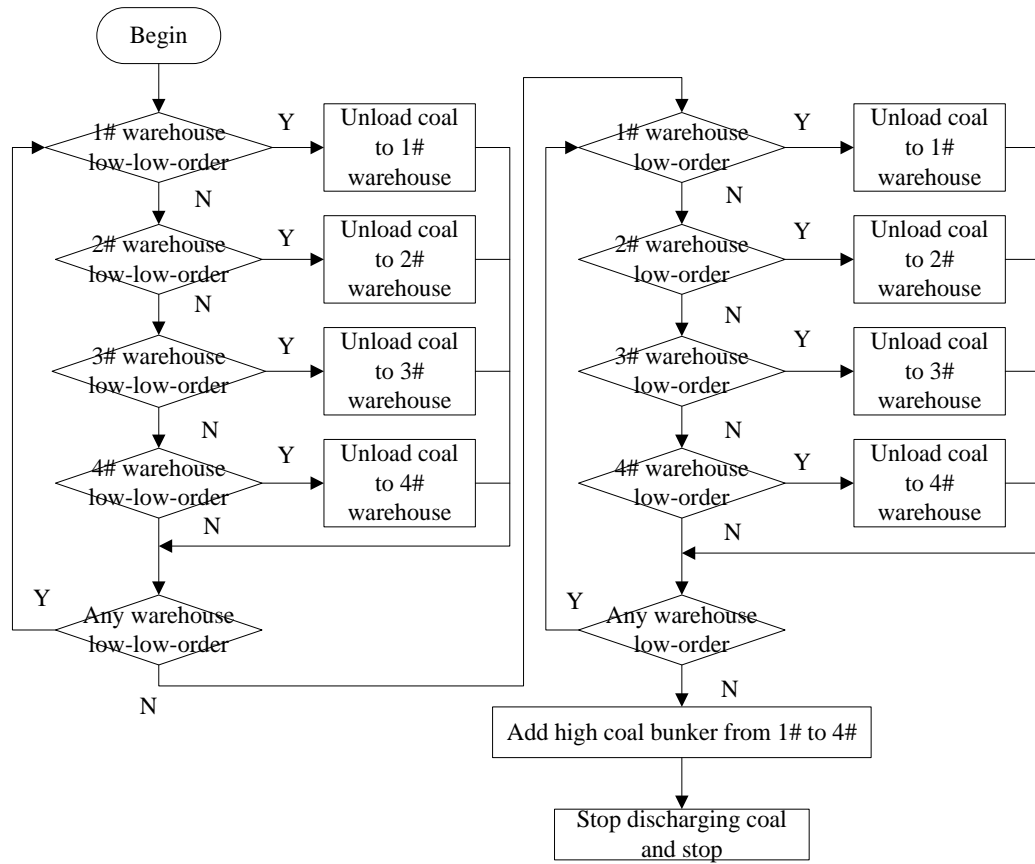
Figure 3. Automatic Blending Control Flow Chart

5. Hardware Design of the Control System of Coal

According to the control system I/O points, PLC of the coal conveying control system selects the OMRON CJ1M series products, specific configurations are shown in table 1.

Table 1. PLC Hardware Configuration Table of Coal Conveying Control System

Serial number	Module name	Model	Number
1	CPU module	CJ1M- CPU13	2
2	Power-supply module	CJ1W- PA205C	1
3	I/O control unit	CJ1W- IC101	1
4	I/O interface unit	CJ1W- II101	1
5	16 points switch input module	CJ1W- ID211	7
6	16 points switch output module	CJ1W-OC211	6
7	I/O extended cable	CS1W- CN713	1

6. Conclusion

At present, plant coal handling control system takes PLC as the main in domestic thermal power plant, it has the following characteristics: it can withstand the harsh industrial environment, it has a strong anti-jamming, structure module, system configuration is simple, it can connect with industrial field signal through input and output

points, it has the corresponding I/O module for different field signals, programming is simple and it has an online programming function, and it has good reliability. Coal conveying control system adopts PLC program control can realize the selection of multiple operating modes based on the above advantages, it makes the whole system more reasonable and complete, the operation is more reliable and more flexible, maintainability, self check ability, safety and security capabilities and communication ability have been further improved, it is propitious to solve field problem which caused by the past coal handling system, which greatly improves the automation level of coal handling system.

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