Design on Monitoring and Controlling System of Blast Furnace Recovery of Waste

Xian-bin SUN$^{1,2,*}$ and Xin-ming JIA$^{1,2}$

$^1$Qingdao Technological University, Qingdao, P.R. China
$^2$Qingdao Mingyu Intelligent Equipment Technology Research Institute, Qingdao, P.R. China

*Corresponding author

Keywords: Blast furnace slag, PLC, Monitoring system.

Abstract. A constant temperature and variable flow control system was designed for that blast furnace slag is not continuous and water temperature largely fluctuated, which included hardware and software. Data acquisition module in the hardware part used Siemens S7-300 series PLC. The software part used Wincc and Step7 to realize system configuration and the data acquisition for respectively. The system is verified by experiments. The results show that the system has the characteristics of stable running, easy to operate and maintain. It can realize the function of real-time monitoring of residual heat in B. F. waste water to ensure that system can be run under the optimal conditions.

Introduction

The blast furnace slag is one of the by-products during the production of steel and it is also a very useful secondary resources. At present the blast furnace slag was used in the form of a material, however, a quantity of heat resources are not fully unilized. There is a serious waste and harmful emissions. If the building within the suitable range, it’s a best choice of energy conservation that recalling the afterheat for it. Not only can solve heating source near steelworks, it can also reduce water consumption. It has a lot of economic benefits.

Currently, it lacks professional monitoring management software in monitoring of residual heat in B. F. waste water. It generally uses the traditional industrial control structure and can’t analyze the process and the results. As a result, the article develops a hardware and software platform. A dynamic supervising and process parameter collecting system of computer in the process of recovering waste heat in B. F. waste water. According this system, it can monitor the run-time status and improve the efficiency of heat utilization to guarantee the system runs being global optimal under our monitoring. Meanwhile, it can combine the control system of producing facilities with the enterprise management information to supply a contented decision scheme for administrators.

System Components

Process Overview

In this system, design flow of circulating water of first flushing water and secondary heating water is 30m³/h, the process is as follows: the flushing water is pumped from water pool, filtered by automatic backwash filters, heated by self-cleaning plate heat exchanger and discharged into sedimentation tank. The clean water which is pressurized by pump, heated in self-cleaning plate heat exchanger and drained into heat supply pipe.

Test System

Final more format below. The system included three parts: Data Collection, Information Management and Process Optimization. This experimental test system is able to realize real-time monitoring of the key parameters, such as the operating pressure, the fluid flow of the filter, and the influent and the
effluent temperature, the pressure and the fluid flow of the heat exchanger. Besides, this system can realize the analysis and optimal control for the filter and heat exchanger, as shown in Fig.1.

The functions need to be realized in this system are as follows: the slurry pump for the circulating water uses frequency conversion control, which could alter the motor speed and the fluid flow of the filter and the heat exchanger will change correspondently which could make sure the temperature of the second circulating water from the heat exchanger is suitable; the pump for the second circulating water uses frequency conversion control to alter the motor speed to change the fluid flow of the heat exchanger, which could simulate the changed fluid flow heating work condition for the end-user in the heat emitter. This system uses real-time monitoring for the differential pressure before and after the fiber bundle filter in the filter, and when the pressure reach the set value, the electric control valves in the filter will move, the exit and the entrance will change, besides, the heating pump for the circulating water will stop working, and the slurry pump for the back wash will work and wash the filter. In addition, this system uses real-time monitoring for the heating water temperature in the exit and entrance of filter and heat exchanger, and analyse the heat loss in the filter and heat exchanger. The air blower uses frequency conversion control to alter the heat release of heat emitter, and the temperature of circulating water from it will change also, which could simulate the temperature alteration in the 24 hours.

![Figure 1. Diagram of blast furnace slag heat water heating experimental test system.](image)

**Temperature Measurement**

Temperature measurement uses platinum resistor, -150~1300 °C, rank 0.5. which produced by Jinan Huaxing Instrument Institute, The test point should be placed at the center of the piping and the distance between the mount point with it should be no bigger than 150mm. The pipeline between measurement points’ upstream and downstream within each 300mm and measurement points should be in good insulation.

**Flow Measurement**

Flow measurement uses electromagnetic flowmeter HXLDE-65-11300-1.6-60 of Qingdao Aike Instrument Institute, rank 0.5. The flowmeter should be installed in the horizontal pipe. Upstream straight should not be less than 20 times of pipe diameter and downstream straight pipe length is not less than 15 times of pipe diameter.
Pressure Measurement

Pressure measurement uses 1151 series capacitance transmitter, rank 0.25. Static pressure measurement hole should be located in areas from any disturbance (elbow or valve, etc.) at least 5 times of pipe diameters downstream, at least 2 times the diameter at the upper reaches.

Other Components Of The System

Apart from the measuring instruments, the system needs to have a circulating pump, inverter, tube heaters, temperature controller, electric stainless steel butterfly valves and ball valves, electric control boxes and so on, to maintain the experimental system running normally and stably.

Realization Monitoring Function of the System

The Network Topological Structure

SIEMENS S7 series PLC company network (Figure 2) applies three bus complex structure. The lowest level for the remote I/O link is responsible for communication with field devices and remote I/O link in the configuration deploys cycle I/O communication mechanism. The middle level is the PROFIBUS field bus or master-slave multi-point link. The former is a new field bus and can take the communication of scene, control, monitoring levels. It takes the control way of combining token mode with Master-slave round wheel. The latter is a master-slave bus and use the master-slave polling type communication. The highest level is industrial Ethernet, which is responsible for sending production information management and provide users with TF interface to achieve agreement with the MMS protocol AP.

Structure of Software Platform in System

The structure of software mainly includes two parts: PLC and the upper PC control-software. The base software was developed with Step7 to carry out data collection and others. The upper PC control-software was developed with Wincc to carry out configuration, display the data and delivery the order. As well as, it was developed with Delphi, asp.net to carry out data management. The whole system has AI / AO and DI/DO points more than several hundred, respectively. PID conditioning loop and operate a number of internal variables. The system software architecture diagram is shown in Fig.3.
The Realization of Data Management Software

The system carries out such functions as uploading of historical data, searching report, the beacon analyzing and so on with Delphi and asp. To meet the demands, its function structure is shown in figure 4.

![Figure 4. The Function structure.](image)

![Figure 5. The temperature variation curve of cinder water and heating waste.](image)

Experimental Results

The experimental system of monitoring that residual heat in B. F. Granulating water includes acquisition, analysis, display and storage about flux and press signal in real time, and it also can control the electrically operated valve and transducer. It can not only deliver 4~20mA current signal, but also communicate with the upper computer with RS485 or RS232 which realizes the distribute control system. Through hand operation and comparison with automatic monitoring, the results shows that the outlet temperature of the heat exchanger is close to the settings and the precision is better than 1°C. The effect is notable and the rate of power saving is over 30%. The temperature variation curve of cinder water and heating water is shown in Fig.5

Conclusion

The application of the system can achieve slag water heating remote monitoring. Managers can get the real-time system running condition in the control room. It can greatly reduce the intensity of the work of the workers and the maximum extent to avoid failure. At the same time it greatly improves the automation system, when certain parameters change, the system can automatically analyze and press the relevant control procedures intended to ensure the optimum chemical conditions in the operating system and energy-saving effect is remarkable.

Acknowledgements

This work was supported by the Shandong Key Research and Development (Public Welfare) Projectand A Project of Shandong Province Higher Educational Science and Technology Program (Grant No. 2018GGX103016).

References

[1] Zhang Yuan, Liu Ze, Wang Dong-min. Research progress of the stabilization of heavy metals using fly ash based geopolymer [J]. Bulletin of the Chinese Ceramic Society, 2016, 35(6):1751-1755 (in Chinese).
[2] Qi Yi-jin, Xu Zhong-hui, Xu Ya-hong, et al. The effect on immobilization of MSWI fly ash with coal fly ash [J]. Environmental Science & Technology, 2017, 40 (06):98-103 (in Chinese).

[3] Zhang Zhi-hong, Guo Jia-yu, Guo Guan-lin, et al. Engineering characteristics of stabilized contaminated soil with heavy metals by cement and SR[J]. Chinese Journal of Environment Engineering, 2017, 11(5):3172-3178 (in Chinese).

[4] Meng Jiu-ling, Zhang Li-juan, Chen Mian-biao, et al. Pollution Research of heavy metals from Soil-vegetable around a waste landfill plant[J]. Environmental Science & Technology, 2017 (3):182-189 (in Chinese).

[5] Yang Wenyong, Kang Kai. PLC Programming technology in grain distributing automatic control system. Technical communication of grain and oil storage. 2014 (5): 18-19. In Chinese.

[6] Huang Guoqing, Chen Qing, Ning Weiting. Analysis of process layout of bulk grain inlet and outlet silo Group. Food and feed Industry 2014, (6): 15-17. In Chinese.

[7] Zhan Sheng, Cuicui Ji, Sheng Hua. Application of Siemens PLC and WinCC in the Monitoring-Control System of Bulk Grain Silo. The 30th China Control and Decision-Making Conference, P4689-4693, 2018-06-09, Shenyang, Liaoning, China.