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Research and application of PID feedback temperature control system based on Simatic S7 Plc

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Abstract: The article combines PLC control technology, PID control theory and the frequency conversion control technology to constructthe general frame of temperature control system ,which is described the composition of the temperature control system,program compiling and the configuration of the implementation, through the SIMATIC S7, ZIGBEE (SZ06 module) and industrial Ethernet.The module（SZ06）can realize PC and S7-200 programmable controller of short distance wireless communication, and the use of STEP7 software complete temperature control system configuration and PID feedback control algorithm is compiled,.Eventually ,according to the specific process control, using WINCC (Kingview6.55) to complete all display painting surface and configuration data to achieve control of real time temperature monitoring and improve the system stability and robustness .

Keywords: PLC; STEP7; WINCC; PID feedback control algorithm

I. INTRODUCTION

SIMATIC S7 PLC *programmable* logic controller, it adopts a kind of programmable memory to be used for its internal storage procedures and implement those user oriented instructionssuch asthe logic operation, sequence control, timing, counting and arithmetic operations.The whole radio frequency identification of PLC programmable logic control can work in a variety of harsh environment without outside manual intervention,especially suitable for all kinds of temperature control in the environment ,such as heating furnace temperature control system, temperature control system, etc[1]. Compared to the traditional electrical control system (Relay control technology), PLC control system has the advantages of small size, low energy consumption, high efficiency ,not easy out of trouble and many other advantages, but the compiler more complicated.The application of the algorithm is key to ensure the efficient operation of the system In the temperature control system, PID feedback control algorithm, fuzzy algorithm, neural network algorithm and iterative algorithm algorithm is endless, but in contrast, PID gradually become the core algorithm in temperature control system because of its good practicability, high reliability advantages .

The SIMATIC S7 PLC comes with PID feedback control wizard and the operation is simple, so it is used more and more frequently and is becoming more and more popular, but everything has two coins,the problems of low control precision,real time difference and stability difference of temperature control system as followed.Therefore, the research and optimization of SIMATICS7 PLC PID feedback temperature control system is of great significance to the enterprise.

II.INTEGRAL CONSTRUCTION OF TEMPERATURE CONTROL SYSTEM

With the acceleration of the pace of industrial automation, intelligent temperature control system is becoming increasingly universal in the iron and steel, coal, metallurgy and other aspects of the application[2], it is the key to how to choose reasonable hardware and software and control algorithm to achieve the basic functions of the temperature control system to ensure the system stability, temperature acquisition of real-time and precision control accuracy has become the integral design of the temperature control system.

2.1 Basic structure of the temperature control system

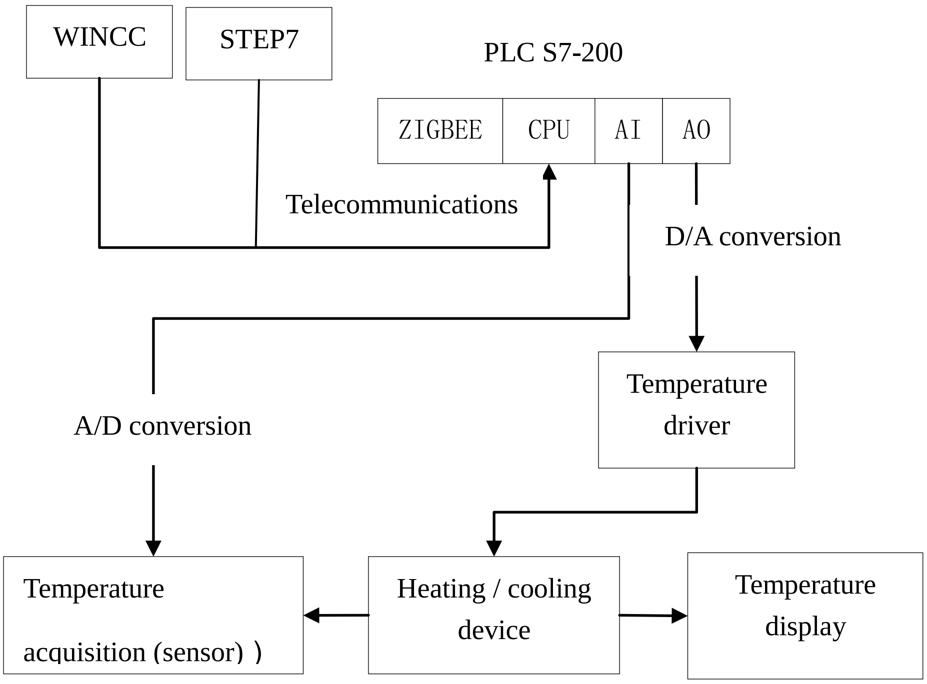

Fig.1 Schematic diagram of the temperature control system

The basic structure of the temperature control system is shown in Figure 1,includes 4 parts. It is mainly composed of wireless communication SZ06 module, PLC type S7-200 master module, temperature acquisition / drive / conversion / display module, heating / cooling device module and so on.

The realization process of temperature control in the temperature control system:PC with installed the WINCC configuration software and STEP7 programming software and S7-200 PLC (CPU224XP) should be set up wireless communication by means of communication SZ06 module to ensure the effective transmission of data Prior to data acquisition(Wireless solutions are becoming more and more attractive for the communication systems of manufacturing plants[3]).At the beginning of the realization process, temperature sensor carry on information collectionof heating / cooling device cavity temperature and transform it into a voltage signal and the voltage signal is transformed into PLC identifiable digital signal through the A/D transmitter,then the PLC will given temperature value and collecting the feedback back temperature values were compared, compile PLC internal PID feedback control algorithm to achieve the temperature regulation again. The simulation output port output a trigger pulse (high-speed pulse train PLS) to control the temperature of the driver to operate heating / cooling device,and repeat the above operation until the cavity temperature and setting value reach agreement.In brief, the process of the temperature control system is to compare the signal value with the set valueand control the system by using the deviation value and make the whole process forms a closed loop negative feedback system[4].The main PLC control module plays a central role in the whole system.

2.2 Hardware selection and configuration of temperature control system

In the process of design of temperature control system,the selection of software and hardware is a key step in the performance of the system,so reasonable selection is crucial.In order to avoid the complexity of PLC wiring in the temperature control system,this system intends to use SZ06 module to realize the wireless communication between each module and the SZ06 module has many advantages of low cost, low power consumption, large network capacity and so on.

PLC system mainly uses the cpu224xp models with SIMENTIC company, which has its own analog input and output module that is the key to data communication,and the hardware adopts modular designwith the various special function modules and function expansion module[4], for analog volume control, position control function and the series of PLC high reliability, strong anti-interference, with a flexible, high price.For the temperature control system of temperature acquisition device mainly adopts PT100 temperature sensor (comes with A / D transmitter) and the types of sensor Is adopted by the industry because of acid the strong acid resistance,high-quality and fairly linear.

III.REALIZATION OF PID REGULATING TEMPERATURE CONTROL SYSTEM

3.1 PID algorithm

The output of the PID controller is a function of time ,which can be regarded as the sum of the 3 parts, proportional, integral and derivative terms[5]:

$$M(t) = K_P * e + K_i \int_0^1 edt + Minitial + K_d \frac{d_e}{d_t} e$$

The above quantities are continuous variables, the first item is the proportion,two of the middle of the term is the integral and *Minitial* represents the initial value of the output of the PID loop in the integral term, the last item is a differential term.Periodic sampling and discretization processing are required because the PLC is unable to handle continuous variables.The discretization formula is shown as followed.

$$M_n = MP_n + MI_n + MD_n$$

$$MP_n = K_c * e_n = K_c * (SP_n - PV_n)$$

$$MI_n = K_c * \frac{T_S}{T_I} * (SP_n - PV_n) + M_x$$

$$MD_n = Kc * \frac{T_D}{T_S} * (PV_{n-1} - PV_n)$$

The PID algorithm is finally obtained by the above conditions:

$$M_n = K_c * (SP_n - PV_n) + K_c * \frac{T_s}{T_i} * (SP_n - PV_n) + M_X + K_c * \frac{T_d}{T_s} * (PV_{n-1} - PV_n)$$

The PID control parameters (loop table) are defined in Table 1

Table 1 parameter information

Parameter	Data format	Parameter type	illustration
Output value M_n	REAL	Input / Output	0.0~1.0
Gain K_c	REAL	Input	Ratio constant
Default value SP_n	REAL	Input	0.0~1.0
Feedback value PV_n	REAL	Input	0.0~1.0
Sampling time T_s	REAL	Input	Positive
Integral time T_i	REAL	Input	Positive
Integral term M_x	REAL	Input / Output	/
Differential time T_d	REAL	Input	Positive
Former value PV_{n-1}	REAL	Input / Output	/

3.2 Implementation and control of the PID wizard in PLC

Due to the temperature control system itself has a certain delay and inertia, which makes the system appear the large dynamic deviation.Therefore,in order to reduce the error to improve the control precision, the system intends to adopt a wide range of PID feedback control algorithm,and utilize the engineering setting methods to select a reasonable sampling time interval to obtain the optimal temperature dynamic regulation curve on the basis of ensuring the performance of the work.

The following as an example, the system temperature control range between 0~150℃, sampling time is set to 1s. The gain is set to 1, integral time set 2.5min, differential time set for 2.0 min and process variables by the measurement of environmental decision, the default value is set to 80℃ (quantitative and converted into digital quantity 60000), PID control process from Figure 2, figure 3, figure 4, 5 shows,

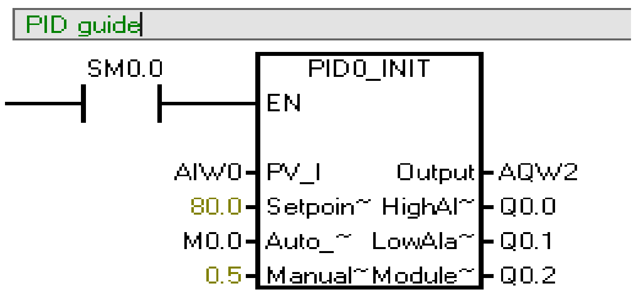

Fig .2 PID control ladder diagram

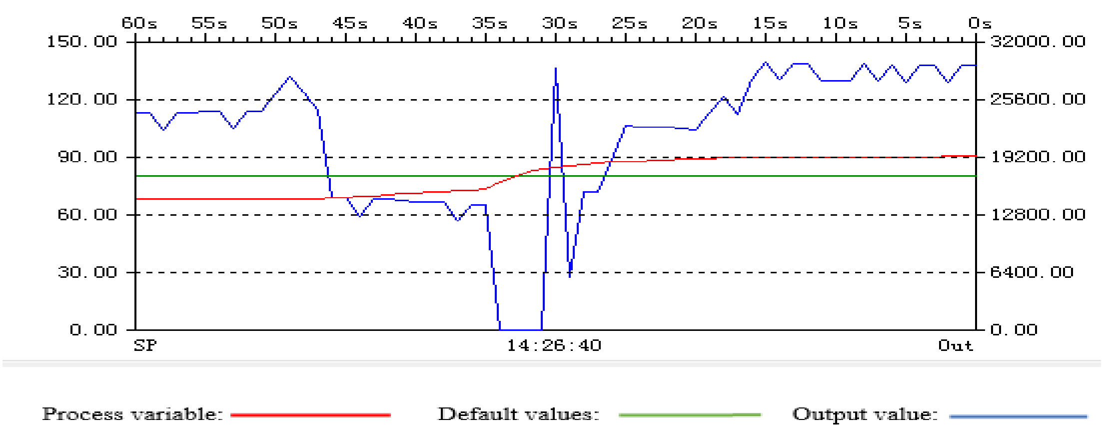

Fig. 3 Schematic diagram of PID high temperature feedback

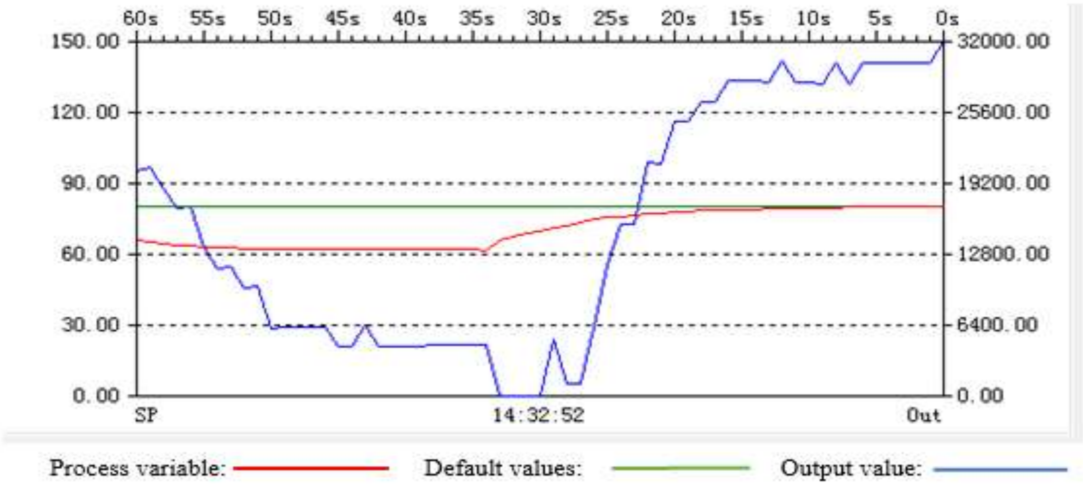

Fig. 4 Schematic diagram of PID low temperature feedback

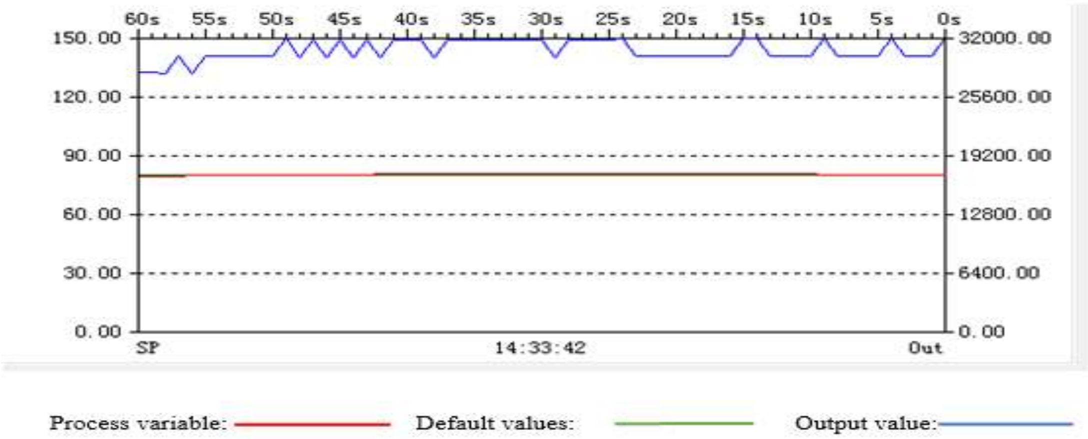

Fig. 5 PID temperature self tuning diagram

As shown in the picture, we can see that When there is a large deviation between the process variables and the default values, rise / fall of the magnitude are larger of the curve of the output value and the regulating speed of PID is faster;When the process variable reaching the preset value, the output curve fluctuation is smaller and gradually tends to be smooth.

3.3 Implementation of WINCC monitoring configuration

The WINCC monitoring configuration software in the engineer station provides a graphical display of industry, information, archiving, and report forms, and an open interface for user to solve some programs[6].After the establishment of the new project, the WINCC and the control master station are established by adding a new driver S7 protocol,then enter the control object name under the S7 protocol.

In Kingview 6.55 graphical editor,drag and drop the appropriate graphics from the gallery to display the parameters and set some parameters in the property bar can be set up and monitor the dynamic link of the object to achieve remote monitoring.

IV. CONCLUSION

In this paper, the design of the temperature control system based on the PLC control adopts a methods that combining PLC its own internal PID feedback control algorithm wizard and the communication module (including wireless communication module, temperature acquisition / conversion module) to achieve adaptive temperature control,to ensure the timeliness of temperature acquisition and accuracy of measurement and control, to further improve the stability and robustness of the system.The control precision and automation degree of the temperature control system is relatively high,so it is a reasonable choice for the majority of users of the heating furnace and the storage temperature management in our country.

REFERENCES

[1]. Lu Jingjing. Optimal design of temperature control system based on PLC control system [J]. electric power and energy, 2015,36 (4): 593-596（in Chinese).

[2]. Liu Shiquan.Application of PLC in temperature control system[J].Electric world, 2012 (04): 174/6-175/7（in Chinese).

[3]. Ramazan Bayindir,Yucel Cetinceviz.A water pumping control system with a programmable logic controller (PLC)and industrial wireless modules for industrial plants-An experimental setup[J].ISA Transactions50(2011)321-328.

[4]. Peng Xiu Ying, Chen ya, Yan Lei Luo. Based on PLC control of electric heating cylinder water removing machine temperature control system [J]. Agricultural Mechanization Research. 2011,4(04): 186-189（in Chinese).

[5]. Song Lepeng, Liu Guo.Temperature control system of heating furnace based on PLC control [J].Automation technology and application, 2007,26 (10): 121-122（in Chinese).

[6]. Lin Fu.Research on PID temperature control system of fluidized bed dryer based on PLC[J].Journal of Zhongyuan University of Technology, 2014,25 (1): 26-29（in Chinese).

[7]. Li Huicheng, Zeng Bi, Wu Qingquan, Li. A design of temperature control system based on fuzzy control [J]. computer technology and development.2009,12(12):236-240（in Chinese).

[8]. Ren Junjie, Su Xiuli, Liu Zeyang.Implementation of distributed control system based on PLC SIMATICS7[J].Micro computer information, 2005,21 (6): 44-46（in Chinese).