Design of Temperature Control System for Electric Heating Furnace

Yakun Li

Zhengzhou University of Industry Technology, Zhengzhou, Henan, 451199

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Abstract: This design uses the single-chip microcomputer as the core to monitor and control the temperature of the electric heating furnace. The use of single-chip microcomputer to control them not only has the advantages of convenient control, simplicity and flexibility, but also can greatly improve the technical index of the controlled temperature, thereby greatly improving the quality and quantity of products. In order to achieve high-precision temperature control, the single-chip microcomputer system adopts the PID control algorithm to change the on and off of the electric furnace and the power supply by controlling the two-way thyristor, thereby realizing the control of the temperature by changing the heating time.

1. Introduction

Although the temperature control system has been widely used in various industries in China, the overall development level is still not high in terms of temperature controllers produced in China. Compared with advanced countries such as Japan, the United States, and Germany, it still has a large gap. Mature temperature control products are mainly based on "point" control and conventional PID controllers. They can only adapt to general temperature system control, and intelligent and adaptive control instruments for higher control applications. Domestic technology is not yet available. It is very mature, and there are fewer control instruments that are commercially available and widely used. With the development of China's economy and its accession to the WTO, the Chinese government and enterprises have attached great importance to this, and have reorganized relevant enterprise resources. They have established R&D centers of some countries and enterprises, and carried out innovative research to make China's instrument industry Rapid development.

This design uses a microcontroller as the core for control. The single-chip microcomputer has the advantages of high integration, good versatility, strong function, especially small size, light weight, low energy consumption, high reliability, strong anti-interference ability and convenient use, etc., and has wide application in digital and intelligent aspects. . This system uses AT89C51 single-chip microcomputer to make temperature control much simpler.

2. Design of Single Chip Temperature Control System for Electric Heating Furnace

The design process of the control system is divided into four parts: overall design, hardware design, software design and system debugging. Before designing the control system, we should first consider the in-depth investigation and analysis of the control object, and recognize the process flow, and determine the tasks that the system needs to accomplish according to the problems raised in the production. Then write the argument, choose the control plan, control the quality of the program, directly affect the control effect, system investment and the economic benefits of the system.

The heating circuit is used to achieve heating of the system to a predetermined temperature. When the temperature does not meet the requirements, the control circuit uses the on-off characteristics of the track to determine the energization and de-energization of the heating circuit.

The measuring circuit function is to process the measured signal into a digital signal and send it to the MCU for processing. The type selection of temperature sensing components and transmitters is related to the temperature and accuracy level being controlled.

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In addition to the above circuit, AT89C51 also uses 74HC4060, RS232-RS485 and MAX197, MC14499 and other chip interface circuits. The 74HC4060 is used for the keyboard interface, the RS232-RS485 is used as the serial communication port, and the MAX197 is the input interface of the temperature measurement circuit for discretizing the continuously changing signals. The MC14499 is used for the LED display interface. Finally, the man-machine dialogue function is realized through the keyboard display circuit in the control circuit.

3. System hardware design analysis

The schematic consists mainly of design, diagnosis and inspection. The design of the schematic diagram should meet the following requirements: 1. The components used should be used fairly, and the parameters of the resistors, capacitors, etc. should be accurately marked. 2, the schematic should be complete, CPU, peripheral devices, expansion interfaces, input / output devices should be readily available. 3. The schematic design should conform to the working principle of the project, and the connection should be accurate. 4. The design, diagnosis and inspection of the schematic diagram are completed in the Protel DXP software environment.

After the system design is completed, enter the stage of printed board fabrication, device soldering and software programming. Careful inspection of the finished printed board is carried out, and finally the device, socket and components are soldered one by one on the printed board. In the process of designing the printed board, the area, layout and length of the printed board should be carefully considered to reduce the delay of the signal and the interference of the bar.

4. Software program design and simulation debugging

The main program mainly realizes the initialization of the system, and compares the operation result with the limit value by calling the subroutine to determine the jump direction and realize the alarm function and calculation function of the system.

Take out the given value, calculate the deviation value signal E(K), and compare the result of E(K) and the set dead zone value. If E(K) does not exceed the dead zone range, then the current output adjustment is 0, return to the detection program; if E(K) exceeds the dead zone range, calculate the adjusted output value of $\Delta P(K)=PP(K)+PI(k)+PD(K)$.

The interrupt program mainly includes the T0 timer interrupt service program, the system clock overflow program, the read keyboard and the key processing program. The subroutine mainly includes a filtering subroutine, a nonlinear correction subroutine, a display subroutine, an A/D conversion subroutine, a thyristor triggering subroutine, and the like. The T0 timer interrupt service subroutine works as follows: The T0 timer is used as a timing interrupt for the sampling period and is interrupted every 5 seconds. The T0 interrupt service program first reads the A/D conversion value, performs digital filtering and nonlinear correction, then performs PID control algorithm operation, and puts the obtained temperature into the display buffer area, then displays the subroutine display temperature and outputs the adjustment value. To control the on-time of the solid state relay in this timer, so as to achieve the purpose of regulating the temperature.

Since various disturbances from the outside are constantly generated, in order to achieve the effect that the value of the on-site control object remains unchanged, the control effect needs to be continuously performed. If the disturbance occurs and the field control object value changes, the field detection component will record the change, then transfer it to the PID controller, change the process change value, pass the transmitter to the input of the PID controller, and then His set value is compared to obtain the deviation value. The regulator adds the control signal jointly issued by our preset setting parameter control law according to this deviation, so that the opening degree of the regulator can be changed, and the opening degree of the regulator is changed. Small or large, and then the value of the field control object changes, want to set the value step by step, in order to achieve the purpose of control.

5. Summary

Traditional electric heating furnaces have been unable to adapt to the development of the times, so further improvements are needed. In this design, the design of the temperature control system of the heating furnace based on single-chip microcomputer is described, including the hardware composition and software design. In the hardware design, the temperature is mainly collected by the temperature sensor, the temperature is converted into a varying voltage, and then the amplifier will the signal is amplified, and the analog temperature voltage signal is converted into a corresponding digital temperature signal voltage by an A/D converter. The whole system is compact, simple and reliable, flexible in operation, powerful in function, high in cost and performance, and better meets the needs of modern production and scientific research.

References

[1] Tao Yonghua. New PID Control and Its Application [M]. 3rd ed. Beijing: Mechanical Industry Press, 2013

[2] Wang Danli. MATLAB control system design simulation application [M]. 1st edition. Beijing: China Electric Power Press, 2017

[3] Zhang Yigang. The principle and application of single chip microcomputer [M]. Beijing: Higher Education Press, 2013

[4] Zhao Wenzhong, Cheng Qiming. Microcomputer Control Technology [M]. 4th ed. Beijing: Mechanical Industry Press, 2008

[5] An Peng. Multi-channel pressure data acquisition system based on MAX197. Today Electronics [J]. 2016(5):12-15

[6] Zhang Ming, Wang Shi. Model algorithm control based on prediction bias. Journal of Tsinghua University[J].2017(2):10-50