Research on Green Energy Saving ECO Intelligent System Engineering Cycle

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Abstract. With the improvement of living standards, the national coverage of heaters is also higher. From the original only the northern part of the installation of heating devices, to the south of the central area has also installed heaters, and even some people in the southern area installed heaters. With the increase in sales volume and fierce competition, companies need to reform and innovate products to meet the higher requirements of customers for energy-saving effects, comfort and safety. The design of the heater involves theories of structure, integrated circuit, program algorithm, aerodynamics, heat transfer and so on. Due to the technical level and cost constraints of enterprises, few companies can produce safe, energy-saving, moisturizing and comfortable heaters suitable for the public. In this study, the green energy-saving circulating heater of ECO intelligent system adopts the incremental ECO processing algorithm, with the single-chip STC89C52 as the main control chip system, combined with the peripheral STC89C52 temperature data acquisition, HIH-3010 humidity data collector, A/D Conversion module, keyboard settings, LCD1602 liquid crystal display and other circuit modules. This design realizes the temperature value that the heater provides the user with the optimum indoor temperature value and sets the heating according to the user’s needs. When the set temperature value is reached or the temperature is high, the controller will control the heating element to reduce power or automatically power off to achieve safe power saving effect.

Keywords. Green energy, saving, ECO, intelligent system engineering.

1. Introduction
In the environment of economic globalization, people’s living standards continue to improve, every family generally have a heater. At the same time, customers have higher and higher requirements for the comfort and safety of the products. This brings greater challenges to the company. After investigation, heaters commonly used in the heater market include bulb heaters, electric wire heaters, heat pipe heaters, thermal air conditioner heaters, and floor heating heaters. At present, there are no
household heaters with ECO intelligent control system as the core function, most of them are still traditional heaters, and the ECO intelligent system has practicality, environmental protection and greenness, and has great development potential [1-5]. Heating products need to meet the different needs of consumers, suitable for different living spaces, different regional temperature differences, and products must be innovative and practical. After investigating that there are heaters in the market, it is not difficult to find that there are many problems with traditional heaters. The analysis is as follows: (1) Existing thermal air conditioner heaters have poor heating effect; (2) Existing heat pipe heaters and electric wire heaters consume large amounts of energy; (3) Existing electric heating wire heaters, hot air conditioning heaters are easy to lack oxygen drying; (4) Existing heat pipe heaters and electric wire heaters are uneven in heat and humidity.

It is more important to control the temperature and heating time of the heater. The most important thing is the judgment of the controller of the heater on the indoor temperature, humidity and heating time [6]. If the ECO intelligent system is applied to the heater controller, the intelligent of the heater can be greatly improved, so that it can better meet the needs of people's lives and solve the problems of the traditional heater.

2. Heater Design

The overall structural design of the green energy-saving circulating heater based on the ECO intelligent system is shown in figure 1. The heater mainly includes ECO intelligent precision temperature control module, humidification function, IP24 high waterproof module, and energy-efficient keel heating module. The heater is based on the ECO intelligent system. Firstly, the stabilized electric energy is used as the heating material to supply the power. At the same time, the temperature detection device performs real-time detection, and then the ECO intelligent system performs algorithm judgment and heating control, and finally realizes the indoor temperature. Maintaining a constant range increases the safety of the heater and saves energy.

![Figure 1. Heater overall structural design.](image)

2.1. Overall Structural Circuit Design

In the design process of this product, the physical quantity conversion process in a series of devices such as a humidity sensor, a temperature sensor, a temperature control, a humidifier, and a heating element is innovated. The circuit design of the heater is also a major focus of the heater function.

2.2. Circuit Design of ECO Intelligent System and Data Acquisition

The detection temperature of the heater controller is generally in the range of -30 to 100 °C. The humidity sensor of this product heater uses DS18B20 as the temperature sensor for the heater [7] and the thermosetting polyester capacitive sensor HIH-3610. The DS18B20 sensor has a temperature range of -55 °C to +125 °C and an inherent temperature resolution of 0.5 °C. It is suitable for temperature and environment in various regions and maintains accurate temperature detection. The change detected by the sensor is converted into a voltage change, and the voltage signal is converted into a digital signal by analog-to-digital conversion using an analog-to-digital conversion chip TLC549. The
sampling resolution of the TLC549 is 8 bits [6]. It performs analog-to-digital conversion on the principle of successive approximation, and converts the analog quantity into a digital quantity, which is sent to the internal processing of the MCU through an algorithm.

2.3. Display Circuit
Vision and touch are the best sensing conditions for the human body. In order to improve the display effect of the heater controller in this product design, LCD1602 liquid crystal display is adopted. The temperature, humidity, and time are displayed on the LCD 1602 display. The 8 data ports of the LCD1602 in the hardware circuit are connected to the PI port of the microcontroller [8]. Pin interface diagram of LCD1602 liquid crystal display.

3. ECO Intelligent System Working Principle and Performance Analysis
The circuit is mainly modular in design. The heater works in the indoor environment. When the main program completes the system initialization, each sub-function module is called to complete the precise temperature control of the heater ECO intelligent system. The modular subroutine mainly includes: initialization, temperature data acquisition, temperature control algorithm and power adjustment. The main functions of the software are: initializing the temperature value and time value of the heater; collecting and converting the T1 and T2 signals; using the ECO intelligent system to calculate and output the control quantity to control the running power of the heater heating body. The main program flow chart of the system is shown in figures 2 and 3.

Figure 2. Temperature controlled circuit.

Figure 3. Temperature control algorithm flow.
4. Results and Discussion

4.1. Temperature Controlled Circuit
Temperature control is achieved by adjusting the operating power of the heated keel. This product is designed with an electromagnetic relay to control the operating power of the heating element. The MCU controls the relay operation by $\Delta T$. When $\Delta T > 1$, the relay switch is closed, so that the power of the heating element is increased. When $\Delta T < 1$, the relay switch is turned off, and the power of the heating element is lowered. Heating control circuit schematic is shown in Figure 4.

Figures 4. Main program design.

4.2. Control Algorithm Flow
The temperature control algorithm is the most important part of the implementation of the entire heater controller system algorithm. Due to the temperature control characteristics of the controller, the design uses the difference algorithm for calculation. The main method of this algorithm is to obtain the information such as the values of parameters $T_1$, $T_2$, $\Delta H_{\text{out}}$ and $\Delta H_{\text{in}}$ required by the ECO intelligent system.

$$\eta_{\text{Carnot}} = 1 - \frac{\Delta H_{\text{out}}}{\Delta H_{\text{in}}} = 1 - \frac{T_2 \Delta s}{T_1 \Delta s} = 1 - \frac{T_2}{T_1}$$

The received sample value is taken as the current input, and the difference is made with the set value to obtain $\eta_{\text{control}}$, and then $\Delta T = (T_1 + T_2)/m1$ is combined to calculate $\Delta T$. The flow $\eta$ control program flow chart is shown in figure 3.

5. Conclusions
Through the preliminary design results of the experiment, energy saving can be achieved in the function of the structural system, and the inner control and the circulation control are used to make the best balance between the heating body and the data collection point. Therefore, the design can be derived from the high temperature electric heating of the furnace body and solve the industrial application in the future.

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