

Design of New Energy Saving and Water Saving Device based on Intelligent Circulation System

Sen Yang

School of Electrical and Control Engineering, North China University of Technology, Beijing
100144, China

Abstract

According to statistics, the energy consumption of domestic hot water accounts for 10%~20% of the building energy consumption, which is the fourth largest energy consumption activity after heating, air conditioning and lighting. On the one hand, bath water is the most important form of domestic hot water, accounting for the largest proportion; on the other hand, in the cold water section before bath, water resources are wasted, and the existing zero cold water heater has high energy consumption and high water saving cost, so the promotion is blocked. With the concept of "water saving, low carbon bathroom" as the starting point, and with the goal of reducing water waste and building energy consumption, a new energy saving and water saving device design based on intelligent circulation system is designed.

Keywords

Intelligent Circulation System; Energy Saving and Water Saving; Energy Saving and Emission Reduction; Waste Heat Recovery.

1. Introduction

For China's economic development and the improvement of residents' living standards, people's demand for a comfortable life is increasing. Nowadays, homes and commercial places are generally equipped with 24-hour hot water supply, which has become the standard of residents' life. This is followed by an increase in building energy consumption, of which hot water energy consumption accounts for a considerable proportion. According to statistics, in the total energy consumption of the whole society, building energy consumption accounts for about 46%, of which hot water energy consumption accounts for 13%. At present, China has a large urban registered population, and the monthly demand for hot water from urban families is also quite huge, which leads to the urban residents consuming a large amount of electricity and natural gas every month. In particular, bathing water is the main form of hot water consumption, but it also has a great potential for energy saving, so while improving the quality of life, energy saving is also particularly important.

Most of the bathroom shower system in China use ordinary showers, need to manually touch, manually adjust the shower to the appropriate water temperature, inevitably cause waste of water resources. Although the existing constant temperature shower can avoid the waste of water resources in the process of manual temperature control, due to the existence of cold water section, it still needs to discharge cold water for a period of time before shower, which also waste water resources. The existing zero cold water heater can solve the problem of cold water section through the return water pump technology to realize the shower process. Zero cold water, but high energy consumption, water saving cost, the promotion is blocked.

2. System Model Design

2.1. General Layout

In view of the waste of water resources in cold water section and the loss of medium and low grade energy in family bathroom bath wastewater, the team designed a shower water zero waste and waste heat recovery system based on intelligent circulation device, which is mainly composed of intelligent circulation device and waste heat. The recovery device consists of two major parts. The intelligent circulation device of this system adopts the three-way pipeline design, and it controls the opening and closing control of the branch road by the steering gear. The main channel of the three-way pipe is connected to the mixed water pipe of the mixed water valve. The built-in temperature sensor is used to monitor the mixed water flow temperature of the mixed water valve. Users can set the body temperature of the shower water, when the water temperature is in the set temperature range of the shower water temperature in the main channel; when the water temperature in the main channel is not timely, the circulation branch conduction, the water circulation to the return pool A, effectively solve the problem of zero cold water high energy consumption and high water saving cost through the return pump technology. To achieve the zero waste of shower water in the shower process, and the water-saving effect is remarkable.

2.2. Hardware Part Design

The intelligent circulation device adopts circulation device-three pipe, the main path is connected to the mixed water valve mixed water pipe, the two branches are on and off controlled by the switch valve. The MG996R steering gear is used to control the branch on and off state through the rotating branch valve, and the core controller Arduino UNO senses the water temperature in the main path through the temperature sensor, realizing the way to control the working state of the intelligent circulation device. Because the thermal conductivity of copper is $386.4 \text{ W}/(\text{m} \cdot \text{K})$, the copper pipe with good thermal conductivity is selected as the heat exchange heat pipe. The core controller Arduino UNO is used to sense the water temperature of the AB pool through the temperature sensor. When the temperature difference of AB meets the setting conditions, the pump works. The sensor part monitors the water level height in the circulation tank A. When the water level is lower than the preset value, the buzzer alarms to remind the user to replenish water.

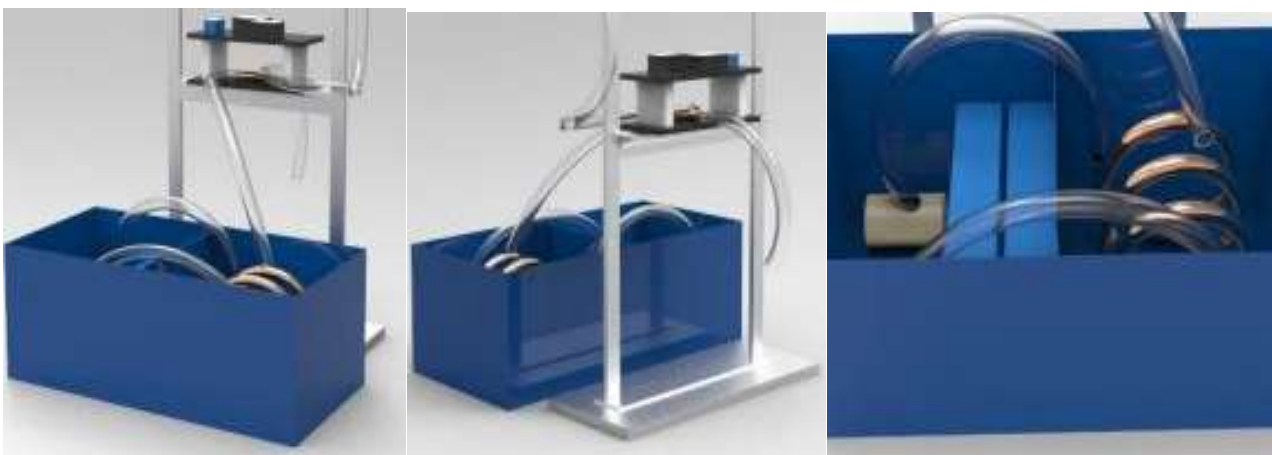


Figure 1. System modeling diagram

2.3. Arduino Control of the Program Design

For the design process of shower water zero waste and waste heat recovery system based on intelligent circulation device, the team used it. Arduino UNO Development board + expansion

board serves as the core controller of this system. Arduino IDE Is an integrated development environment based on Processing IDE development. Developers only need to write the program code in IDE and upload the program to the development board. Called by Arduino, open source platform provided by Wire, DHT, Servo, library files, complete 1602 LCD display and steering gear operation part of the programming.

The waste heat recovery device of this system is a device suitable for family bathroom. The low grade heat energy in bath wastewater is recycled in the way of heat exchange. This product fills the vacancy of the waste heat recycling device of bath wastewater in the family bathroom. The system plays a very important role in reducing the fuel consumption, reducing the heating cost and reducing the environmental pollution. According to statistics, the waste heat recovery of bath wastewater through the way of heat pipe heat exchange can reduce the heating cost by more than 50%, creating favorable conditions for reducing energy consumption.

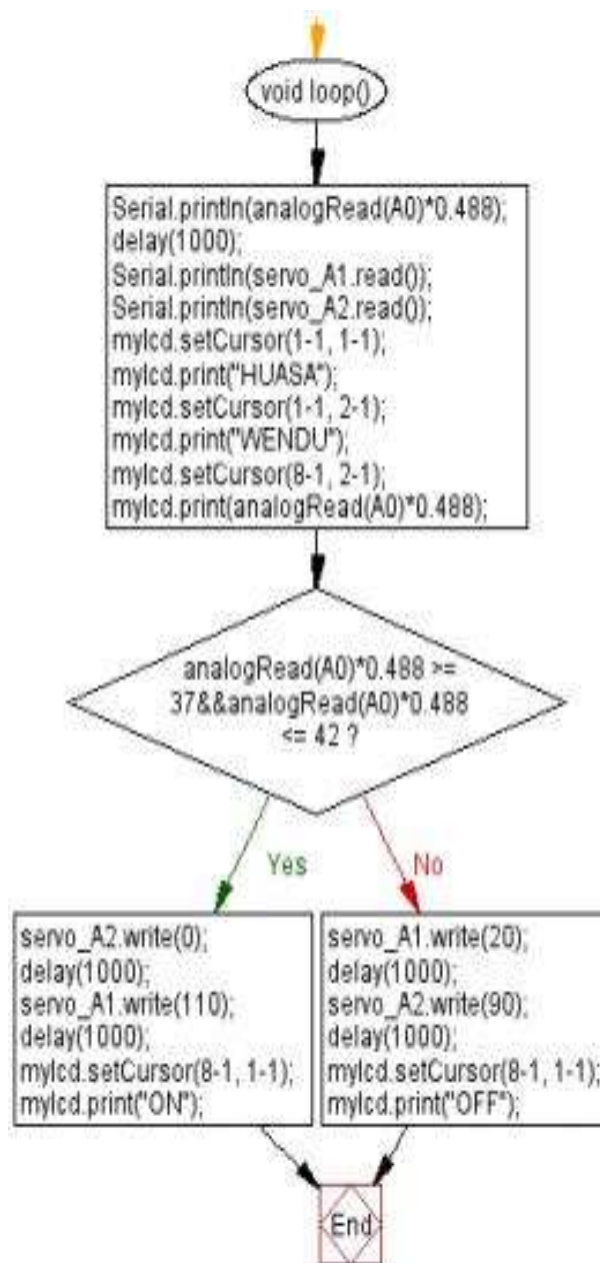


Figure 2. programming flowchart 1

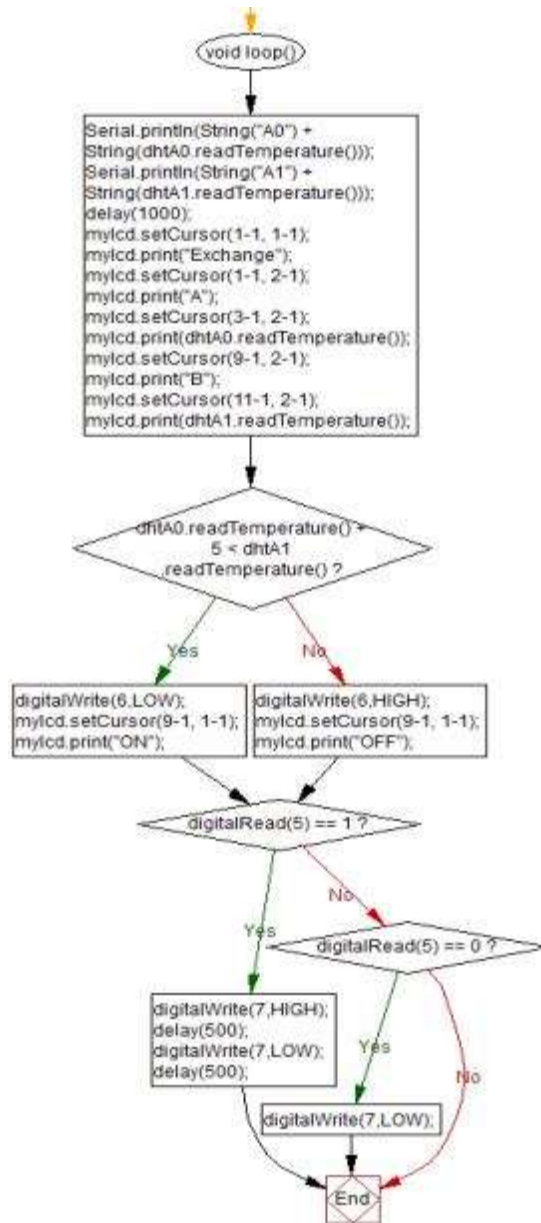


Figure 3. programming flowchart2

3. Operational Principle and Innovation Points

3.1. Operational Principle

Design of new energy saving and water saving device based on intelligent circulation system is composed of intelligent circulation device and bath waste water waste heat recovery device, with two Arduino UNO development board + expansion board as the core controller of the system, using a variety of sensors installed in the system to sense the environment information, in Arduino IDE development environment control program through the control of water pump, steering gear and other devices, and the relevant information displayed in 1602 liquid. On the crystal display screen, the user is easy to read the working state of the system. Intelligent circulation device: CM controls the switch status of the three-way pipeline branch through the steering gear. When the core controller detects the water temperature in the main pipeline without the setting interval, the shower outlet branch and the circulation branch is closed, and the water circulation goes to the circulation pool A, the system can save 3~4L of water

resources per shower for the solar water heater, on average each. Each shower can save 5~20L of water resources.

3.2. Innovation Point

Temperature monitoring: temperature sensors are installed in the main passage, circulation tank A and sewage tank B of the intelligent tee pipeline. Monitor the water temperature in real time. Intelligent circulation device: using three-way pipeline design, the opening and closing states of the two branches are controlled by steering gear. When the water temperature of the main path is inappropriate, the circulation branch is opened and the water is recycled to A; when the water temperature is appropriate, the shower exits. Branch road opened, the shower water. Body temperature setting: set the body temperature of the shower through the Arduino design. Intelligent control of waste heat recovery: when the water temperature in sewage tank B is 5 °C or higher than the water temperature of circulation tank A, Arduino single piece.

The machine controls the water pump and drives the heat pipe for heat exchange.

4. Theoretical Design Calculation

According to the annual bath time according to 360 days, winter 90 days, summer 90 days, spring and autumn 180 days through the survey, the surveyed residence, summer average weekly bath 5.9 times, spring and autumn, winter average weekly bath 4.1 times and 3.4 times respectively. The system bath wastewater waste heat recovery heat theory calculation, when the bath shower effluent water temperature is 37 °C ~42 °C, take 40 °C, the bath wastewater into the waste heat sewage pool, the water temperature in the sewage tank is 31 °C ~36 °C, take 35 °C. The annual average tap water temperature is 15 °C, and the capacity of the heat exchange tank (circulation tank A) is 150L. When the water level is 100L or above, the heat exchange is carried out, and the water storage capacity is 100L performed the theoretical calculations.

$$Q = \varphi \times c \times m \times \Delta t \quad (1)$$

Formula: Q- -waste heat recovery; φ - -actual water flow coefficient caused by various losses, generally take 0.93; c- -fixed pressure specific heat capacity of water, take 4.18 KJ/Kg °C; m- - mass flow of water, kg / s; Δt - -before and after heat exchange of bath wastewater. The temperature of the landing. This product is a thousand people shower, can save 134364.2 kw h electricity, equivalent to save 33.78 t standard coal, visible. The energy-saving and emission-reduction benefits of this system are relatively significant.

Table 1. Control table of parameters for different energy sources

Fuel types	Fuel unit price	Fuel value(MJ)	Heat Efficiency(%)
Coal	0.75	20.95	65
Gas	4.0	35.26	85
Electricity	0.8	3.6	95

5. Conclusion

Facing the carbon neutral scenario, it is urgent to explore the low carbon energy technology route, the energy grade is expanding to the low grade range, this system uses the low grade energy in the bath heat wastewater, to preheat the cold water in the circulation pool, improve the initial water temperature of the cold water, In order to reduce the energy consumption in the heating process of water heater, so as to reduce the energy consumption of domestic hot

water, reduce the building energy consumption. The system is designed for the family bathroom a small bath waste water waste heat recycling device, using more economical, high feasibility of heat pipe heat exchange of waste heat recycling, fill the existing bath waste water waste heat recovery, the system mostly adopts heat pump, and only for the public bath places caused by vacancy, can effectively reduce the family life. The energy consumption brought by the use of hot water has high promotion and application value. At the same time, although the existing constant temperature shower can avoid the waste of water resources in the manual temperature control process, but due to the existence of cold water section, the waste of water resources; the existing zero cold water heater can solve the problem of cold water section and realize zero cold water in the shower process, but high energy consumption, water saving cost and promotion is blocked. In view of the above problems, the intelligent circulation device in the system is designed, which has high application value for the long pipeline between the heater and the shower device, and has remarkable water-saving effect, such as solar water heater.

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