Application of Solar Energy Circulation System in Wall Insulation

Handong Zhang*, Jie Yang, Guoliang Xu

College of Civil Engineering and Architecture, Zhejiang University of Water Resources and Electric Power, Hangzhou 310018, China

*corresponding author’s e-mail address: 939649164@qq.com

Abstract. With the rapid development of science and technology, people are more in pursuit of green, high-quality and comfortable life. So solar energy enters our world, it brings warmth and environmental protection. However, there are not many systems combining solar energy with house insulation. In the night, the wall temperature loss is too fast, the use of air conditioning is not environmental protection. It will increase air pollution. This paper studies the solar energy household heat preservation cycle system, which is a new application of solar energy.

1. Introduction

Aiming at the problem of wall insulation, the circulation insulation system is designed with unique structure and high efficiency, which can heat the wall around. This self-heating wall with heating function has strong practicability[1]. The water is heated by solar energy, which raises the temperature of the water. It is delivered to the wall of the house through the water pipe of two calibers, increasing the temperature of the wall and maintaining the room temperature[2]. This hybrid system improves safety, stability, cost savings, and overall energy utilization. It has positive significance for reducing waste of building materials, improving environment, and strengthening wall insulation.

2. Action mechanism of solar energy circulation system

2.1 Main components of circulatory system

This energy-saving and environment friendly wall insulation circulation system is composed of the main body of the house, the pump, the solar heater and the water pipe, as shown in the figure:

(1) Water pump: connected with the solar heater through the water pipe and installed on the roof platform. The roof has a certain height, which can reduce the consumption of electrical energy in the process of downward water transfer. In addition, the siphon effect and atmospheric pressure of the water are also conducive to the withdrawal of water. The water pump is protected by the wind box to shield the wind and rain, and is powered by household power.

(2) Solar heater: It is composed of two water storage tanks and 12 heating pipes. The water storage tank adopts a common thermal storage water tank on the market, each of which can store 200 liters of water. The cold water is heated by the solar heating tube, and the water in the water reservoir is heated by the principle of heating up and cooling down.
(3) Outlet pipe (diameter 60mm): pre-buried in the roof or exposed on the roof surface in advance and given protection device.

(4) Water delivery pipe (diameter 30mm) placed in the wall: The installation of the water delivery pipe and bricks in the wall is the core of this system. For details, see (Fig. 2 and 3)

(5) Side water delivery pipe (Diameter 30mm): Same as (4).

(6) Water delivery pipe (diameter 60mm) placed in the ground floor: the water delivery pipe is prefabricated and buried in the concrete of the bottom floor of the house, and it is thickened around it and resistant to compression.

(7) Wall block (prefabricated water pipe hole): made of cement hollow block, see details (Fig. 1-2)

2.2 Special porous brick
Self-made porous brick: The porous brick is made of clay, shale and fly ash as the main raw materials, and is formed and roasted. The product size is 200 ㎜×115 ㎜×80 ㎜, the hole type is a round hole, the brick body has a symmetrical structure on the left and right, and there is a reserved hole with a diameter of 65mm on the left and right for inserting the water pipe (φ=60mm).

(8) Water pipe hole: The hole φ=60mm, located at the symmetrical position of the brick, used to insert the water pipe, so that the water pipe is firmly fixed in the wall, and the diameter of the hole is slightly larger than the diameter of the water pipe, which is convenient The water pipe is inserted.

(9) Brick hole: the hole φ=10mm, evenly divided in the brick to increase the thermal insulation effect, which is no different from the hole of the ordinary porous brick.

(10) PVC pipe: The water pipe adopts PVC pipe, and its main component is polyvinyl chloride. PVC pipe has strong corrosion resistance, easy bonding, low price, and hard texture. It is suitable for water supply system with delivery temperature not exceeding 45°C, and is suitable for this water delivery system.

(11) The way of building brick walls: Transit.

(12) Wall-building cement: The wall-building cement is portland cement with a thickness of 10 mm.

(13) Wall cement: Same as (12) Portland cement, with a thickness of 8mm.
(14) Specification size: The brick length is 200mm, the left and right water pipe holes are φ=65mm, the middle is 10mm cement thickness, and the remaining four are 15mm gaps. This size design is consistent with the connection of the water pipe and the brick body. The holes of the upper and lower water pipes are aligned to facilitate the insertion of the water pipes.

![Fig. 4. Bricks in the wall](image)

![Fig. 5. Structure diagram](image)

(15) Insulated water tank: a container for storing hot water. The hot water collected through the collector tube must be stored in the insulated water tank to prevent heat loss. The water tank is composed of three parts: electric heater, insulation layer and water tank shell. The shell is made of stainless steel plate. The insulation method of the insulation layer is the polyurethane foaming process. The inner tank is made of stainless steel, enamel and other materials, making the heat preservation effect good, corrosion-resistant. Electric heaters are used to heat water on cloudy days.

(16) Connect the pipeline: put the cold water into the hot water storage tank, and then transfer the heat to the insulated water tank through the heat collector. A closed loop is formed, and heat insulation treatment is performed outside the pipeline.

(17) PVC pipe: same as (10) water pipe can be pre-buried in the roof or it can be exposed on the roof and given protective devices.

(18) Water pump: The water on the ground floor of the house is pumped up to circulate, and the water pump device is covered with a protective device.

(19) Heat collector: All-glass solar vacuum heat collecting tube is selected, which is the heat collecting element in the system, which is heated by the radiant heat of the sun.

(20) Bracket: the shelf supporting the heat collector and the heat preservation water tank. It is required to have firm structure, high stability, wind and snow resistance, aging resistance and no rust. The material is stainless steel, aluminum alloy or steel sprayed.

2.3 Thermal resistance of ordinary wall
The heat transfer resistance $R_0$ of the ordinary wall is\(^3\):

$$ R_0 = \frac{1}{h_0} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{1}{h_n} $$

In the formula: $h_0$-indoor air convection heat transfer coefficient [W/(m·K)]; $h_n$-outdoor air convection heat transfer coefficient [W/(m·K)];
$
\delta_1$ one wall body surface cement mortar plastering Thickness (m);
\lambda_1$ The thermal conductivity of the wall mortar plaster [W/(m·K)];
\delta_2$ The thickness of the ordinary brick wall (m);
\lambda_2$ The thermal conductivity of the ordinary brick wall [W/ (m·K)];
\delta_3$ Thickness of cement mortar plastering on the outside surface of one wall (m);
\lambda_3$ Thermal conductivity of plaster mortar plastering on the outside surface of one wall [W/(m·K)]
3. System feasibility and advantage analysis

3.1 Feasibility analysis
Compared with the traditional thermal insulation method, the wall circulation system and solar energy installation have the advantages of energy saving, green environmental protection and applicability.

1) Place a water guide pipe in the pre-supported cavity of the cement brick block as a carrier of heat conduction.

2) Connect the installed water pipe to the main pipe (60mm) of the water outlet through the multi-port to indirectly connect with the water storage.

3) Install an electric heater in the solar water storage to facilitate the heating of the water when there is no solar energy on a cloudy day (auxiliary function).

4) Use the same method to connect the water inlet of the pump.

5) Add protective measures to the roof piping system (pipes are placed in the roof). The wall pipes are fixed and protected by grouting (cement mortar) (reinforce the pipes, avoid the second (second maintenance).

6) Combined with the entire system, conduct modular experiment and assessment, and compare with the expected results to judge whether it is qualified.

7) The environmental protection, energy saving and heat preservation system has a simple structure and convenient operation. It can effectively reduce the cost of building wall insulation. It can be widely used in ordinary civil buildings, and can also be widely used in ecological park buildings, office buildings, tourist buildings, etc. Highlight the theme of energy saving and environmental protection.

3.2 Advantages of the circulation system compared with traditional insulation measures

1) The "infiniteness" of solar energy reserves: the energy emitted by the sun per second is about 118668kw. The total amount of solar energy reaching the surface of the earth in one year is equivalent to about 12046596 trillion tons of standard coal, which is one of the world's major proven energy reserves. Ten thousand times. Solar energy has inexhaustible "infinity".

2) Universality of Existence: Compared with other energy sources, solar energy has the universality of existence in most areas on the earth and can be used on the spot. This provides a bright prospect for countries and regions lacking conventional energy to solve energy problems.

3) Cleanliness of use: Solar energy, like clean energy such as wind energy and tidal energy, almost does not produce any pollution when it is developed and utilized.

4) Economics of utilization: The economics of solar energy utilization can be viewed from two aspects: one is that solar energy is inexhaustible, and no "tax" is levied when receiving solar energy, and it can be used anywhere; the other is in the current technology At the development level, solar energy utilization is not only possible but also feasible. Therefore, solar energy is an inexhaustible, inexhaustible, cheap, environmentally friendly and safe energy source for human beings.

5) The combination of solar energy and wall insulation system has created a new direction for the use of solar energy. It uses solar energy to heat water and circulate in the wall to achieve the effect of insulation. It has many beneficial benefits of environmental protection, energy saving and high efficiency.

6) The installation is simple, the maintenance is convenient, it can replace various thermal insulation devices in the existing market, and the energy consumption is low, and the environmental pollution is small.

4. System benefit analysis

4.1 Economic benefits
The cost of this wall insulation system is not high, and it is necessary to pre-lay the insulation water pipes during the construction of the house. However, the service life is longer than that of the existing
wall insulation system, and it only needs regular maintenance and repair, and the maintenance cost is included, besides, the cost is relatively low. And the device has obvious ecological benefits. In the process of use, most of the solar energy is used to heat the water body without the need to consume a large amount of electrical energy. This has huge economic benefits under the current background of huge electrical energy consumption.

General thermal insulation cost: electricity cost: $100 \times 12 = 1200$ CNY; material cost: 10000 CNY; solar system insulation cost: electricity cost: $80 \times 12 = 960$ CNY; material cost 5000 CNY.

Remarks: A savings of 5140 CNY per year, equivalent to the price of two ordinary household air conditioners.

4.2 Social benefits
This new type of wall insulation device fully embodies the "Green, Energy-saving and Recycling" concept of life in this era, and it also reflects the national "Sustainable Development" strategy. Its promotion and popularization can effectively reduce energy consumption and ease power station pressure has a positive and beneficial impact on the development of the country and society.

4.3 Ecological benefits
The entire wall insulation device is powered by solar energy, and the insulation effect of the entire system is significant, which can reduce the continued operation of the air conditioner, thereby effectively reducing the emission of freon, and has great benefits for improving the quality of the atmosphere. At the same time, the water in the device, the circulation of water has greatly reduced the waste of water resources. In short, the entire device played a benign role in ecology.

5. Market prospect development research
Wall insulation materials sold on the market today have great defects. Compared with this insulation system, the performance and structure are not advanced, and there is not much value[8]. The solar circulation insulation system has a scientific and reasonable structure, strong wall insulation effect, simple installation and convenient maintenance. It can replace the existing market. Various thermal insulation devices with low energy consumption and little environmental pollution. After entering the market in the future, a large number of economic and ecological benefits can be obtained.

6. Conclusion
Aiming at the problem of wall insulation, the circulation insulation system is designed with unique structure and high efficiency. This self-heating wall[9] with heating function has strong practicability. It is delivered to the wall of the house through the water pipe of two calibers, increasing the temperature of the wall and maintaining the room temperature. This hybrid system improves safety, stability, cost savings, and overall energy utilization. It has positive significance for reducing waste of building materials, improving environment, and strengthening wall insulation[10]. Changed how the solar energy is used.

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