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Analysis of an Integrated Heating System with Solar Energy, Capillary Network and Phase Change Energy Storage Applied in Rural Residences

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Abstract

This paper studies a newly heating system applied in rural residences in order to improve the thermal environment comfort and the reliability of this system. Propose an integrated heating system with solar energy, capillary network and phase change energy storage technology in it, comparing the orthodox heating system mode with this newly heating system method. Then makes a simulation analysis to this integrated heating system with FLUENT software. The results shows that this integrated heating system can make the indoor temperature distribute uniform, offer better thermal comfort as well as reduce commercial energy consumption in rural houses. This combined heating system can lay a fundamental to the further study of integrated heating system in rural residences and seek for a reasonable method to the renewable of rural residential heating technology.

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1. Introduction

For many years people who are living in northeast rural areas of our country have adopted to use heated kang heating system. This way of heating makes the utmost of residual heat produced by fuel burning in the stove with the characteristics of lower expenditure. However people's demand to the thermal comfort of indoor environment have

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risen with the improvement of their life quality. The drawbacks of the heated kang which lacks continuous heating to the indoor surroundings has beyond people's necessity. Normally, indoor air temperature has to be kept by increasing the quality of fuels or the amount of radiator facilities [1]. In this way lots of disadvantages appear, such as the increasing expenditure, the wasting of resources and the sever contaminant to the environment. Therefore, it is urgent to make an integrated heating system in settling the problem of high energy consumption in rural residential buildings [2].

Solar energy, as a sort of clean energy, is widely used to individuals all around the world. Solar energy hot water system, as a well-known energy conservation and environmental production, is broadly applied in the domestic and overseas. It is estimated that solar energy hot water system can provide up to 80 to 95 percent of hot water dosage in summer during which period other source of energy can be saved. In the sunny days of transition season and winter, the water which is heated by the collectors can reach 50~70°C. Even in rainy days the water's temperature can meet the demand of daily household by auxiliary heating source. While in the capillary network terminal heating system, it can distribute energy efficiently as long as the water in the collectors reach the temperature of about 40°C. This can also make a great efficiency improvement of collectors as well as thermal comfort in the room.

Phase Change Material, applied in the heated kang, can storage the redundant heat from the procession of heating the kang in order to diffuse heat to the indoor environment more durable. Moreover, it can alter the uniformity of kang's surface temperature and diminish its surface temperature fluctuation to improve the indoor temperature [3-4].

2. Methodology

The integrated system combine phase change material (PCM) and clean solar energy with orthodox heating method. The system consists of several following parts: solar thermal collector, storage water tank, pipe and pump, terminal capillary network, phase change heated kang, firewall, and soil heating. The principle of the operation can be illustrated as followings. As the picture depicts, hot water which generated by the collector is stored in the storage tank and supply the water to the capillary network in order to release the heat to the room through the pump installed the water supply pipe between storage water tank and capillary network.

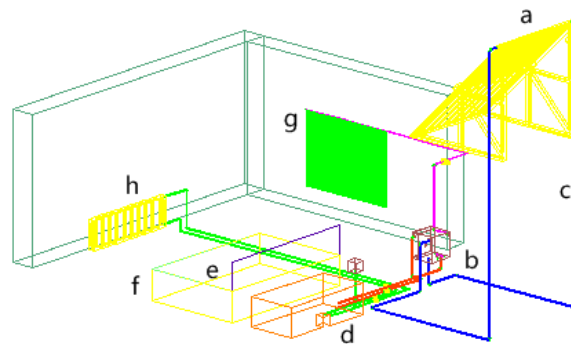


Fig. 1. Sketch of solar energy, capillary network and phase change energy storage heating system. (a) solar thermal collector; (b) storage water tank; (c) pipe; (d) pump; (e) terminal capillary network; (f) phase change heated kang; (g) firewall; (h) soil heating.

Making the heated kang, firewall and soil heating stove as the heating source. Exhaust gas heat the coil pipe in the stove to supply hot warm in the radiators via the pump installed in the water supply pipe of the soil heating, then the gas goes into phase change storage heated kang and firewall chimney flue to heat the heated kang's surface and wall surface to make use of the waste heat of it. PCM in phase heated kang is able to absorb and store much more heat in order to increase the temperature indoors. When the temperature gets lower, the heat which stored in the PCM release to keep the indoor temperature constant.

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