Design of Comprehensive Utilization System of Semiconductor Thermal Power Generation

Yuzhe Wu1*

1 School of energy and power engineering, Wuhan university of technology, Wuhan, Hubei, 430063, China
* wuyuzhe@whut.edu.cn
*Corresponding author’s e-mail: 981282100@qq.com

Abstract: For the solar steam generation system, optical materials are obtained through experimental comparison and verification. A nanofluid material composed of a double-layer structure with a light absorber on the upper layer and an insulating material with two-dimensional or three-dimensional water transport channels on the lower layer is proposed, which is hydrophilic. It uses capillary force and promotes fluid flow to the hot zone, and interconnected pores are used for fluid flow in and out of the structure. The device is embedded with a semiconductor thermoelectric power generation sheet in the lower layer, the upper surface is in contact with the photothermal layer, and the lower surface is in contact with bulk water. The temperature difference is formed and the electromotive force is generated, which makes the energy utilization efficiency higher.

1. Introduction

The current total water storage on the earth is about 1,386 billion m³, of which ocean water is 1,338 billion m³, accounting for 96.5% of the world's total water. In the remaining water volume, surface water accounts for 1.2% and groundwater accounts for 30.1%. The main human use of fresh water is about 35 billion m³, which only accounts for 2.5% of the total global water storage. Among these few freshwater resources, 68.7% are frozen in the ice caps of the Antarctic and Arctic, alpine glaciers, and permafrost, making it difficult to use. At the same time, the replenishment of deep groundwater is slow and difficult to recover after mining, and it is usually not used as a usable water resource.
In the context of social development, our lives are increasingly dependent on energy. Among them, electric energy is a great invention and discovery of our human beings. Nowadays, the consumption of electrical energy in the world is increasing, and it is inseparable from industry and people's daily life. But there is no good cleaning method for electricity generation. In today's era, people mainly rely on thermal power to generate electricity. We know that fossil fuels for thermal power generation include solid, liquid, and gaseous fuels such as coal, oil, and natural gas. The process of thermal power generation is to drive the power generation device through the heat generated by burning fuel to convert it into electrical energy. The flue gas pollution produced by the combustion process aggravates the harm of acid rain; dust pollution reduces air quality and has a negative impact on people's lives and plant growth; resource consumption and low efficiency increase resource shortages and cause many problems for environmental governance; In addition, thermal power generation also causes problems such as noise pollution. It seems that thermal power technology must be continuously improved to meet the development requirements of a harmonious society. At the same time, the research and development of new technologies should be accelerated, so that cleaner and more efficient technologies can replace backward and polluting methods of power generation as soon as possible to provide convenience and technology for human living environment and survival needs.

2. Principle of solar steam generation system

2.1. Semiconductor thermoelectric power generation sheet
Thermoelectric power generation technology uses the temperature difference between high and low temperature heat sources and uses a low boiling point working fluid as the circulating working fluid. Based on the Rankine cycle, the high-temperature heat source is used to heat and evaporate the steam generated by the circulating working fluid to drive turbine power generation Technology, its main components include evaporator, condenser, turbine and working fluid pump. The working fluid in the evaporator is heated by a high-temperature heat source and evaporated. The evaporated working fluid expands in the turbine adiabatically, pushing the blades of the turbine to achieve the purpose of power generation. The working fluid after power generation is introduced into the condenser and its heat It is transferred to the low-temperature heat source, so it is cooled and restored to liquid, and then sent to the evaporator by the circulating pump to form a circulation. The working principle is shown in Figure 2.

![Figure 2: Working principle of semiconductor thermoelectric power generation sheet](image)

2.2. Research status of thermoelectric power generation at home and abroad
Thermoelectric power generation, also called thermoelectric power generation, is a green and environmentally friendly power generation method. Thermoelectric power generation technology has the advantages of simple structure, sturdiness and durability, no moving parts, no noise, long service life, etc. It can reasonably use low-grade energy such as solar energy, geothermal energy, industrial waste heat and waste heat to convert into electrical energy. The research on thermoelectric power
generation technology began in the 20th century. 1940s. Due to its significant advantages, thermoelectric power generation has been widely used in aviation, military and other fields. The United States and the former Soviet Union have successively developed thousands of radioisotopes or nuclear reactor thermoelectric generators to be used as power sources for space and ocean installations. With the depletion of fossil energy, the United States, Japan, the European Union and other developed countries pay more attention to the research of thermoelectric power generation technology in the civilian field, and have made considerable progress. Domestic research on thermoelectric power generation mainly focuses on the theory of generators and the preparation of thermoelectric materials.

3. Double structure design
The solar steam generation system studied in this project is mainly composed of a double-layer structure. One layer is a hydrophilic heat-absorbing layer, which can efficiently convert light to heat. It is required to effectively absorb sunlight and convert it into heat. It provides the possibility for efficient steam generation; the other layer is a hydrophilic insulating layer, which is a support material, which requires low thermal conductivity and good thermal insulation performance to reduce heat loss, and requires porosity, with closed pores and open pores, closed pores can help the structure to float on the water surface and effectively reduce thermal conductivity, while open pores can provide water transport channels for continuous and effective water supply, and are hydrophilic to use capillary force to transport water to the surface of the absorption layer, And require light weight to ensure that the entire structure can naturally float on the water.

Figure 3: This experiment semiconductor thermoelectric power generation sheet

When two objects with a temperature difference approach, there are two ways to form "heat" transfer. In other words, the formation of molecular motion velocity transmission. The first is the collision of molecules. The temperature is slow and the energy is low. The high temperature is fast. The two combine and work together to form "neutralization". The second type is "thermal radiation", which is "electromagnetic radiation" in the final analysis. It's just that the wavelength of this electromagnetic radiation is longer than that of visible light, but the radiation emitted when the temperature is high is "visible light". Therefore, "electromagnetic radiation" in space is the most basic form of energy transfer. As long as the object is above absolute zero, it can emit "electromagnetic radiation" lines to the outside world. It's just that different objects have different intensity of electromagnetic radiation at different temperatures.

4. System feasibility analysis
(1) Technical feasibility:
In this project, by studying the micro-nano-scale heat and mass transfer problems of the double-layer structure of the steam generating device and the principle of semiconductor thermoelectric power generation, the device is optimized and the device is optimized, using economic and easily available materials, to improve the evaporation performance of the entire device, and to solve the problem of microchannel transmission. Heat and mass transfer issues can improve the evaporation efficiency of the system and make fuller use of energy. Through experimental design, the material selection and
performance test of the double-layer structure were carried out, and the differences of the comparative materials were determined through characterization.

(2) Economic and practical feasibility:
From the point of view of experimental materials, the materials of this experimental device are cheap and easy to obtain. Solar energy and unpurified water can be easily obtained even in some poor and underdeveloped areas lacking fresh water. Solar energy, a renewable resource, is very abundant, highly dispersed and highly dispersed. no pollution. The carbon nanoparticle film in the experiment is also easy to obtain and can be applied to freshwater and energy-deficient areas on a large scale. From the point of view of practicability, under the background of global fresh water shortage, it is very urgent to study an effective solar steam generator. This experimental device is a portable hydropower cogeneration device, which is easy to manufacture, convenient to use, and suitable for shortages. Large-scale promotion of water in underdeveloped areas.

5. Project innovation
(1) The energy-saving effect is obvious: by studying the micro-nano-scale heat and mass transfer problems of the double-layer structure of the steam generating device and the principle of semiconductor thermoelectric power generation, the device is optimized and the use of economically available materials improves the evaporation performance of the entire device. Solve the heat and mass transfer problems of the microchannels, improve the evaporation efficiency of the system, and make fuller use of energy.
(2) Save material cost input: Nano particles are low cost, high efficiency, and easy to use as a light-to-heat conversion material. When the solar energy intensity is 1 kW·m⁻², the best dust-free paper thickness and carbon particle concentration are used.
(3) The excellent performance of using semiconductors: the use of semiconductor temperature difference to generate electricity is no noise, long life, and low investment cost, easy to prepare and install, clean and pollution-free, and stable performance.

6. Conclusion
In recent years, various light-absorbing materials, such as carbon foam and graphene oxide (GO), have been used as light-to-heat conversion materials for solar evaporation, especially two-dimensional and three-dimensional water coated on the surface of paper with graphene. The porous and hydrophilic structure of the transport path has been constructed and has great potential as an effective steam generating device. However, the production process of these materials is complicated and the price is relatively expensive, which limits the application of these achievements in real life.

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