

Preliminary study of the thermoelectric power generation theory

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Abstract. Thermoelectric power generation technology has many advantages, no medium leakage, no wear, no noise, small size, light weight, convenient movement and high reliability. It is also not limited by temperature, so it shows great superiority in the recovery of low grade heat source utilization. This paper discusses the principle of thermoelectric power generation, explores the theoretical analysis model and summarizes the development prospects of thermoelectric power generation.

Introduction

China's air pollution is very serious. Among the 161 cities monitored, there are more than 46 cities occurring severe pollution. Besides, 16 cities are seriously polluted. With the deterioration of air quality, haze weather increases. Haze weather not only affects the atmospheric environmental quality but also endangers human health. Based on the theoretical derivation, experimental determination, graphic simulation and numerical calculation, this paper establishes the thermodynamic model of the temperature difference power generation device and determines the electric power of the temperature difference generator. It concludes the optimization scheme of the temperature difference generator. This paper not only analysis the effect of air purification but also proves the device can run normally.

Performance parameters of thermoelectric power generation

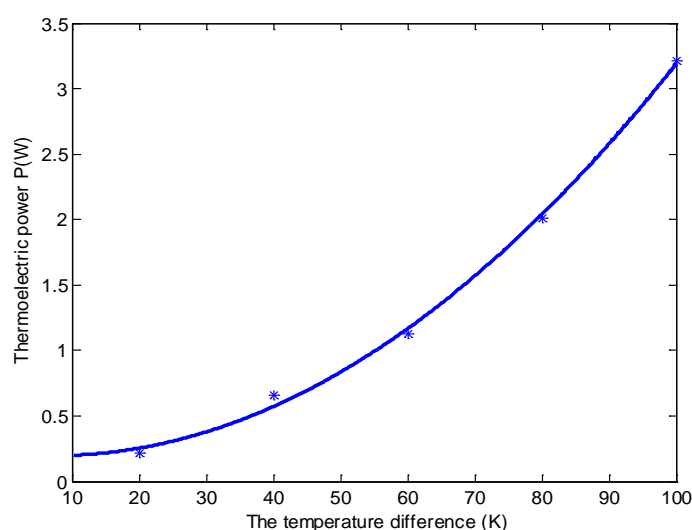


Figure 1 The thermoelectric power with variation of temperature difference

The model of thermoelectric power generation chip is TEG1-199-1.4-0.5, and the total number of thermoelectric power generation chip is 9 which are arranged between two pieces of graphite sheet in the way of. In order to get the curve of output power with the change of temperature difference between the cold junction and hot junction, we close the purify modular, that is to say, just make the device work in the way of storing electric energy. According to the data we get by

measuring the different temperature difference between the cold junction and hot junction of thermoelectric power generation chip and the output power under those different conditions, we get the curve of the output power, as Figure 1 shows.

According to the Figure 2, we can draw the conclusion that with the increase of temperature difference between hot and cold junction of the thermoelectric power generation chip, power generation also increase. At the same time, the amount of increase becomes larger. So to increase the output power of the thermoelectric power generation chip , we need to increase the temperature difference between the cold junction and hot junction, which is the key factor to design the device and also the guarantee that the device can work well.

Thermodynamic models

To simplify the problem,we make the following assumptions in the process of modeling:

- ① There is no difference of the 9 thermoelectric power generation chips ,that is to say the thermal conductivity, length, cross-sectional area and any other parameters are all same.
- ② Ignore the thermal radiation of hot and cold junction and the system' s heat exchange with the surroundings ;
- ③ The heat conducted by the graphite sheet is uniform in different area of the graphite sheet.

And the schematic diagram of the temperature difference power generation device just as the Figure 2 shows.

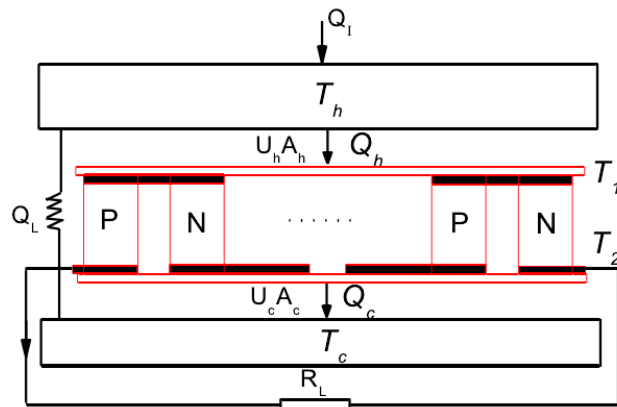


Figure 2 .The schematic diagram of the temperature difference power generation device

Outlooks and Prospect

At present, there are mainly two bottlenecks in the development of thermoelectric power generation. For one thing, the thermoelectric conversion efficiency is not high, mainly subject to the performance of semiconductor thermoelectric materials. For another, the application scope is limited. Domestically, the development of thermoelectric power generation technology is slow and the actual application is seldom reported, the typical solar thermoelectric power generation schematic diagram shown in Figure 3.

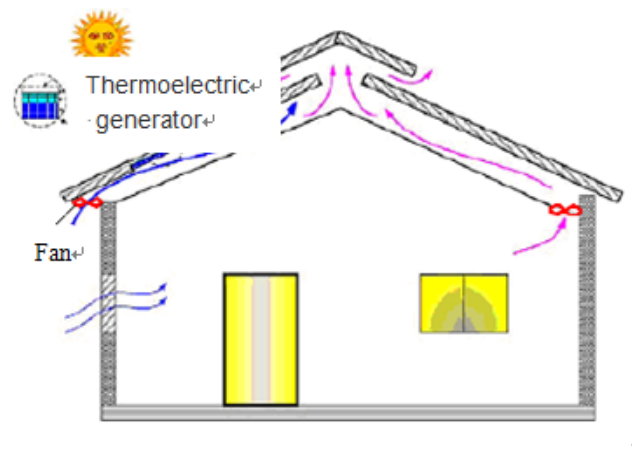


Figure 3 Schematic diagram of a typical solar thermoelectric power generation

Conclusions

(1) Using solar thermoelectric generator to supply power is feasible and can ensure purification module to operate stably.

(2) Analysis, which is based on the experimental determination of purification performance, proves that this device has a certain effect of purification and it is practical and economical.

(3) The thermodynamic model of this device is established by theoretical derivation and we get the optimized air speed $1.8\text{ m/s} \sim 2\text{ m/s}$ by numerical calculation.

(4) Three kinds of purification modes not only ensure the PM_{2.5} purification, but also ensure the efficient production and storage of electrical energy, flexibly and conveniently.

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