

HEAT RECOVERY FROM COMMERCIAL KITCHEN USING THERMOELECTRIC GENERATOR

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Abstract - Now days we come across various new technology being developed every day due to rising cost and less available source of traditional fuel reserves. Various new technological advancement is being made to replace those traditional electricity generation methods with the best substitute. Heat can be a good source to generate energy from it. The principle of Seebeck effect can be used for such applications. In this project, we converted the waste heat from commercial kitchen which is emitted from L.P.G. stove which is used for cooking into useful electricity directly. We have used Peltier module which acts as a thermoelectric generator (TEG) and follows the principle of Seebeck effect. The temperature gradient across the two surfaces of the Peltier module produces an emf in the external terminals of the module. Direct current (D.C) is produced and is used to charge up the battery.

Key Words: Peltier module, Seebeck effect, TEG, Energy Harvesting.

1. INTRODUCTION

One third of energy produced in the power station is lost in the form of heat, remaining energy produced is used to run the turbine and generate electricity [1]. Renewable energy is the most widely developed now a day by inventing new technologies to use them to fullest. Various other alternates are being developed by the researchers for energy harvesting. One of them is the TEG, which does not have any moving parts as in case of turbines, but it serves the purpose of generating electricity. The temperature gradient across the two surfaces of the Peltier module generates electricity by the principle of Seebeck effect. Heat can be utilized from various sources where it is wasted, to generate electricity using this method. As per the future analysis the renewable resources are to be used to the most because of the environmental issues. Burning of fuel is hampering the environment very adversely. These alternatives of energy harvesting will be very much popular after a certain period of time. Including solar

and wind energy which are being developed very rapidly and at a convenient cost which can be afford by everyone. Here comes in picture the use of TEG which are available at very low cost and can produce a good amount of electricity which can be used to power low capacity lights at home and at various places. In this paper we have developed a sandwich of Peltier modules and have attached it to the chimney in a commercial kitchen.

2. PELTIER MODULE (TEG) DESCRIPTION

A Peltier module is a solid semiconductor based electronic component capable of converting a voltage input into a temperature difference which can be used for cooling or heating. But it can even work in a reverse fashion, when the temperature difference is applied to the device then it is capable of producing DC electric power.

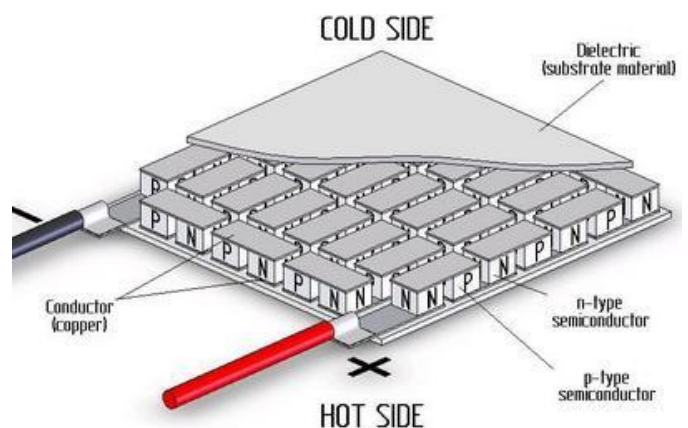


Fig - 1: Internal view of a Peltier Module [2]

The ceramic substrate is made of Alumina, Beryllium Oxide or Aluminum Nitride. The Peltier module works in two mode cooling and heating. When the voltage is given to the module it will either cool or heat the surface of it. By changing the connection at the

terminal, it will work opposite to that of which it was working before. This is why when the temperature difference is applied to the ends of the module it produces voltage at the terminal. The module used is TEC1-12706.

3. MODEL DESCRIPTION

Using the Peltier module, the electricity can be produced which we discussed above. It can also be applied in various places to produce electricity. We have used this in the commercial kitchen, where the heat generated is quite high. Use of the single Peltier module would have not given the output which can be useful so we prepared a sandwich of Peltier module and heat sink at the both ends to achieve high temperature difference. Five of such sandwiches are used to get the appropriate amount of voltage at the terminals which is connected to battery to store the current obtained. The sandwiches are placed on the chimney where the maximum temperature difference is obtained. We checked the difference at two different places and selected the position where we got the maximum temperature difference. Hood of the chimney was the position where the maximum temperature difference was obtained. We made the hole of size of the Peltier module placed one heat sink inside the chimney and placed the sandwich and other heat sink outside on the surface of chimney. And bolted them together.

3.1 Peltier module sandwich

The main reason to make the sandwich of the Peltier modules is because the single Peltier module could not produce the maximum current. We worked on it and removed the best option for this, we attached three Peltier modules in a series which was giving good amount of voltage as well as current at the terminals. To improve the efficiency and obtain more temperature difference we attached two heat sink on each side of the module which we call it as sandwich of Peltier module.

This resulted in high voltage as well as high current at the terminal of the sandwich. We used five such sandwiches in our project. Using this gave high current which was not obtained by using a single Peltier module. Current helps in charging the battery quickly which is necessary. Only voltage is of no use, current is also the important factor to charge the battery quickly. We used thermal paste between the Peltier modules as well as heat sinks to get better heat conduction.

Connecting of three Peltier modules in series make them work as a single module only, the only difference we get is in the current we get at the terminal. The sandwich is shown in the Fig - 2 which is used in our project.

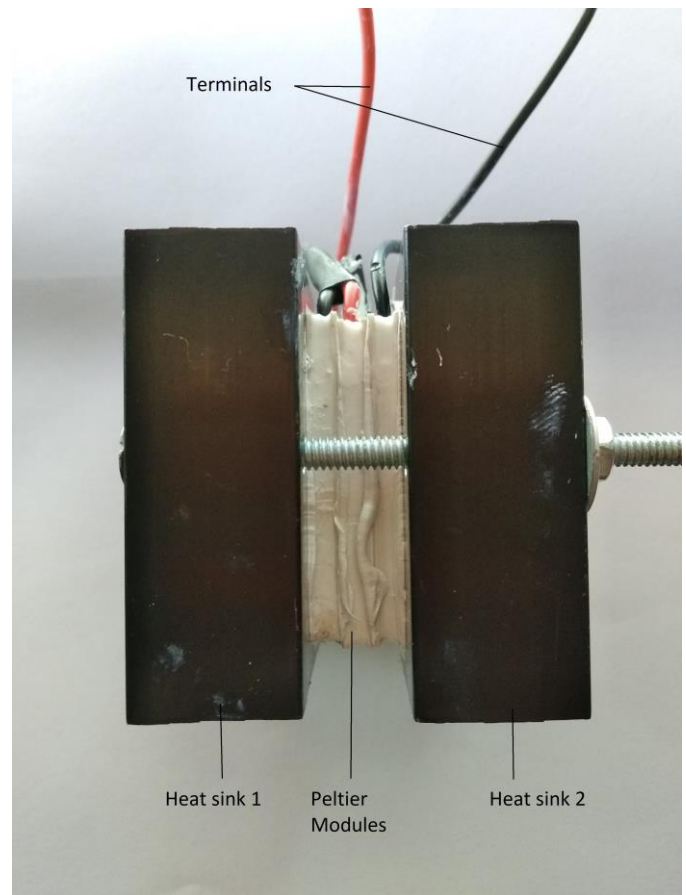


Fig - 2: Peltier module sandwich

3.2 Position of Peltier module sandwich

We considered two different positions for placing the sandwiches. Firstly, we thought about the position at the outlet of the chimney outside the kitchen, where we could get the lower temperature at the cold side of the sandwich. But the problem of placing sandwich there, was the temperature of hot air which was too low. So the difference being obtained was too low.

Secondly we took the temperatures inside the kitchen and the temperature of hot air at the hood of the chimney. This position gave the maximum temperature difference. So we finalized this position for placing the Peltier module sandwich. We made the cutting in the hood of the chimney of size smaller than Peltier module, and attached the sandwich as discussed before in this paper.

Though the temperature inside the kitchen was bit higher than the outside temperature the difference we got was relatively higher in the second position. Applying heat sinks on both the surfaces also increased the efficiency.



Fig - 3: Position of Peltier module sandwich

4. RESULTS AND OBSERVATIONS

The following observations and results are noted while testing the project.

Sr.No	Temperature at hot surface (°c)	Temperature at cold surface (°c)	Temperature gradient (°c)	Voltage (V)	Amperes (A)
1	65	30	35	1.2	0.4
2	76	31	45	2.0	0.6
3	82	31	51	2.5	0.9
4	90	32	58	2.9	1.1
5	105	34	71	3.8	1.4
6	109	34	75	4.2	1.9
7	115	35	80	4.5	2.0

Table-1: Observation Table

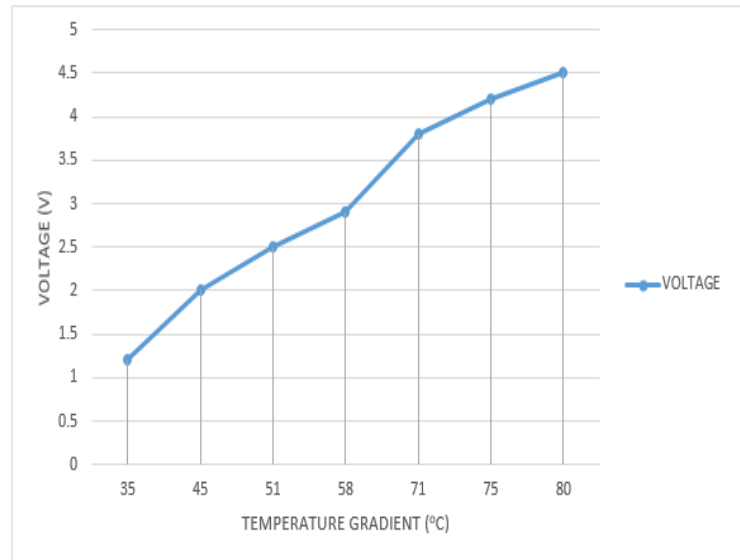


Chart - 1: Voltage VS Temperature gradient

5. CONCLUSION

Thus, the waste heat or hot air in the kitchen is successfully converted into useful electric energy without any use of mechanical component. This energy can be stored and used for any purpose. Our project produces maximum of 4.5 volts which can be increased by increasing the number of Peltier module sandwiches. The power produced by our project is sufficient to glow a DC bulb. The efficiency of thermoelectric generator is very low but these are more versatile than the conventional electricity generation methods.

6. REFERENCES

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