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THERMOELECTRIC GENERATOR AS ALTERNATIVE ELECTRICAL ENERGY SOURCE (COMPLEMENTARY)

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Abstract. A thermoelectric generator converts thermal energy using wood as the primary source, resulting electrical energy. There are advantages of using a wood-burning stove.

Keywords: thermoelectric modules; fuel cells; thermoelectricity; seebeck effect; peltier devices.

1. Introduction

Romania as an integral part of the European Union, is complying with the new energy efficiency norms, so we are constantly searching for new economically and performant electricity generating possibilities. We have chosen wood, as an renewable source. Thermoelectricity is the process of converting heat into electricity. It is characterized by the Peltier-Seebeck effect. The Seebeck effect is manifested in the appearance of an electrical voltage at the end of two different materials which are found at different temperatures.

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The Peltier effect consists of absorbing or disposing of heat to the crossing area between two semiconductors, when they are crossed by electric current.

Thermoelectrics have the following advantages:

– it converts the residual heat into electricity;

– it doesn't cause phonic discomfort;

– it is fiable and has low maintenance costs;

– easy exploitation

The constructive solution we adopt is the use of thermoelectric modules (https://en.wikipedia.org/wiki/...). Thermoelectric generators are static devices that convert heat directly into electricity. Unlike traditional thermal engines, these generators do not contain moving parts, and are completely silent. However, compared to these, they have lower efficiency, and much lower power generation. In the construction of the thermoelectric generators a modular solution is usually adopted (Fig. 1), the advantage consists in providing a quick intervention in case of malfunction, as well as the achievement of a larger range of electrical powers.

Thermoelectric modules are made by inserting a number of thermoelements coupled, so that the *n-p* junctions are in thermal contact with the hot plate, and the p-n junctions are in contact with the cold plate. Because the operation of the thermoelectric modules requires a higher temperature difference, there is mechanical stress between the junctions of the thermoelements due to the dilatation of the hot plates and the contraction of the cold ones. They may have values large enough that can lead to the destruction of the thermoelements. The solution of these problems in the practical constructions is made according to the module geometry and the working temperature range.

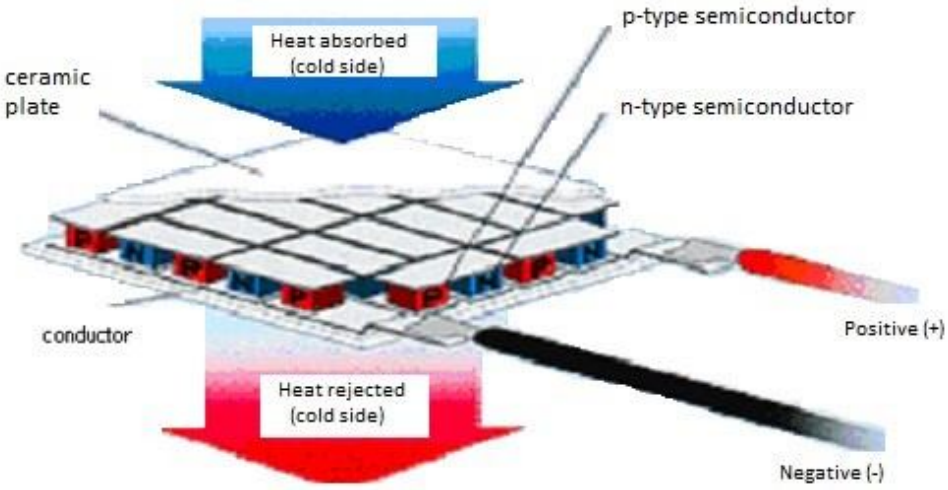

Fig. 1 – The components of a module.

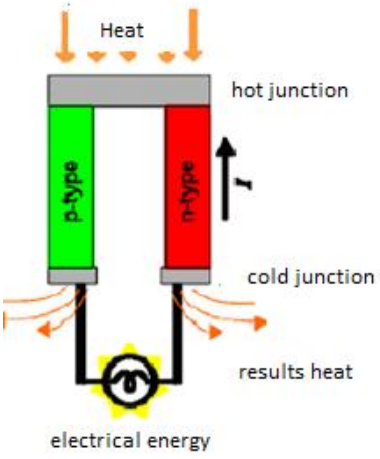

Fig. 2 – The process of transforming heat into electricity.

Peltier devices (Şora, 1978)are known as *thermoelectric modules*, they are devices that function as heat pumps. The proposed technical solution is made up of two ceramic plates, between whichbismuth telluride is positioned, having a cubic shape. This alloy (bismuth telluride) works between 260,…,380°C without losing its physical and chemical properties.

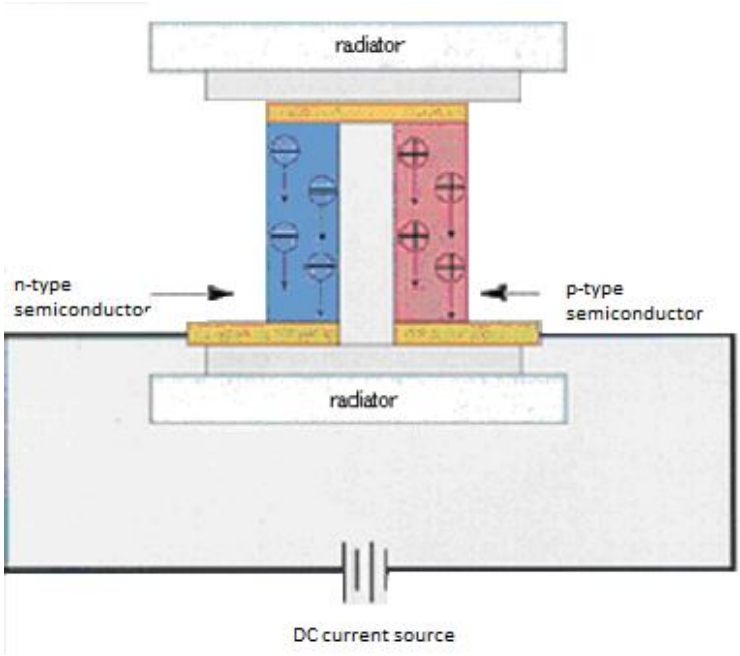

Fig. 3 – Peltier effect.

The functioning principle is based on the Seebeck effect that emphasizes the heat conversion phenomenon in electricity (Fig. 2), it consists on the appearance of an electrical voltage at the extremes of the two materials. The cooling property of these devices is due to the Peltier effect (Fig. 3), whilst the property to generate electricitythrough the Seebeck effect. A thermoelectric module has the advantage that it can be used as a chiller or electric generator. Seebeck effect (Belous, 1986): consists of the occurrence of an electromotive force in a circuit made up of two or more different metals or semiconductors, whose contact points are at different temperatures. The Seebeck coefficient is defined as derived from the thermoelectric voltage in relation to the temperature in an open circuit formed by two welded materials at one end:

$$Ks = dUAB/dT.$$

The electromotor voltage depends on the nature of the materials, and the temperature difference between the two contacts.

2. Results and Analysis

For our application we use modules HZ-20 based on bismuth telluride. It generates a significant amount of electricity from any heat source, which we mount in series to achieve a superior yield.

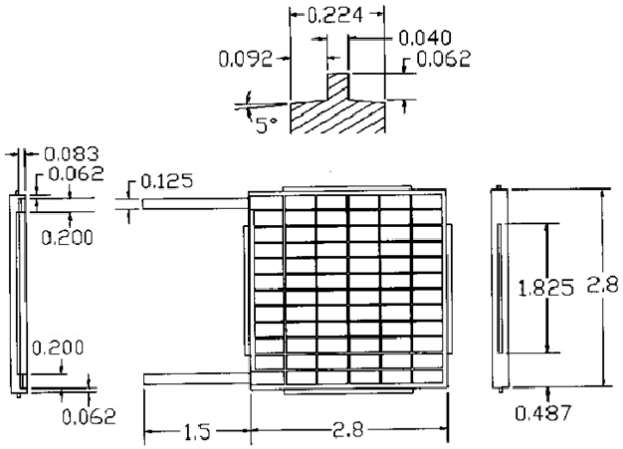

Fig. 4 – Module dimensions.

Dimensioning of the component elements (Fig. 4):
a) mounting of the modules in series (Fig. 5)

Fig. 5 – Mounting in series of two modules.

$$Ut = Ub1 + Ub2 – Ud; Ud = 0.6\ VUb1 = 2.38\ VUb; 2 = 2.38VUt = 4.16V$$

where: Ut is the total voltage; Ub1 – voltage at the first module; Ub2 – voltage at the second module; It – total current intensity; Pt – total power; R – resistance;

b) mounting of the modules in parallel (Fig. 6)

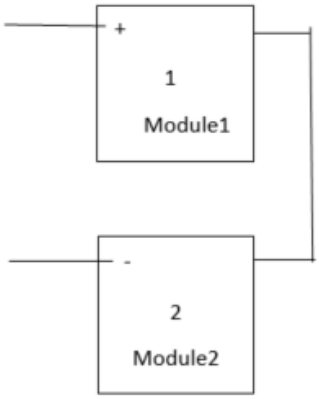

Fig. 6 – Mounting in paralel of two modules.

$$Ut = Ub - Ud;\ Ub = 2.38\ V;\ Ud = 0.6\ VUt = 1.78\ V;\ It = I1 + I2;\ I1 = 5\ A;$$
$$I2 = 5\ AIt = 10A;\ Pt = Ut(I1 + I2) = 1.78 \times 10 = 17.8AR = 1/R1 + 1/R2;$$
$$R1 = 0.3\ \Omega;\ R2 = 0.\ 3\ \Omega\ R = 6.\ 66\ \Omega,$$

where: Ut is the total voltage; Ub – binding-post voltage; It – total current intensity; I1 – current intensity in the first module; I2 – current intensity in the second module; Pt – total power; R – resistance; R1 – resistance in the first module; R2 – resistance in the second module.

3. Conclusions

We chose to mount the modules in series because we get more power.

We have developed four variants for these modules:

– water cooling element from a closed tank through in which the cooling water flows from another open tank

– it refers to a solution called a thermoelectric pot, because the bottom of the pot is provided with a thermoelectric generator

– a thermoelectric generator is mounted in the wall of a stove, the cooling being done from an open tank

– it is chosen as a solution for mounting of some thermoelectric generators on the outlet flue from the stove. The cooling is made with water that is found in the attached tanks (or we can also use fan cooling).

There are two possible solutions in the water cooler variants:

a) the heated water is replaced periodically with cold water, resulting in warm water in the household

b) in case, there is running water, the cooling water can be replaced continuously by the cold water circulation through the tanks, the water flow

being determined experimentally in such a way as to permanently ensure the level of the cooling tank.

For all variants with a cooling water tank it is possible to replace the tank with a sealed tank, through which the cooling water circulates in open circuit.The condition is to have a running water network.

These solutions are complementary to solar panels for the winter season. We recommend the use of cooling water reservoirs instead of fans (electricity consuming).

REFERENCES

BelousV., *Creaţia tehnică în construcţia de maşini – Inventica*, Editura Junimea, Iaşi, 1986.

Şora I., *Bazele electrotehnicii*, Editura Politehnica, Timişoara, 1978.

* * * https://en.wikipedia.org/wiki/Thermoelectric_modules[2]https://en.wikipedia. org/wiki/Thermoelectric_cooling[3]https://en.wikipedia.org/wiki/Thermoelectric_effect#Seebeck_effect.

* * * www.Inbproducts.

* * * www.Students.iuuc.edu.

GENERATOR TERMOELECTRIC CA SURSĂ DE ENERGIE ELECTRICĂ ALTERNATIVĂ (COMPLEMENTARĂ)

(Rezumat)

Un generator termoelectric converteşte energia termică folosind ca sursă primară, masa lemnoasă rezultând energia electrică. Se prezintă avantajele create de folosirea unei sobe cu masă lemnoasă ca agent termic.