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Study of the Possibility of Using the Pelte Effect to Create Cooling Devices Based On Photovoltaic Converters

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Abstract: *The possibility of using Pelte modules to create cooling systems with a selected volume is shown. The choice of insulation materials and construction can significantly improve the operational properties of the unit.The use of a photovoltaic module as a power source can significantly increase the efficiency of Pelte modules.*

Keywords – burning hydrocarbon fuels, renewable energy sources, photoconverters, Pelte-device modules, photoconverter, Pelte elements.

1. INTRODUCTION Currently, a huge part of electric energy is generated by burning hydrocarbon fuels-oil and natural gas, whose reserves are limited. Nuclear power is expensive and requires a high degree of security. In addition, these methods of energy production have a significant impact on the environment due to the impact of harmful emissions from power plants into the environment [1-3]. Therefore, more and more attention is being paid to the use of other energy sources. Among them, a special place is occupied by renewable energy sources, the most promising of which for Uzbekistan is the use of solar radiation energy.

However, the practical application of photovoltaic converters as sources of electrical energy has some technical difficulties, among which is the conversion of the energy of photovoltaic stations by means of additional technical devices, namely inverters, to alternating current of industrial frequency.

Therefore, there is a search for technical solutions in which it is possible to directly use the energy of photoconverters without using intermediate devices [1].

One of the possibilities is the use of the Peltier effect to implement the processes of cooling and heating.

In this paper, we study the features of the use of the Pelte element for cooling. For this purpose, two types of devices are used-Pelte-device modules (Pelte elements combined in a single design) designed for 25 Watts and 36 Watts of power.

To implement the technical solution, we have created three types of devices for cooling volumes of 2, 12 and 28 liters.

When creating the devices, standard sealing methods were used, and a system was developed that uses multi-layer sealing using a cheap and convenient, as well as affordable type of thermal insulation-foam.

These devices have built-in cells with Pelte elements-Pelte modules and heat exchange parts both inside the chamber and on the outside of these modules, radiators. Two types of radiators were used-with natural and forced cooling. For natural cooling, the areas of the heat exchanger inside the chamber and the radiator are calculated.

When using forced cooling, the radiator area is calculated and the required air flow is estimated using low-power, high-efficiency fans.

The results of experiments using two types of Pelte modules are presented below.

2. Experimental method. At the first stage, chambers designed for cooling small volumes, namely 2, 12 and 28 liters, were created. If you were to create chambers with volumes of 2 liters and 12 are mostly used a multilayer sealing with the use of foam, for a chamber volume of 28 liters applied traditional system inside the camera, the insulation with the use of tested glassy insulation on the plastic cover ,and the outer thick layer of insulation, as in refrigerators of the used experimental chamber is fully encircled the slim metal body.

A thermometer or a pre – graduated measuring system-a sensitive thermal sensor-was installed inside the experimental chambers prior to conducting experiments to study the effectiveness of their functioning.

Preliminary studies of the operation of Pelte modules have shown that there is a need to evaluate or calculate the effective power, on a small volume , as well as evaluate and calculate the heat exchange systems –the radiator and the cooling part of the device. For this purpose, we have studied the designs of a number of standard refrigerators from various manufacturers.

In the future, for a detailed analysis of the functioning of the systems, we selected both types of radiator operation - with natural and forced cooling of radiators.

3. Experimental results and their discussion. At the initial stage, work was carried out to study the efficiency of using Pelte modules for cooling the chamber without forced heat exchange of radiators. The results showed that although heat transfer from the chamber occurs when power is applied using standard DC voltage sources, a certain feature of the modules ' operation is

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revealed: their efficiency strongly depends on the presence of a variable component and fluctuations in the output parameters (as indicated in the instructions for elements).

Therefore, in the future we will use stabilized sources and batteries charged from photovoltaic modules.

To better simulate the processes, a chamber with a volume of ~ 2 liters was used at the beginning of the experiments. It was found that with good thermal insulation parameters of the unit, the chamber volume is cooled both when using the 25-watt and 36-watt power modules.

Therefore, further experiments were carried out using a 12-liter chamber, which is quite widely used for small-sized refrigerating devices (for automobile refrigerators, as cooling devices when traveling to places where there are no sources of electrical energy).

Preliminary experiments have shown that cooling the radiator with arbitrary or perpendicular blowing of the radiator in thermal contact with the hot side of the Pelte module is not efficient enough. Therefore, in the future, a system of air purging the radiator is used perpendicular to the surface of the radiator plates, parallel to the surface of the Pelte module. Under such conditions, the conditions for the most efficient operation of the device are achieved, namely, the hot surface of the module is located close to the room temperature-30-32°C. It is in this work that the maximum temperature gradient of devices operating using the Pelte effect is achieved.

Figure 1 shows the time dependence of the temperature inside the chamber, when using a single module with a power of 36 watts.

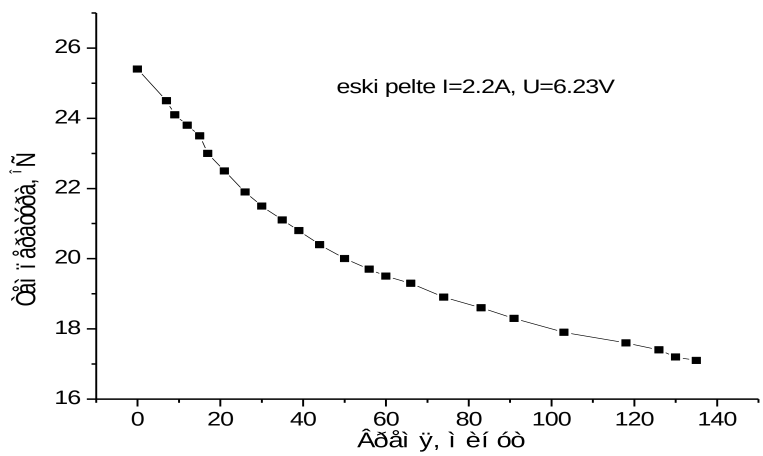
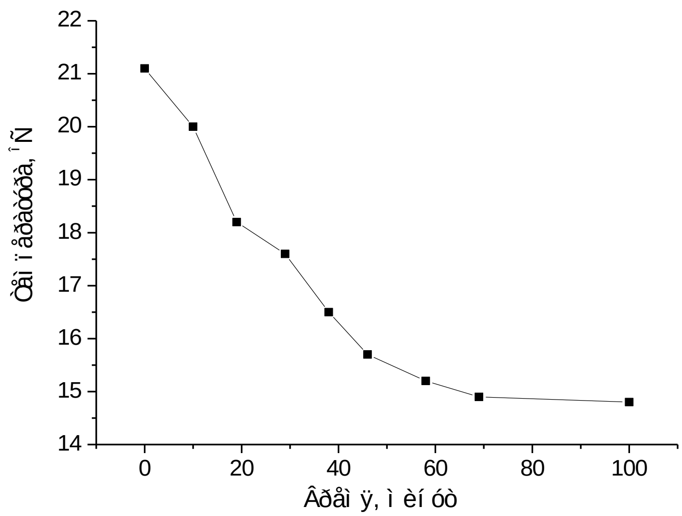


Figure 1. Time dependence of the temperature course inside the chamber.

As can be seen from figure 1, heat transfer is carried out with an exponential dependence. THEprocess time constant calculated from the graph was τ≈34000 s.

To optimize the experimental conditions, the thermal insulation of the chamber was improved and the process was repeated. In this case, the results obtained are markedly different from the previous experience. Typical experimental curves are shown in figure 2.



2. Time dependence of the temperature course inside the chamber.

The process time constant determined from the graph was $\tau \approx 131.40$ s..

It follows from the results that the heat transfer process is determined by the power of the cooling device, therefore, for an arbitrary volume of the chamber, it is experimentally possible to choose a cooling system from Pelte modules.

However, as expected, this process is significantly affected by the thermal insulation properties of the working chamber and the parameters of the power source. When using a current source without a variable component, you can expect an improvement in efficiency compared to using AC rectifiers

Thus, for the design of an efficient cooling system, it is also necessary to select the optimal structural materials.

4. CONCLUSION. The possibility of using Pelte modules to create cooling systems with a selected volume is shown.

The choice of insulation materials and construction can significantly improve the operational properties of the building.

The use of a photovoltaic module as a power source can significantly increase the efficiency of Pelte modules.

The developed cooling device can be used as a refrigerator if necessary-in bars.

A word of caution. Caravan Fridges. The three way fridges fitted inside most caravans, regardless of their size, are notorious for flattening batteries when run on the 12 volt setting. Furthermore they can flatten a fully charged battery quicker than you can drink a stubbie.

Even though these fridges have a 12 volt operating option, they do not operate on the same principle as your 12 volt car or camping fridge. Your 12 volt car or camping fridge/esky has a small compressor to generate the cold and this uses around 4 amp-hours. On the other hand the three-way fridge in your caravan works on a heat exchanger principle with the heat element using 30 amp-hours (often more) and for that reason most User Manuals advise NOT to operate the caravan fridge on 12 volts when the vehicle is not running.

Equally you should NOT use a caravan fridge when connected to a solar/battery power supply.

If you wish to run your caravan fridge on a solar/battery mix then you will need around 600 watts of solar panels plus a couple of very good, fully charged, batteries to keep the fridge running at night and even then the batteries are unlikely to last the distance. Run your caravan fridge on gas or 240 volt generator.

The above information is based on research and practical experience gained over years of camping both at Pandanus Park and other camp locations throughout Queensland and New South Wales, and always in the warm months. It is not intended to be exhaustive and is provided for guidance only.

The author makes no recommendation as to brands of solar panels, batteries or solar regulators.

The author is a qualified electronics technician.

Further, impartial advice can be obtained from other Internet sites.

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[http://www.pandanusparkinc.com/Solar%20Panels%20Guide.html]

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