ON THE POSSIBILITY OF THE PELTIER ELEMENT IN THE EFP SYSTEM AS THE HEAT FLOW MEASURING DEVICE.

ISRA Hassan abdelaziz Abuashi-BAHÝL, Vladimír.

Abstract

The paper presents our results in the experimental effort in the study of the Peltier element performances as the chip for the heat flow measurements. We have developed the special electronic, computer aided, device for the direct heat flow measurements on the base of the Seebeck event with the mentioned chip.

We present the basic principles and physical laws of course. Next we present the preliminary results of our measurements and tests in common with the calibrating equations.

The possibility of this device or principle in the electronic fire protection (EFP) system is suggested and discussed.

Key words: Peltier element, heat-flow, fire protection.

THE INTRODUCTION

The knowledge of the burning processes is very important from the fire protection point of view. This is not only because of the fire influence upon its surroundings but also because of to be successful in the fire extinguishing and fire alarming or fire protection. It seems us to be suite to select from the many fire representing factor the one only and this selected factor study very deeply and narrowly. We have selected in this paper the irradiative heat transport process for such a kind of study as we see it as the most important in the case of a fire.

The heat radiation influences the fire attack especially in such a way that the radiation prepares to fire combustible materials just near the fire zone. The heat radiation did not only combust the near materials but in many cases it limits the activities of fireman. These should be especially protected against the irradiative heat, e.g. special suits, shields, water screens and so on.

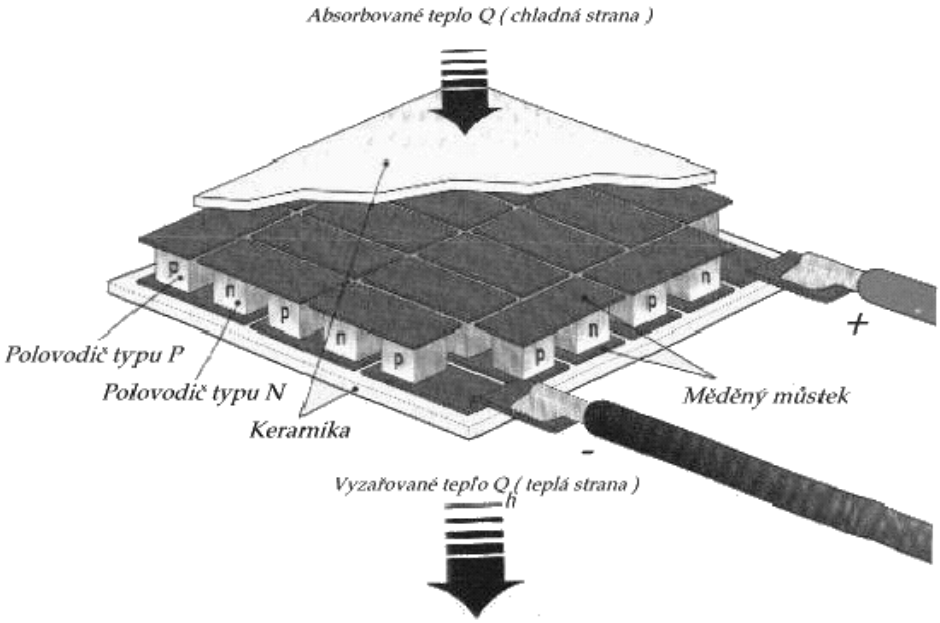
This is according to our opinion the reason why it is very important to study the heat radiation processes, especially those one, which allow us to transfer the measured heat flow value to the electric power.

We allow us to present our, non-traditional access to this problem on the basis of the results which have been achieved in our department in Zvolen. The usage of the Seebeck event is the key principle of this system and as the Seebeck event is the opposite one to the Peltier event, we have great advantage to use the Peltier elements in our experiments as they are commercially were easy accessible.

The Seebeck event and the Peltier element

The French physicist A.Ch.J.Peltier has in his study of the Seebeck event found the opposite course of the physical values and had grounded the base for future very broad usage of the event which has his name (Peltier event).

If there are two line vireos of different metals coupled into the closed circuit and their joints have various temperatures, i.e. the heat is flowing through such a device, it begin to flow the electric current through them as the result of the heat flow. Such an event is named Seebeck event. Upon this discovery there is grounded the Peltier's element (Figure. 1). This is in principle realised from two semi conductive corpuscles and conductive bridge. As the semiconductor material there are used especial matters (vizmut, tellurids), which have convenient thermoelectric performances, mainly low per-unit resistance and small thermal conductivity. For the bridge elements there are used copper materials with small electric resistance. Coupling several (E.g. 129) of such elements we get "commercial" Peltier element. Connection of several such elements there is possible to realize the thermo battery. Single thermo elements are serially connected and they are positioned between two ceramic laminate plates with good thermal conductivity. Ceramic laminate plates are used as the electrical insulation materials. In the case that the electric current flows through the wires and elements one of the plates is getting heat and the opposite one is sinking heat. This is the normal and usual commercial usage of the peltier elements. But if we apply the heat flow on the ceramic plates, we get the electric power on the element's contacts. This is our usage from heat to electric power which is easy measurable and the only problem is to calibrate and automated such a device.



Picture 1 The Peltier element construction

-Absorbovane teplo Q (chladna strana) - Absorbed heat Q (cold side) –
- Polovodit typu p- semiconductor type p
Medeny mustek –cooper-
- Polovodit typu N- semiconductor type N.
-Keramika – ceramics.
-Vyzarovne teplo Q_h(tepla strana)- Radiate heat dissipation (heat side).

Let us mention here some of the advantages of the Peltier's element:
- no moving parts
- Small dimensions and low weight
- Relatively robust construction
- No-shine no noise nor EMI
- No need of service
- Wide area of working temperatures
- Local cooling
- No-load for environment

And now some of fields for application:
- Military industry, submarines, missiles
- Compact exchanger warm
- Cooling electronic element (mainly executive CPU's)
- Cooling the infra-red detectors
- Low noise amplifiers
- Little refrigerating box
- Infra-red sensors
- Laboratory cooling plant
- Airplane and automobile industry

PELTIER'S ELEMENT FOR FIRE PROTECTION SPECIALIZATION

The electro technical usage or step of the Peltier's element, realized in our laboratory as the electric power source is schematically depicted on the figure 2. Here there are the following parts: loading resistance (R_Z) consisting of calibrating ampere-meter (R_A) and load resistance (R_{Z1}), the volt meter (V) and the tested Peltier element (PC).

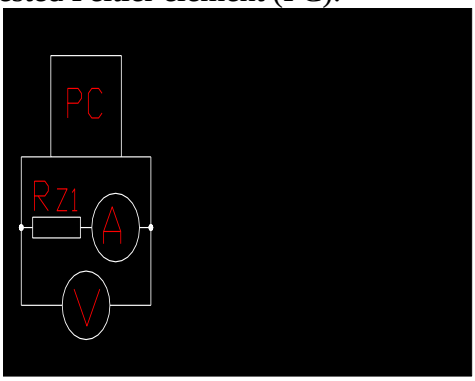


Figure 2. Electro technical scheme for the Peltier element.

Technically the Peltier element is embedded according the figure 3. In the "live section" where is the Peltier element flows the heat. Lifeless material is used as the thermal insulator.

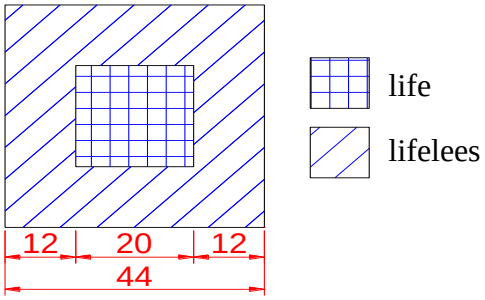
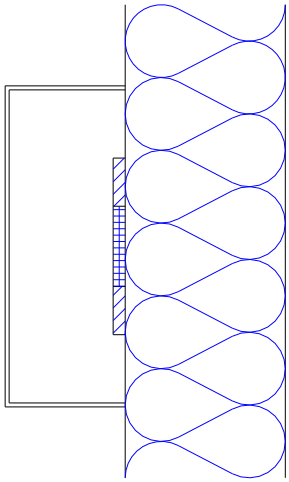


Figure 3 Embedding of the Peltier element .

After many series of experiments we realized, that the Peltier element is very sensitive scanner of very low heat flows too and it should be embedded very carefully in its configuration and construction. Simply, it should be cowered and carefully calibrated. Our calibration device with cover is schematically depicted on the figure 4.



Composition:
- cover
- Peltier element
- thermo paste
- polystyrene 50 mm

Figure 4 Measuring wall of polystyrene with the embedded Peltier element.

From the many series of experiments we get for the Peltier element in usage the following equation:

$$q = 0{,}2304.U_{PC} + 2{,}9246 \qquad (1)$$

Where: U_{PC} [mV] – electric tension on Peltier's element after amplification.
The relevant graph is on the figure 5.

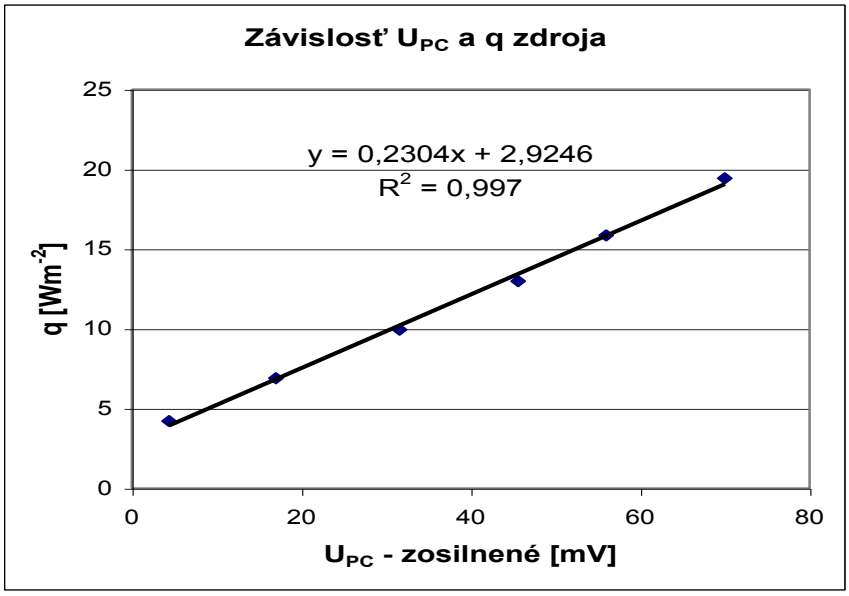


Figure 5 the linearity of the Seebeck event. Or the calibrating regression.

After performance tests and experiments we considered our apparatus to be ready for the practical usage. We have measured in two constructions roof and window. The situation for window is schematically on the Figure 6a.

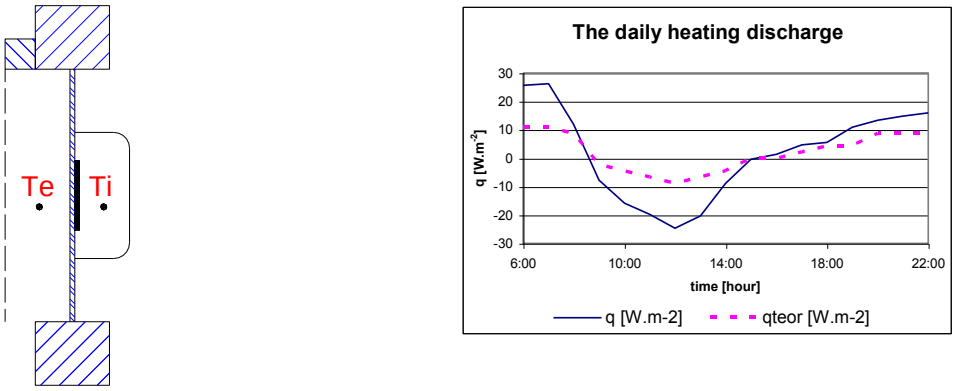


Figure 6 Measuring situations for window. Left Fig. 6a. Right 6b.

For better understanding we present here the measurement of the heat flow through the imbricate roof. We have measured every hour the heat flows and temperatures in the room. The results can be presented as the proof that the internal temperature (Ti) reflects the heat flow from the outside.

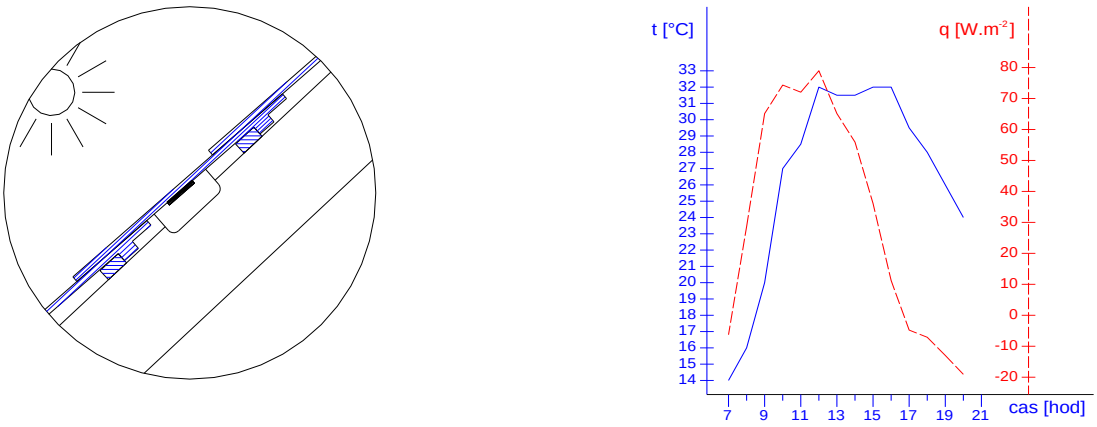


Figure 7. The measuring situation for simple imbricate roof. Left fig. 7a. Right 7b.

RESULTS OF MEASUREMENTS

Measurements for the window

Results measuring are gratifying, because the tension on Peltier's element is depending out of thermal flow (Figure 6b). On this figure there is possible to see the thermal balance. We can see heating discharge morning and then is the situation inverted. With influence sunny radiation of the temperature raised in exterior (Te) over temperature in interior (Ti) and Peltier's element in this case records heat again.

The measuring on simple imbricate roof

Measuring was realized in sunny weather. The scheme of measurement is depicted on the figure 7a. On the diagram of the figure 7b we can see the course of the thermal flow transmigrate over the roof tile. On the same graph we can see reaction of the inside temperature. It was measure with mercury thermometer, independent of our measurement system.

DISCUSSION

We have presented here the successful series of measurements and tests of the basic part for the heat flow measurements. Of course we are not the first in the world which have used in their measuring devices this principle. No matter, our research and development continues and now we have at our disposal complete, computerized device ready for further development and for next ways of usage.

The greatest advantage of this our device is that all we have realized with our own forces. We have no so called "black boxes" in it, including the software. This is also of our own realization in the C++ Builder and micro assembler languages.

We are quite open for any kind of co-work in the next development, research and usage of our devices and ideas.

Especially we are interesting on co-work in the fire protection signalization, measurements and testing.

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Vladimír Bahýl, Ass. Prof. Technical university in Zvolen, Faculty Wood Science and Technology, Department of Physic Electrical Engineering and Applied Mechanics, Masarykova 24, 960 53 Zvolen, Slovakia, bahyl@vsld.tuzvo.sk .**ISRA Hassan abdelaziz ABUASH** ، phd technical university in zvolen, faculty of ecology department of environmental engineering Israaa25@yahoo.com