Ministry of Higher Education and Scientific Research

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وزارة التعليم العالي والبحث العلمي

جامعة الانبار

كلية الهندسة

قسم الهندسة الميكانيكية

الكـــراس التـــعريفي لتجـــــــــــارب

مختبـــــــــــر التثليج

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تجربة رقم (٠٥)

المحتويات

الفصل الاول (تجارب المختبر)		
١	رقم التجربة	
٢	اسم التجربة	
٣	الهدف من التجربة	
٤	المعدات المستخدمة في التجربة	
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الفصل الثاني (الاجهزة المستخدمة في المختبر)		
٨	اسم الجهاز	
٩	وصف الجهاز	
١٠	طريقة استخدام الجهاز	

(Experiment 05)

Name of the experiment:

Thermo-electric refrigeration (2)

The goal of the experiment:

- **Study of the effect of Peltier**
- **Study of the effect of Tomas J. Seebeck**
- **Finding the performance coefficient of the unit when it works as a refrigerator**

Introduction

The discovery of the basic base of thermo-electrical refrigeration dates back to the German physicist Thomas Seebeck. In 1820, this scientist discovered that if a closed circuit of two different materials is connected to each other, an electric current will flow in the circuit when one of the connection points is heated, as in Figure 1 below, but Seebeck could not explain this phenomenon physically.

In 1834, Peltier discovered that when a direct electric current is passed through an electrical circuit composed of two different materials, the contact (or connection) areas between the two materials become either hot or cold depending on the direction of the direct current, as in Figure 1. Peltier was also unable to explain this phenomenon physically. In 1838, Linz explained the importance of discovering both Seebeck and Peltier by placing a drop of water on the contact zone between the two different materials and passing an electric current through the circuit. He discovered that when a current pass in a certain direction, the drop of water freezes, and when the direction of direct current passes through the circuit is reversed, the frozen water drop melts, as the direction of direct electric current flow is what determines which of the two sides will be hot or cold.

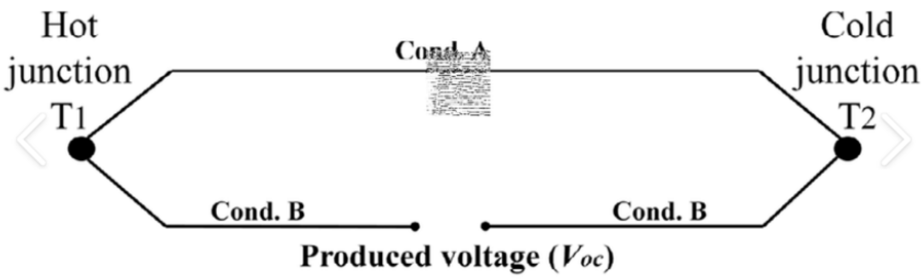

Figure 1. Basic thermoelectric refrigeration system

In the thirties, semiconductor materials were discovered, which developed the use of the Peltier effect for on-site cooling. In the sixties of the last century, various companies began to develop this use in the work of refrigeration such as small refrigerators, water

coolers and the like, until it came to the use of this type of systems in spacecraft and submarines powered by atomic energy.
The thermoelectric refrigeration system is based on the Peltier phenomenon. When a direct current passes through two semiconductor materials N and P, the temperature rises at one pole and decreases at the other pole, becoming cold. When electrons pass from P to N, the energy absorbs, making the upper surface cold, as in Figure 2, and after passing through the lower surface, the energy is released, making this region hot, and this structure is called pair. The diagram in Figure 2 is an example of a single module which gives a very low cooling capacity and to obtain a useful cooling capacity it is necessary to connect several pairs in a row as in Figure 3.

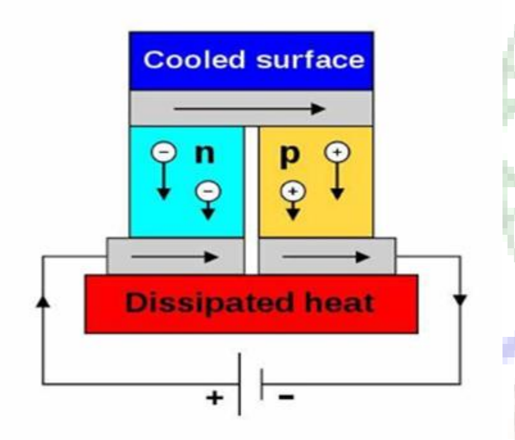

Figure (2) Thermo-electrical refrigeration unit

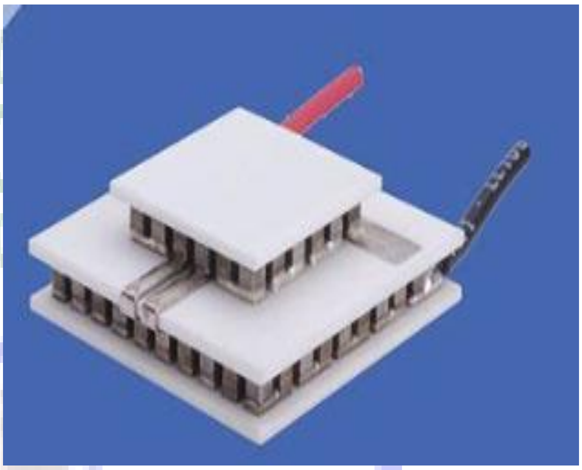

Figure (3) Thermoelectric cooling application

- **The used device used**

Figure 4 shows the layout of the laboratory instrument used in this experiment called the group of thermoelectric pairs connected in series (module) and placed between two aluminum molds to connect them tightly. In all these molds, there are two special holes to place two mercury thermometers to measure temperature, one to measure the temperature for the hot side and the other for the cold side. There is an electric heater consisting of a resistive wire made of nickel-chrome alloy to heat the outer side of the aluminum mold that is directly connected to the cold side of the unit and the cold side composition has thermally insulated. The hot side of the unit is connected to the finned aluminum mold that acts as a heat dissipation surface. To increase the rate of thermal dissipation, an existing electric fan can be used for this purpose. There is an electrical regulator by which the capacity entering the unit can be changed and regulated and thus change and regulate the cooling capacity of the unit The cooling capacity cannot be calculated directly. For this purpose, an electric heater was developed to equalize or balance the resulting freeze. The heater is regulated by an electrical regulator that controls the amount of power supplied to it and this unit can be used as a refrigerator or heat pump. At the front end of the device is the main power switch, which controls the power supplied to the transformer. There are also four keys in the lower half of the front that can be used to conduct different experiments.

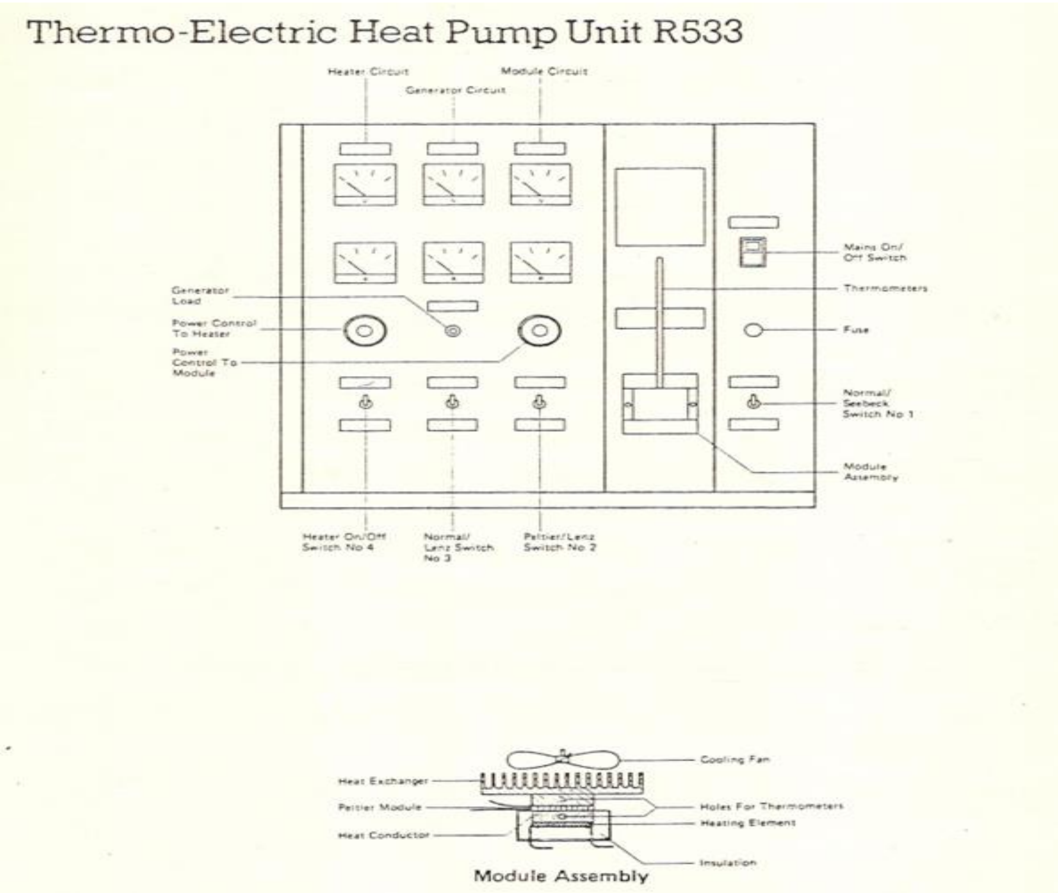

Figure 4. Module assembly

- ## Test method
- ### First- Peltier effect

1- The unit is to be used to conduct more experiments consecutively, the unit must be stopped working at the end of each experiment and left until the cold and hot surface temperature reaches room temperature.
2- Before conducting any experiment, it must be ensured that the electrical regulators used to control the power of the unit and the electric heater are in the position that gives the less power.
3- Make sure that the main power switch is off
4- Put two thermometers with an appropriate gradient in the gaps allocated to them and use a third thermometer to measure the temperature of the laboratory
5- a- Put the switch 1 on the normal position.
   b- Put the switch 2 on Peltier mode.
   c- Put the switch 3 on normal.
   d- Put the switch 4 on off
6- Put the main power switch on (ON).
7- Use the power regulator for the unit to get at least five or six readings. 8
8- Note the temperatures for both the cold and hot side where the effect of Peltier is clear from the temperature difference, record the temperatures when the unit reaches a stable state and record the voltages and current also every time

- **Second -Study the Thomsen or Lenz effect,**

1- repeat steps 1 to 4 first above.
2- a- Put the switch 1 on the normal position.
   b- Put the switch 2 on Lenz mode.
   c- Put the switch 3 on normal.
   d- Put the switch 4 on off
3- Use the power regulator for the unit on a minimum number of readings of five or six.
4- Note the temperatures for both the cold and hot side and record the temperature values when the unit reaches a stable state, as well as record the voltages and current also each time

- **Third- Thermo-electrical refrigerator performance coefficient**

1- repeat steps 1 to 4 first above.
2- a- Put the switch 1 on the normal position.
   b- Put the switch 2 on Lenz mode.
   c- Put the switch 3 on normal.
   d- Put the switch 4 on off
3- Put the main power switch on (ON)
5- Rotate the power regulator of the unit clockwise and wait for a period of time, when the temperature of the cold side reaches a degree lower than the temperature of the laboratory, connect the switch of the heating wire and organize the amount of power equipped to raise the temperature of this side to the temperature of the laboratory and wait for the arrival of the unit to the steady state and in this case the capacity consumed by the heater is equivalent to the refrigerating product that is achieved from this unit
6- Repeat the process by preparing more capacity to the unit with the refrigeration capacity equivalent and get five or six readings.
7- Record the voltages and current of the unit and the heater as well as the temperature measured by the cold side thermometer, which must be equal to the temperature of the evaporator, as well as the temperature of the hot side for each case.
8- When you finish recording the required readings, regularly cut off the power to all the keys of the device

- **The calculation**

$$W_m = V_m * I_m$$

$$W_h = V_h * I_h$$

$$C.O.P. = \frac{W_h}{W_m}$$

$$\Delta t = t_h - t_c$$

Where

W_m :The power supplied to the module (W)

W_h :The power supplied to the heater (W)

C.O.P. The coefficient of performance

t_h :Hot side temperature (^oC)

t_c :Cold side temperature (^oC)

Discussion of the results

1- Draw a curve of the relationship between the temperatures of the t_h and t_c and Δt (vertical axis) with the power supplied to the unit (horizontal unit) to show the effect of the Peltier.
2- Draw the relationship between the temperature and the difference between the two degrees with the power equipped for the unit in order to show the Thomsen or Lenz effect schematically.
3- Draw a curve between the performance coefficient (vertical axis) and the temperature difference (horizontal axis).
4- Draw a curve of the relationship between the performance coefficient (vertical axis) and the equipped power of the unit (horizontal axis).
5- Discuss the changing in the above properties in the curves and how they depend each to other.

   Briefly write your conclusions from the experiment about the Peltier effect, the Thomsen effect and the performance of the refrigerator and compare the performance of this type of cycle with other refrigeration cycles and its suitability in different applications.

- **The readingds**

First – Peltier effect

	1	2	3	4	5	6
Hot side temperature (ºC)						
Cold side temperature (ºC)						
Temperature difference ΔT (ºC)						
Heater current I_h (Amp)						
Heater voltage V_h (V)						
Heater power W_h (W)						
Module current I_m (Amp)						
Module voltage V_m (V)						
Module power W_m (W)						
C.O.P.						