**Experiment No. (10)**

**Study of heat waves in solids )) ))**

**The purpose of the experiment :**

To measure the thermal diffusion coefficient in a solid body by monitoring the transmission of heat waves through it

the theory.

Solid bodies transfer heat by conduction, which is expressed physically by the following equation in one-dimensional coordinates:



Whereas:

G : Represents the density of the vertical heat pulse per unit area.

Regression. : 

R : Thermal conductivity coefficient of a solid body

vertical gradient of temperature.

Where the rate of heating somewhere in the solid is given by the equation:







Whereas :

 It is the specific heat of a solid per unit volume :

It is called the thermal diffusion coefficient:

and surely **R** It is assumed that it does not depend on **Z** (because **Z** It cannot be used as a height above the ground.) , If **Z = 0** The surface of the body, which is a homogeneous slice of a solid material subjected to a vibrational thermal grain wave, the equation (1) can be solved by using the boundary conditions in  **Z = 0**

whereas :

is the amplitude of the wave . 

 It is the complete oscillation time of an vibrational wave after a number of vibrations The situation becomes continuous.

Whereas



This relationship explains the smallness of the amplitude of the wave in the increase of the phase difference when the wave goes in the depth 

and phase   A thermal wave at different heights has a diffusion coefficient that can be calculated by two methods:







This theory can be used and applied to the case of a specific volume of sand that absorbs heat waves, which can be used in the atmosphere, but changing the thermal diffusion coefficient with the height above the earth’s surface makes this theory not fulfill the required purpose.

**Used tools:**

In this experiment the thermal diffusion in dry sand can be calculated using waves with short oscillation time and small depth of sand. To clarify, a heat wave square shaped It will fall on the upper surface of the sand in **Z =**0 As the wave continues to penetrate the sand, the high hormonal compounds of this wave will It fades away and the main wave remains The wave becomes sine.

The sand is contained in a suspended box with six thermocouples. Each thermocouple in the box is placed at a certain height. Its other end was connected to a source with a constant temperature, let it be room temperature. The thermocouples are numbered from (6-1) according to the sequence of their height in the sand. Each thermocouple determines the difference in temperatures from sand and fixed source and sensitivity.

**The method of work:**

1- The depth of the thermocouples placed in the cylinder was measured at a constant level using a ruler, ie:

  

2- Place the hot and cold cylinders over the sand in succession for ten minutes each. When placing the hot cylinder, read For every two minutes until you complete the period (ten minutes), as well as reading them when you put the cold cylinder, your output will be recorded in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| 5 | 6 | 4 | 2 | الإسطوانة الساخنة |
| 4 | 5 | 3.5 | 4 |  |
| 3 | 4.5 | 3 | 6 |  |
| 2 | 3 | 2.5 | 8 |  |
| 1.5 | 3.5 | 2 | 10 |  |
| 1.6 | 1.5 | 1 | 12 | الإسطوانة الباردة |
| 2 | 2 | 1.5 | 14 |  |
| 3 | 2.6 | 2 | 16 |  |
| 3.8 | 3.5 | 3 | 18 |  |
| 4 | 3.8 | 4 | 20 |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

3- When reaching a stable state Find the amplitude of the wave  per thermocouple through  And from it find the value  for each double then it find the value  As in the following table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | السعة = |  |  |  | المزدوج الحراري |
|  |  |  |  |  |  | 1 |
|  |  |  |  |  |  | 2 |
|  |  |  |  |  |  | 3 |

4- Find the coefficient of thermal aging **(k)** From the following equation:



Whereas ***t*** The oscillation time (changing the hot and cold cylinders) is ten minutes.

5- find average  For each double, once you reach a stable state, paint with depths. Discuss the graph.

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