Birzeit University

Physics Department

Phys211

Experiment #9

**Thermal Conductivity**

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**Abstract**

**The Aims of the experiment**

* To understand the thermal properties of the insulating materials.
* To determine the thermal conductivity of ebonite and glass using lee’s disk method.

**The method used**

By using the apparatus in the lab that consists of a heavy copper disk C suspended from a firm stand, and by placing the ebonite disk on the top of the disk C and the ebonite was heated by passing steam through a hollow cylinder which is placed on the top of the ebonite.

**The main result**

$$k=0.0195\pm 0.0004 cal/ (sec.m.C)$$

**Data**

T2= 40 C

T1 = 68 C

|  |  |  |
| --- | --- | --- |
| **Temp.(C)** | **time** | **t (sec)** |
| 56 | 00:00 | 0 |
| 54 | 1:42 | 102 |
| 52 | 4:07 | 247 |
| 50 | 6:04 | 364 |
| 48 | 8:28 | 508 |
| 46 | 10:28 | 628 |
| 44 | 12:38 | 758 |
| 42 | 15:36 | 936 |
| 40 | 18:58 | 1138 |
| 38 | 22:45 | 1365 |
| 36 | 27:06 | 1626 |
| 34 | 31:38 | 1898 |

**D** = 36.5/3.14 = 11.6183108457 = 11.6 $\pm 0.1$ cm

**Thickness** = 3.92 $\pm 0.01 mm$

M = 985 $\pm 5$ g

**Calculations**

In the steady state , the rate at which slab C loses heat to the surrounding through its surface is equal to the rate of heat transfer through the ebonite.

$$\frac{dQ}{dt}=kA \frac{T\_{1}-T\_{2}}{d}=MC \left(\frac{dT}{dt}\right)\_{T\_{2}}$$

$$k= \frac{4 M C d (\frac{dT}{dt})\_{T\_{2}}}{πD^{2}(T\_{1}-T\_{2})}$$

K : the thermal conductivity of ebonite

A : the area of ebonite disk

D : the diameter of ebonite disk

d : the thickness of ebonite disk

$T\_{1},T\_{2}:$ the steady state temperatures

C : the specific heat of copper

$\left(\frac{dT}{dt}\right)\_{T\_{2}}$: the rate of change of the temperature at T2

M : the mass of the copper disk

|  |  |
| --- | --- |
| Temp. (C) | t (sec) |
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$\left(\frac{dT}{dt}\right)\_{T\_{2}}=54.989\*3\*10^{-4}e^{-3\*10^{-4}\*40}= $0.016299922

$k= \frac{4 M C d (\frac{dT}{dt})\_{T\_{2}}}{πD^{2}(T\_{1}-T\_{2})}$ = 1.37375\*10^-6 = 0.0195 cal/ (sec.m.C)

$$\frac{∆k}{k}=\frac{∆M}{M}+\frac{∆d}{d}+\frac{∆slope}{slope}+ 2\frac{∆D}{D}+\frac{∆T1+∆T2}{T1-T2}$$

$\frac{∆k}{k}=\frac{5}{985}+\frac{0.01}{3.92}+\frac{2}{45}+\frac{1}{797.5}+ 2\frac{0.1}{11.6}+\frac{2+2}{28}$

$\frac{∆slope}{slope} $ =$\frac{∆T}{T\_{avg}}+\frac{∆t}{t\_{avg}}=\frac{2}{45}+\frac{1}{797.5}=0.0457=0.05$

$\frac{∆k}{k}=0.2\*0.0195=0.0004$ cal/ (sec.m.C)

$$k=0.0195\pm 0.0004 cal/ (sec.m.C)$$

**Conclusion**

$$k=0.0195\pm 0.0004 cal/ (sec.m.C)$$

$$K\_{theo.}=0.17\frac{w}{m}.k=0.0406\frac{cal}{sec.m.C}$$

D = 0.0406-0.0195 = 0.0211

**D >2**$∆k$ (not acceptable)

There were many sources of error in this experiment

* The ebonite disk is not exactly cylindrical so using the diameter is not that accurate in calculations
* There was an air layer between the ebonite disk and the copper disk which affected the heat transfer between the disks .
* The weighing scale that used was not accurate.
* The temperatures were not the exact steady state ones we had to wait more time