(HT1-8) Thermal Conductivity of Insulators, Lee's Disk Method

Aim of experiment

Determination of the conductivity of a bad conductor in the form of a disk

Apparatus

Lee's Apparatus- Thermometers T_1, T_2 – Stopwatch - Bad Conductor in the Form of a Thin Sheet - Micrometer Gauge- Vernier Caliper- Hot Plate.

Theory of experiment

In this case the apparatus consists of a steam chamber S to which a thick brass plate A is attached. C is a similar brass plate and the disk B of the material under test is placed between A and C. A steam current is passed in the chamber S until the temperatures T_1 and T_2 of the two plates A and C become constant.

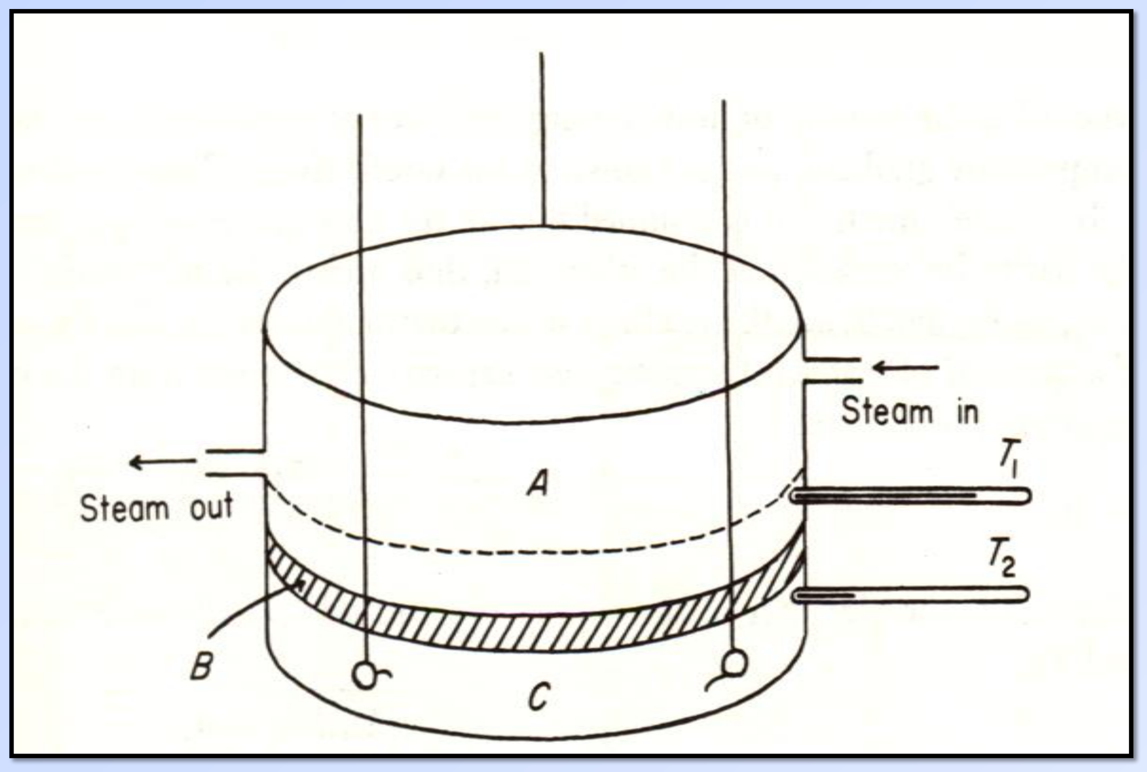

Figure 1. A schematic diagram of Lees disk experiment

The heat rate transferred through the disk is given by:

$$\frac{dQ}{dt} = K\pi r^2 \frac{T_1 - T_2}{d}$$

where *r,* and *d* are the radius and thickness of disk B respectively. Also in the steady state an amount of heat equal to that flowing per second (*dQ/dt*) through the disk B is lost by radiation from the exposed surface of the disk C. If the mass of the disk C, *m* (gm), is known, its specific heat is *S*, and its rate of cooling at T_2 ^oC is $(d\,T/dt)_{T2}$, the rate of cooling can be obtained by removing the disk A and then the plate C is heated to a temperature 10 ^{o}C higher than T_2 and allowed to cool and then drawing the cooling curve for disk C and deduce the rate of cooling *(dQ/dt).*

$$\frac{dQ}{dt} = mS\left(\frac{dT}{dt}\right)_{T_2} \qquad (2)$$

From equation (1) and equation (2)

$$K = \frac{mS(dT/dt)_{T_2}}{\pi r^2 (T_1 - T_2)/d} \qquad (3)$$

From which *K* can be calculated.

Procedures

1. Arrange the apparatus as shown *in figure 1.*
2. Pass a current of steam in chamber S, inserting the two thermometers in the holes in A and C.
3. When the steady state is reached record the two temperatures T_1 and T_2.
4. Remove the steam chest, but leave B in place, and warm the disk C with a the hot plate until its about 10^{o}C above the temperature reached before.
5. Allow C to cool, taking the temperature at frequent intervals (0.5 min.) until it has fallen about 20^{o}C
6. Plot the cooling curve from the results obtained in step (5). Then calculate the slope of this curve (*dT /dt) at* T_2.
7. Measure the diameter *D=2r* of the disk B with a cal1iper, and its thickness *d* with a micrometer gauge.
8. Find the mass of the disk C.
9. Calculate the coefficient of thermal conductivity of bad conductor *K* from the equation:

$$K = \frac{mS(dT/dt)_{T_2}}{\pi r^2 (T_1 - T_2)/d} \quad Cal./sec./cm./^oC$$

Results

Cooling curve data

t (min)								
T (°C)								
t (min.)								
T (°C)								

T_1 at steady state = ^{o}C
T_2 at steady state = ^{o}C
Diameters of the disk, B, (bad conductor) *D = 2r =* *cm.*
Thickness of the disk B *d =* *cm.*
Mass of metal slab, C, *m=* *gm*
Specific heat capacity of slap C *S =0.244 cal./gm./^{o}C*
From the graph $(dT/dt)_{T2}$ = ^{o}C/sec
Then: *K=* *Cal./sec./cm./^{o}C*

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