EXPERIMRNT 1: TO FIND OUT THE THERMAL CONDUCTIVITY OF INSULATING POWDER.

Theory

The apparatus consists of two thin walled concentric copper spheres. The inner Sphere houses the heating coil. The insulating powder (Asbestos powder – Lagging Material) is packed between the two shells.

The powder supply to the heating coil is by using a dimmer stat and is measured by Voltmeter and Ammeter. Thermocouples are used to measure the temperatures. Thermocouples (1) to (4) are embedded on inner sphere and (5) to (8) are as shown in the fig. Temperature readings in turn enable to find out the Thermal Conductivity of the insulating powder as anisotropic material and the value of Thermal Conductivity can be determined.

Consider the transfer of heat by conduction through the wall of a hollow sphere formed by the insulating powdered layer packed between two thin copper spheres
Let,
R_i= Radius of inner sphere in meters=0.0375m
R_o= Radius of outer sphere in meters=0.125m
T_i= Average Temperature of the inner sphere in °C
T_o= Average Temperature of the outer sphere in °C

Where, $T_i = \frac{T_1+T_2+T_3+T_4}{4}$

$T_o = \frac{T_5+T_6+T_7+T_8}{4}$

Note that

T_1 to T_8 temperature of thermocouples (1) to (8)
Form the experimental values of Q, T_i and T_o the unknown thermal conductivity K can be Determined as …

$$K = \frac{Q\,(R_o - R_i)}{4\,\pi R_o \times R_i \times (T_i - T_o)} \quad \text{w/m k}$$

Instrument Image

Specifications

1. Radius of the inner copper sphere, R_i = 37.5mm
2. Radius of the outer copper sphere, R_o = 125mm
3. Voltmeter – (0 – 260 V)
4. Ammeter - (0 – 2 Amp)
5. Temperature Indicator 0 – 300 ℃ (8 channel)
6. Dimmer stat 0 – 2A, 0 – 230 V.
7. Heater coil - Strip Heating Element sandwiched between mica sheets – 200 watts.
8. Chromel Alumel Thermocouples –

No. (1) to (4) embedded on inner sphere to measure T_i.

No. (5) to (8) embedded on outer sphere to measure T_o.

9. Insulating Powder – asbestos powder Packed between the two spheres.

Experimental Procedure

1. Start main switch of control panel.
2. Increase slowly the input to heater by the dimmer stat starting from zero volts Position.
3. Adjust input equal to 100 Voltmeter Max. by Voltmeter and Ammeter.

   W= VI
4. See that this input remains constant throughout the experiment.
5. Wait till fairly steady state condition is reached. This can be checked by reading

Temperatures of thermocouples (1) to (8) and note changes in their readings with Time.

6. Note down the readings in the observations table as given below.\

Observation

1. Voltmeter reading (V) = _____Volts.
2. Ammeter reading (I) = _____Amps.

Inner Sphere

Thermocouple no	1 T_1 ˚c	2 T_2 ˚c	3 T_3 ℃	4 T_4 ˚c	$T_i = \frac{T_1+T_2+T_3+T_4}{4}$
1					
2					
3					

Outer Sphere

Thermocouple no.	5 T_5 ˚c	6 T_6 ˚c	7 T_7 ˚c	8 T_8 ˚c	$T_o = \frac{T_5+T_6+T_7+T_8}{4}$
1					
2					
3					

Calculation

Heater Input

Q = V x I Watts

Thermal Conductivity

$$K = \frac{Q\,(R_o - R_i)}{4\,\pi R_o \times R_i \times (T_i - T_o)} \quad w/m\,k$$

Conclusion

Marks Obtained **Sign of Faculty**