UNIVERSITI TEKNIKAL MALAYSIA MELAKA		No Dokumen	No Isu / Tarikh 0 / 01-10-2018
HEAT TRANSFER **Radial Heat Conduction**		No Semakan / Tarikh 0 / 01-10-2018	Jum. Mukasurat 3

OBJECTIVES

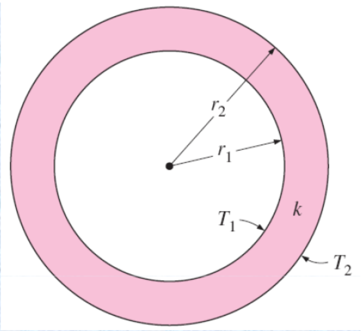
1. Determine the thermal conductivity (*k*) of a brass specimen by using radial heat conduction.

INTRODUCTION

Thermal conduction is the transfer of heat energy in a material due to the temperature gradient within it. It always takes place from a region of higher temperature to a region of lower temperature. A solid is chosen for the experiment of pure conduction because both liquids and gasses exhibit excessive convective heat transfer. For practical situation, heat conduction occurs in three dimensions, a complexity which often requires extensive computation to analyze. For experiment, a single dimensional approach is required to demonstrate the basic law that relates rate of heat flow to temperature gradient and area.

THEORY

According to Fourier's law of heat conduction: If a cylinder with radius r_1 and r_2 and temperature T_1 and T_2 then the heat transfer rate per unit time (Q) by conduction through the wall can be determined as follows :



$$\dot{Q}_{\text{cond, cyl}} = 2\pi Lk \frac{T_1 - T_2}{\ln(r_2/r_1)} \qquad \text{(W)}$$

PROCEDURE

1. Radial heat conduction experiment setup and the schematic diagram of the construction of the apparatus as shown in **Figure 1** and **Figure 2**, respectively.

Figure 1 : HT12 Radial Heat Conduction Unit

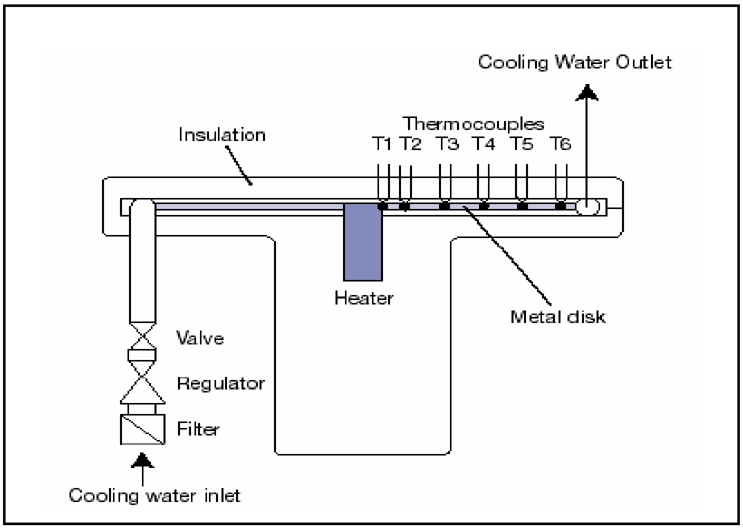


Figure 2 : Schematic diagram showing construction of HT12

2. Switch on the front mains switch A.
3. Turn on the cooling water and adjust the water discharge approximately 1.5 litres per minute. The actual flow can be checked using a stopwatch and measuring cylinder.
4. Set the Heater Voltage to 12 Volts. Adjust the voltage control potentiometer to 12 volts on the top of panel meter with the selector switch set to position V.
5. When the temperatures are stable record the current temperatures T1, T2, T3, T4, T5, and T6 using the selector switch to select each required value in turn.
6. Set the Heater Voltage to 17 Volts using the same method as before. Allow the HT12 to stabilise then repeat the above readings.

7. Set the Heater Voltage to 21 Volts using the same method as before. Allow the HT12 to stabilise then repeat the above readings.
8. Set the Heater Voltage to 23 Volts using the same method as before. Allow the HT12 to stabilise then repeat the above readings.

Results and Disscussion

Let V = Heater Voltage (volts), I = Heater Current (amperes), Heat Flow, Q (watts)

T1 = Temperature at 7 mm radius (inside)
T2 = Temperature at 10 mm radius
T3 = Temperature at 20 mm radius
T4 = Temperature at 30 mm radius
T5 = Temperature at 40 mm radius
T6 = Temperature at 50 mm radius (outside)

Radius at thermocouple T1 R1 = 0,007 (m)
Radius at thermocouple T6 R6 = 0.050 (m)
Thickness of disk (sylinder length) L = 0.0032 (m)

The necessary data for calculations will be recorded to the table given below.

VOLTS	AMP	Q	T1	T2	T3	T4	T5	T6
V	I	W	°C	°C	°C	°C	°C	°C
Radius (mm)			7	10	20	30	40	50

For each set of readings plot a graph of temperature against radius. Observe that each temperature profile is a curve and that the gradient at any point on the curve decreases with increasing radius from the heater at the centre.

Calculations: Using the equation given below, calculate the thermal conductivity.
Thermal conductivity is defined as:

$$k = \ [Qln\frac{r_2}{r_1}]/[\ 2\pi L(T_1 - T_2)]$$

Calculate the thermal conductivity of the brass disk using two different radius and corresponding temperatures. Compare the value obtained with the original value at the same heat flow.

Conclusion :

1. Compare the value of thermal conductivity, *k* of brass obtained from linear heat conduction experiment and calculate the percentage difference.
2. Calculate the percentage difference between the theory and experimental value of thermal conductivity, *k*.
3. Based on the result obtained, which experiment (linear/radial) is more accurate. Explain your answer.