

CHME 302 CHEMICAL ENGINEERING LABORATORY - I
EXPERIMENT 302-4
ONE-DIMENSIONAL STEADY-STATE HEAT CONDUCTION

OBJECTIVE

The objective of the experiment is to find the thermal conductivity of a given material and to demonstrate the effect of the thermal contact resistance at the contact surfaces of adjacent slabs of the same material.

PRELIMINARY WORK

1. Study the basic principles of heat transfer by conduction
2. Visit the lab. in advance to experiment and familiarize yourself with the experimental set-up with the consent of the teaching assistant.

DESCRIPTION OF THE EXPERIMENTAL SET-UP

The experimental set-up is composed of two units for two sets of experiments. First unit is for linear conduction experiment which is shown in Fig 1. It has three brass bars (slabs), each of 25 mm in diameter. The mid-slab is 30 mm in length (Please note the location of the coordinate system). The bar at the left is heated from the left-hand side by means of electrical resistance, and the bar at the right is cooled from the right-hand side by means of tap water. The bars are clamped together side by side in the axial direction. Three temperature sensors (Model: TD5A) are installed in each bar at 10 mm intervals along the bar axis (Nine temperature sensors in total). The bars are insulated peripherally to prevent the heat losses and to obtain a one-dimensional heat flow in the axial direction.

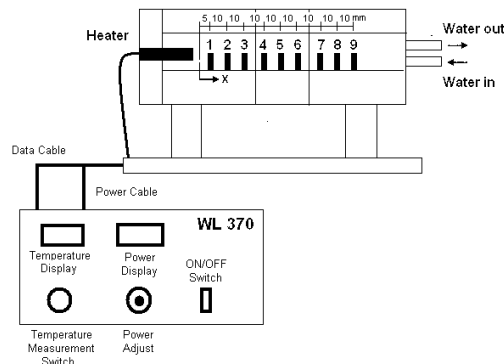


Fig 1. Linear conduction unit

The second unit is for radial conduction experiment. It has a disc with a diameter of 110 mm, and 4 mm thick. The system is heated by means of a heater located at the center, and cooled by tap water that is circulating along the outer diameter of the disc (Fig 2). The disc is insulated from the bottom and top surfaces to ensure one-dimensional heat transfer in the radial direction. Six temperature sensors (Model: TD5A) are installed along its radius.

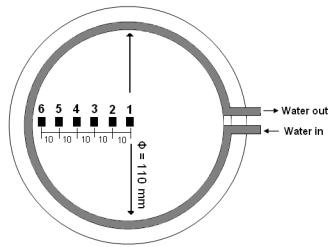


Fig 2. Radial conduction unit

The instrumentation permits the measurement of the temperatures and the power input. The heater power input can be adjusted between 0-100 W and it has a direct readout on the front panel of the set-up console. Each of the temperature probes gives a direct digital readout in °C on the panel. A selector switch allows display of any of the temperature sensor readings.

EXPERIMENTATION

During the experiments, the power input value and the temperature readings for both units need to be recorded.

Procedure

For linear conduction unit:

1. Turn on the power and adjust a power input value.
2. Wait until the system reaches the steady-state.
3. Record the nine temperature values and the power input value.

For radial conduction unit:

1. Turn on the power and specify a power input value.
2. Wait until the system reaches the steady-state.
3. Record the six temperature values and the power input value.

Analysis

For linear conduction unit:

1. Plot the temperature distribution through the three bars on a graph paper (T vs x).
2. Calculate the thermal conductivity value of each brass bar from the temperature gradient value.
3. Compare your results with typical k values for brass given in the property tables of your textbook (note that brass is an alloy of copper and zinc) and discuss your results.
4. Calculate the thermal contact resistance at each of the two interfaces and discuss your results.

For radial conduction unit:

1. Plot the temperature distribution through the three bars on a graph paper (T vs $\ln r$).
2. Calculate the thermal conductivity value of brass disc from the temperature gradient value.
3. Compare your results with typical k values for brass given in the property tables of your text-book and discuss your results

Name:

Date:

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DATA SHEET

Linear Conduction Experiment:

Power Input: _____ W

TEMPERATURE READINGS (°C)								
1	2	3	4	5	6	7	8	9

Radial Conduction Experiment:

Power Input: _____ W

TEMPERATURE READINGS (°C)					
1	2	3	4	5	6