MET 466 – THERMAL PROCESSES LAB

LAB #1 – Group 2
One-dimensional Transient Heat Conduction

Assigned: 2/6/08
Due: 2/20/08

Location of Equipment:

The apparatus for this experiment are located in the Heat Exchanger Room (EPS 008A).

Description of Experiment:

This experiment is intended to show how temperature is distributed through an insulated, solid metallic bar subjected to a fixed temperature difference across the length of the bar. The student should be able to analytically predict the average behavior and explain the deviations of the experimental data from the analytical assumptions.

The apparatus for this experiment consists of a 12 inch long solid metallic bar insulated over its length. Imbedded in the solid bar at progressive intervals are type T thermocouples which will indicate temperature of the bar. The thermocouple locations are as indicated in figure 1 shown below. One end of the bar is exposed to moderate pressure steam condensing on the end of the bar. The opposite end of the bar is subjected to a flow of water from the building supply piping. The established fixed temperature difference across the bar causes a one-dimensional conduction heat transfer through the bar. The thermocouples in the bar are connected to a computer data acquisition system which will read the millivoltage signals generated by the thermocouples and will convert those signals to a temperature indication. These temperatures will be acquired by the data acquisition system and should be exported to an Excel spreadsheet for further analysis. The brass bar has an outside diameter of 0.875 inches while the aluminum bar has an outside diameter of 1.254 inches.

Figure 1: Heat Conduction Apparatus

A = 2.0 inches
B = 1.0 inches
C = 0.5 inches

Experimental Procedure:

Initially the thermocouples should be checked for function by running the data acquisition program while the bar is at room temperature. The indication should read about $68^{o}F$ uniformly. The steam supply line should be charged by opening the appropriate steam supply and condensate valves. The metallic bar should be covered with the roll of fiberglass insulation to minimize the convection losses in order to provide conditions for the one-dimensional conduction assumptions. The building water supply line should be turned on to cool the opposite end of the bar. Once the bar has stabilized its temperature distribution the temperature data should be recorded.

Results:

1. Plot this data and obtain a second order polynomial curve fit equation for the temperature distribution. Be very careful with the units you use in the plot and the resulting curve fit.

2. Using the thermal conductivity, k, for the given bar, and the temperature data obtained, calculate the heat transfer rate locations 1-2, 1-4, 1-7, 1-10, 3-9, and 5-7.

3. Compare the heat transfer rates calculated in #2 and explain any differences in the results obtained.

4. Does your plot in #1 make sense? Why?

(Note: Reference all thermophysical properties)