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***NUCL 355* Nuclear Thermal-Hydraulics Laboratory**

## Experiment 10: Transient Heat Conduction

**Objective:** To study the transient heat conduction in an aluminum slab and in a stainless steel slab during sudden immersion and to compare the data with the lumped parameter model. To estimate the heat transfer coefficient as a function of time based on these comparisons.

**Preparation:** Read the reference material and these instructions then perform the experiment with your assigned group.

**Experimental Apparatus:** The experimental apparatus is illustrated in figures 1 through 3. It contains a slab heating section and an airflow cooling section. Two slabs of 1 inch in thickness each made of stainless steel and aluminum material are used in this experiment. The slabs are instruments with seven type T thermocouples of gauge 36 AWG. In figure 2 the locations of the thermocouples junction in the slab are shown. The slab (2) is sandwiched between two vertical plate electric heaters (3). The slab is suspended on a handle shaft assembly (4) and can be lowered in to the airflow tank (1) or raised with the handle shaft assembly. The air flow is produce by an air blower located behind the tank. A type T thermocouple is also provided to measure the temperature of the air in the tank.
The data acquisition system consists of a thermocouple signals conditioner (1) an A/D converter (2) and a PC computer (3) as shown in figure 3. The signal conditioner basically provides a reference temperature (electronic ice point), a magnification of 200 of the thermocouple output voltage and a lead connector. The A/D converter is an analog to digital converter for multichannel signals. The data acquisition program is written in EXCEL, which collects the data for plotting and analysis.

**Procedure:**

1. Turn on the PC data acquisition system (DAS). Open from the Start menu Programs>>ComputerBoards>>Instacal. Double click on board #1 to check settings. Check data acquisition system for proper connections to the thermocouple leads.
2. Open EXCEL program and check DAS operation.
3. Connect the test slab on to the hand shaft assembly (4) and see whether it can be easily raised or lowered into the tank
4. Sandwich the test slab between the heater plates. Make sure the slab surface is in good contact with the heater surface. For this make use of holding system (5) to clamp tightly the slab between heaters.
5. Start the power to the heaters and heat the test slab. Start the EXCEL program.
6. Heat the slab to 100°C. Monitor with EXCEL program.
7. Once the slab reaches 100$^{o}$C turn off the heaters.
8. Start collecting data in a new file with the data acquisition system.
9. Turn on the blower.
10. Then, remove the holding system (5), pull the heaters apart and lower slab into air flow tank with hand shaft assembly.
11. Do the same for the other slab.
12. Note all of the equipment used and their functions.

**Precautions:**

1. Do not disturb the computer data acquisition process while taking data.
2. Make sure all thermocouple wires are connected to the screw terminal.
3. Make sure that the metal slab is well sandwiched between the two heater surface making complete contact.
4. Handle carefully the heated slab while lowering down into the water bath; avoid direct contact of the heated slab with hands.
5. Shut down heaters immediately after heating is complete.

**Report:**

Plot the data in a semi-logarithmic coordinates. From the plot determine the time constant. From the time constant determine the heat transfer coefficient. Discuss any correlation of the heat transfer coefficient that you can find in the literature (i.e.: Incropera and De Witt, “Jet impingement”, pp 428-434)

Note: Check the validity of the lumped parameter model for both cases.

**References:** Incropera and De Witt, Fundamentals of Heat and Mass Transfer, 5$^{th}$ Ed., Chapter 5.

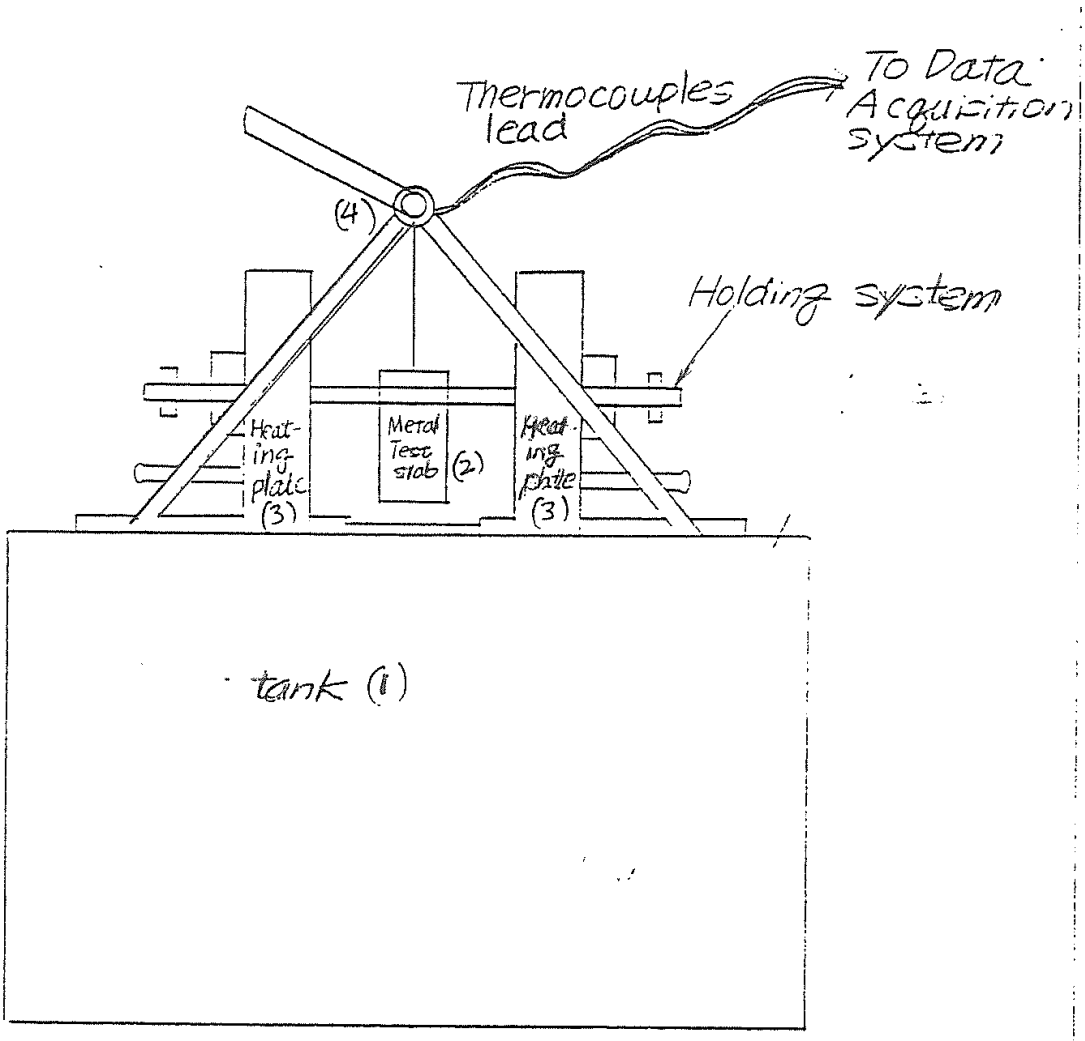


**Figure 1. Heating Slab and Cooling Tank , Tank (1), Slab (2) , Heating Plates (3) Slab Lowering (4), Air blower, Holding System , DAS System**

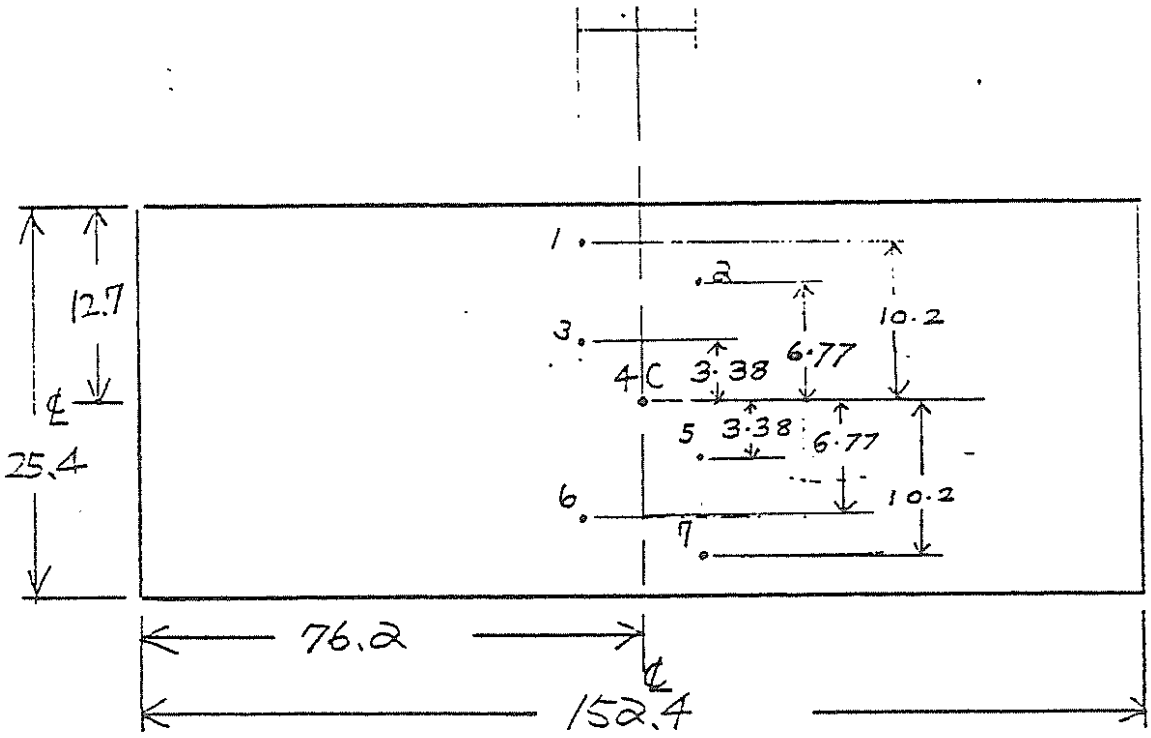


**Figure 2. Block Dimensions and thermocouple positions**

1. **All Dimensions are in millimeters**
2. **The height of the block is 152.4 mm**
3. **Thermocouples are T-type-placed 76.2 mm from the top of the AL block and 65.6 mm from the top of the SS block**

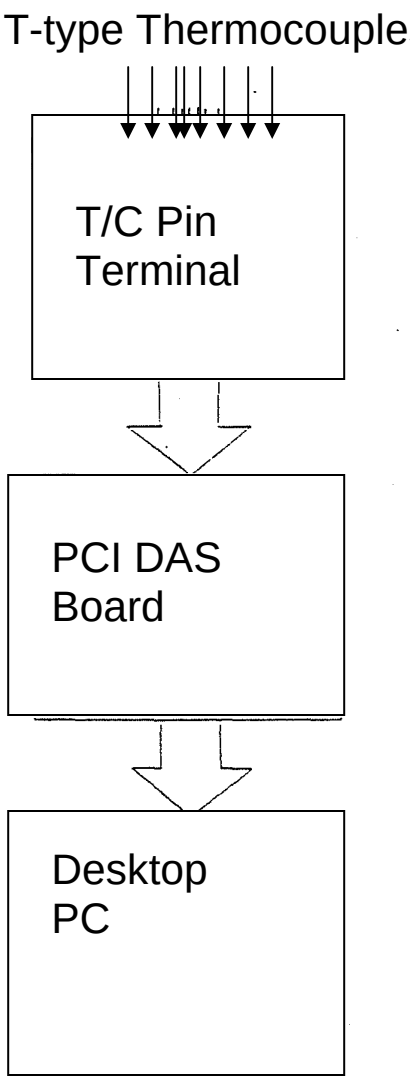


**Figure 3. DAS system Consist of T/C connector board, A/D converter Board (in PC) and PC with data acquisition in EXCEL program**