MET 466 – THERMAL PROCESSES LAB

LAB #6
Convective Heat Transfer for a Cylinder in Cross-Flow

Assigned: 4/9/09
Due: 4/23/09

Location of Equipment:

The apparatus for this experiment is located near the West wall of EPS 008.

Description of Experiment:

A heated copper cylinder is installed across a rectangular duct. Air is pulled through the duct and around the cylinder by an air blower. The surface temperature of the cylinder is measured by a single type T thermocouple junction which is soft soldered to the surface. For demonstration purposes only, the output of the thermocouple will be measured by a digital thermometer. During the actual experiment, the temperature indicated by the thermocouple will be obtained by the data acquisition system.

The heating element in the copper cylinder is connected to a variable transformer. For demonstration purposes only, the power input to the heating element is measured by a wattmeter. During the actual experiment, the power input to the cylinder will be determined by the data acquisition system by separate measurement of the AC voltage and current supplied to the heating element. The current measurement is obtained by the measurement of the voltage drop across a current sampling resistor with approximately 1 ohm resistance. The temperature of the heating element is controlled by varying the voltage applied to the heating element.

A vortex shedding flowmeter is installed between the blower and the rectangular duct. In addition to a direct reading of the air flow rate, the flowmeter supplies a DC voltage output which is linearly related to the indicated flow rate. The air flow rate is controlled by manipulation of valves on the air blower.

Most of the equipment will be demonstrated by the instructor.

DO NOT ALLOW THE TEMPERATURE OF THE CYLINDER TO EXCEED 300 ^{0}F (149 ^{0}C) AT ANY TIME. NEVER OPERATE THE ELECTRIC HEATING ELEMENT WITHOUT A MEANS OF MEASURING THE TEMPERATURE OF THE CYLINDER.

Results:

Obtain a forced convection heat transfer correlation of the form shown in equation 7.44 on page 402 of your "Introduction to Heat Transfer, Fifth Edition" textbook.

Using equation 7.44 calculate the Nusselt number (Nu_D) for each air flow rate setting.

Compare the experimentally determined Nusselt number (Nu_D) with the calculated Nusselt number from equation 7.44. Place these numbers in a table and calculate the percent error between the experimental and analytical values. Discuss your findings.