**Procedure**

The first steps to operating the LHCM is to check that the data acquisition system is saving data via serial communication, and calibrating all thermocouples with an ice bath. An ice bath is prepared by placing the sump pump inside the cooler and carefully filling it with ice as tightly as possible. This ensures that the ice bath achieves a value as close as possible to 0°C throughout the ice bath container. Then, water is added into the cooler to fill the gaps between the ice and pump. Thermocouple calibration is accomplished by immersing each thermocouple in the ice bath, reading a temperature close to 0°C from the serial COM port of the Arduino, and waiting until steady-state to ensure the thermocouple can register an isothermal temperature. The merged water pump supplied cold water from the ice-water mixture at a temperature under 2 °C constantly throughout the experiment. The ends of the closed loop tubing were inserted into the apparatus by pushing the tubing until it couldn’t be inserted anymore.

The assembly of three modules of the apparatus, the sample, and the insulative sleeve was constructed by applying the conductive thermal paste on each end before stacking the modules. The assembled heat tower was placed in the center of the insulative sleeve. Next, all thermocouples were fastened to the sample being tested and the [PUT TESTED SAMPLE HERE]conduction paths by inserting the thermocouple through the insulation sleeve and into the center of the cylindrical apparatus until the thermocouple could not be pushed in further.

Next, the insertion heater was powered to 30, 40, and 50W with a variable transformer and wattmeter. If a thermo-controller were included in the setup, the PID controller’s alarm could be set to 200°C. This ensures the PTFE, rated up to 260°C (500°F) does not melt. If the PID controller turns off the insertion heater, the user must stop collecting data and wait until the PID controller turns the heater back on, and the system achieves a steady state again. This is because once the heater is off, the system no longer has a constant heat flux, and therefore the Fourier equation cannot be used to solve for k.

Finally, the user should wait until the temperatures sensed by the two thermocouples in the sample each do not vary by more than 0.5°C over 5 minutes. Once that threshold was reached, the system was deemed to have come to a steady state. The steady-state temperatures were then recorded. Some key aspects of the experiment that were monitored for safety included the maximum surface temperature of the insertion heater, to ensure that it was operating at safe temperatures, well below the melting point of the PTFE. Another key aspect of the experiment that needed to be monitored was ensuring that there was plenty of ice in the ice bath. As ice was visually observed to melt, more ice could be continuously added while the temperature of the water pumped out of the ice bath was closely monitored.

The sample was placed between the upper heated conduction path and the lower cooled conduction path. The sump pump inside the ice batch was turned on. The in-line outlet thermocouple should read the same temperature at steady-state

The three modules of the heat tower and the sample were assembled, and the thermal paste was applied between the gaps of each module to minimize the uncertainties. The array of [8] thermocouples was inserted into the heating tower, which collected data with I2C protocol with Arduino. The heat tower was placed inside an insulative sleeve of PVC pipe. The merged water pump supplied cold water from the ice-water mixture at a temperature under 2 °C constantly throughout the experiment. The heat source of the electric heater was placed inside the tower. Change of temperature was collected at the rate of [check system protocol].