THERMODYNAMICS AND TRANSPORT LABORATORY

TA INSTRUCTIONS FOR THE HEAT EXCHANGER BASICS LAB

Ch En 385 – Knotts

Overview

- Students should spend about 1 hour in the lab. Part of this will be doing experiments, but make sure they are answering the analysis questions during waiting periods.
- You should have the apparatus set up to run on the smallest, plate heat exchanger before the students arrive. You do not need to have the apparatus running as it comes to steady state moderately quickly.
- Both streams are mostly water, but the chilled stream has some corrosion inhibitors and phenolphthalein.
    - See the pre-lab for more information on the compounds.
    - The corrosion inhibitors make the chilled water slightly basic.
    - Phenolphthalein is a carcinogen, but it is safe at the concentrations in the chilled water. It is commonly used in titrations as has been used as a laxative for centuries.
    - Make sure to review the SDS/MSDS sheets for these compounds
- You will need to move the supply and return connections to the exchangers during this lab. You as the TA should do this, not the students.
    - Some of the liquid in the streams will spill when you open the connections.
    - Wear gloves while moving the connections.
    - Clean up any spills after the connections are secure.
- Before operating the equipment alone, you should have passed it off with either Dr. Knotts, Will Davis, or Mike Beliveau.

General Instructions

1. Do the following to prepare for students.
    a. Learn how to run the equipment and pass off your understanding with either Dr. Knotts, Mike Beliveau, or Will Davis.
    b. Perform the experiments that the students will do.
2. You should have set up specific times (5 hours a week) for students to perform the experiments. You will be in the lab during these times.
3. You will setup the apparatus before each lab hour following the instructions below.
4. After students are finished with the lab, you will shut down the apparatus following the procedures below.
5. You can grade assignments when in the lab and not answering student questions; however, you should be closely monitoring the students.
    a. Keep them on task.
    b. Ask questions to deepen understanding.

Apparatus

Figure 1 is a picture of the apparatus. Notice the following.

1. Three rotameters are used to control the flow and are labelled: *Hot Water*, *Cold Water*, and *Chilled Water*.
    a. The inlet and outlet for each rotameter are on the back of the device.
    b. The bottom is the inlet and is connect to a supply line on the wall.
    c. The top is the outlet and is connected to one of the inlets of a heat exchanger.
2. The *Hot Water* and *Cold Water* outlets combine before entering an exchanger. This gives you control over the *hot inlet* temperature to the exchanger.
3. The *Chilled Water* is supplied by the Central Heat Plant on campus. (This is the same water used to air condition the buildings in the summer.)
4. The inlets (*hot* and *cold*) to each heat exchanger are on the side closest to the rotameters (in the foreground of Figure 1.
5. The outlets (*hot* and *cold*) of each heat exchanger on the side farthest from the rotameter (in the background of Figure 1.
6. The *hot* and *cold* sides of the exchangers have different connections to ensure they cannot be connected incorrectly.

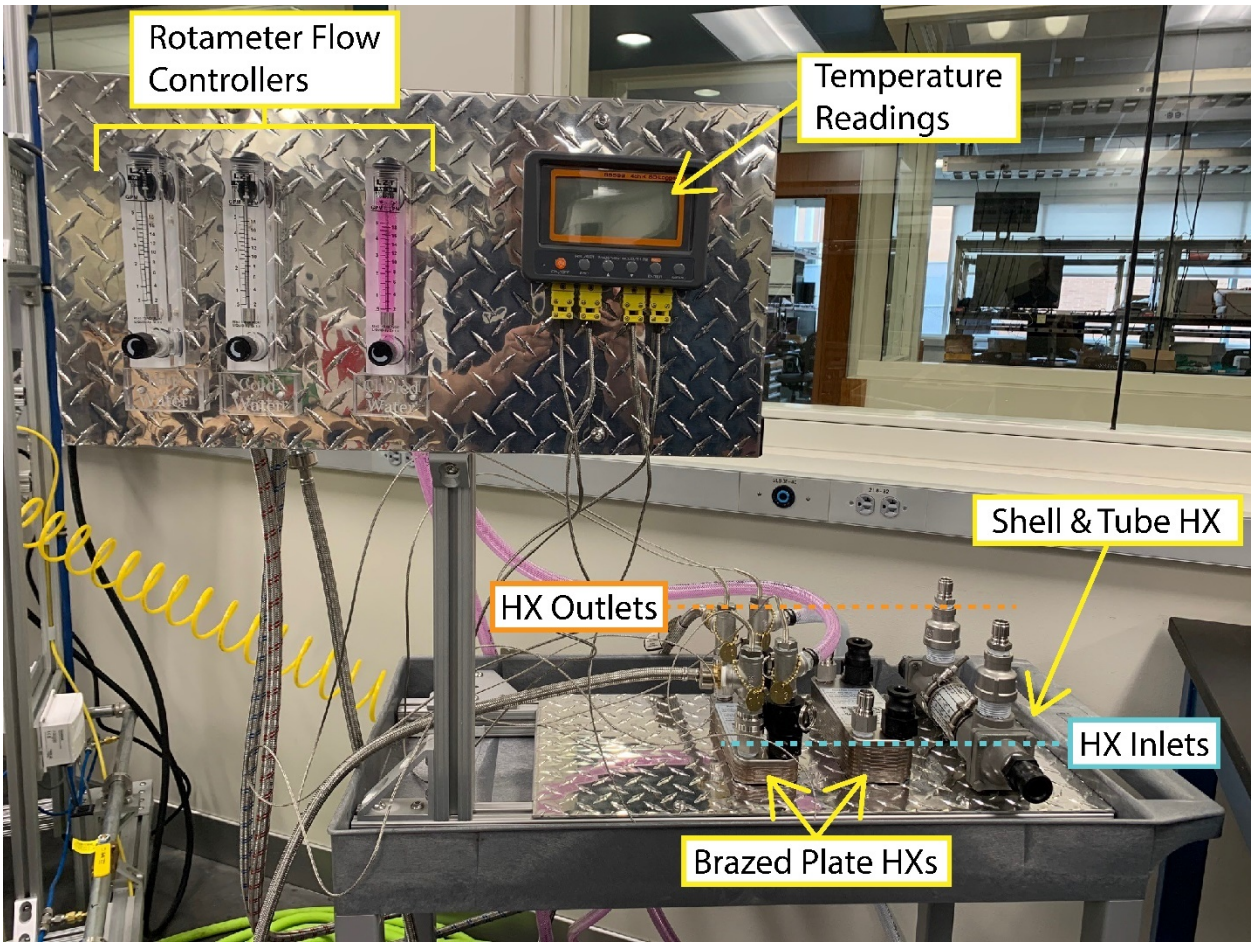

Figure 1 Picture of experimental apparatus.

As mentioned above, the inlet to the rotameters come from connections on the wall. These connections are shown in Figure 2.

Figure 1 is a picture of the wall connections. Each connection is labeled with a brass tag as follows.

- PCHWS: Process CHilled Water Supply—The *cold stream* inlet.
- PCHWR: Process CHilled Water Return—The *cold stream* outlet.
- IHW: Industrial Hot Water—One part of the *hot stream* inlet.
- ICW: Industrial Cold Water—One part of the *hot stream* inlet.

Also note that the *hot stream* outlet of the heat exchanger connects to a floor drain (not pictured).

The chilled water runs in a closed loop. This means that the "heated" chilled water is returned to the heating plant. The *hot inlet* stream, comprised of the IHW and the ICW, is returned to the drain.

As explained above, the three *inlet* streams (PCHWS, IWH, and ICW) connect to the *bottom* of the three rotameters. The PCHWR connects to the *outlet* of the heat exchanger. The floor drain (not pictured) connects to the *outlet* of the heat exchanger.

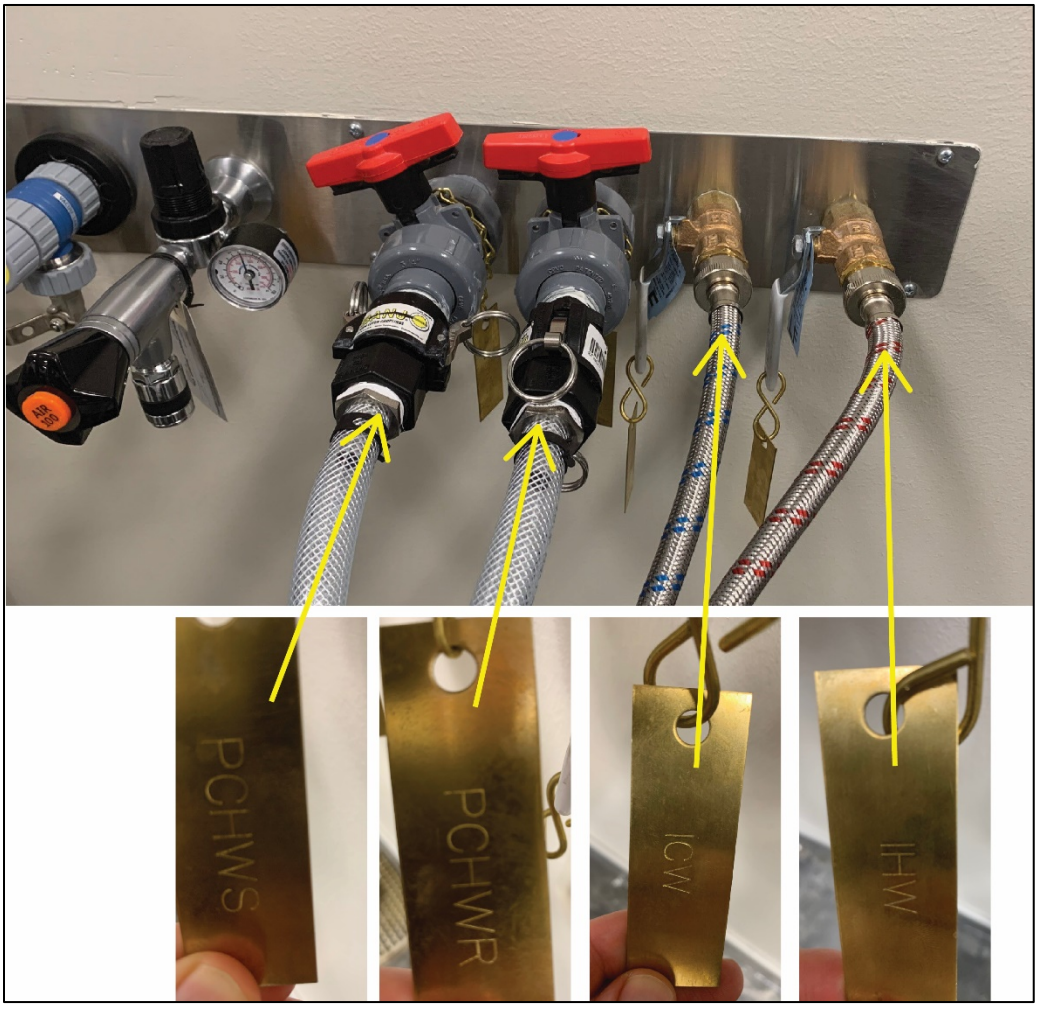

Figure 2 Picture of wall connections and tags.

The streams connecting to the heat exchangers contain the thermocouples. For identification, these are are labelled T1-T4. Figure 3 are pictures of the four tags. The title above each picture indicates the stream in the heat exchanger. The parentheses contain what the other side of the tube is connected to. The 1-4 correspond to the temperatures on the Temperature Readings display (See Figure 1.)

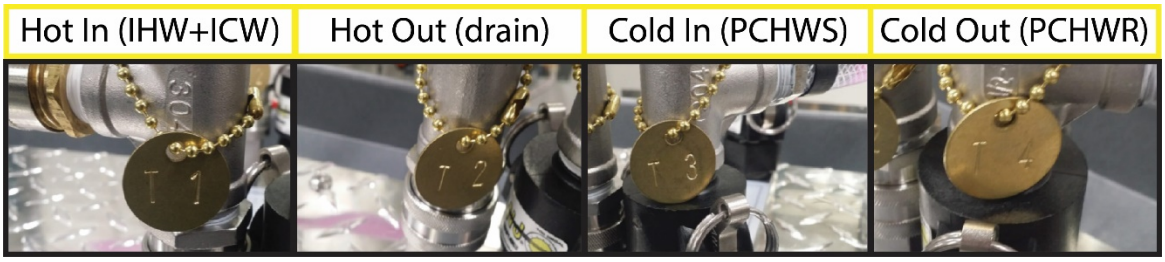

Figure 3 Temperature/Stream tags on heat exchanger connections.

Set Up of the Starting Configuration

Do the following, **before students arrive**, if not already done.

1. Put on gloves.
2. Connect the triangular floor drain tube to the grating of the floor drain by inserting the legs of the spacer into the holes of the grate.
3. Connect the red-striped tube from the *bottom* of the *Hot Water* rotameter to the IHW wall connection.
4. Connect the blue-striped tube from the *bottom* of the *Cold Water* rotameter to the ICW wall connection.
5. Connect the clear and white-striped tube from the *bottom* of the *Chilled Water* rotameter to the PCHWS wall connection.
6. Connect the tube with the T1 label to the inlet side of the smaller plate heat exchanger.
    - The inlet side is closest to the rotameters.
    - This is the *hot* inlet stream.
    - The connection is silver (not black).
    - This stream is coming from the *Hot Water* and *Cold Water* rotameters the combine after exiting the top of the rotameters through Y-connection.
7. Connect the tube with the T3 brass label to the inlet side of the smaller plate heat exchanger.
    - The inlet side is closest to the rotameters.
    - This is the *cold* inlet stream.
    - The connection is black (not silver).
    - This stream is coming from the top of the *Chilled Water* rotameter.
8. Connect the tube with the T2 brass label to the outlet side of the smaller plate heat exchanger.
    - The outlet side is farthest from the rotameters.
    - This is the *hot* outlet stream.
    - The connection is silver (not black).
    - This stream connects to the floor drain.
9. Connect the tube with the T4 brass label to the outlet side of the smaller plate heat exchanger.

- The outlet side is farthest from the rotameters.
- This is the *cold* outlet stream.
- The connection is black (not silver).
- This stream connects to the PCHWR wall connection.

10. Ensure the valves on the rotameters are *fully* closed.
11. Open the ball valves on the IHW and ICW wall connections by turning the lever 90° counterclockwise.
12. Open the ball valves on the PCHWS and PCHWR by squeezing the lever below the handle against the handle and turning 90° counterclockwise. (These chilled water valves have a locking mechanism that must be lifted before turning.)

The lab is now ready for students. Nothing should be flowing.

Notes:

- The connections labeled T1 and T3 are *inlet* streams and should always be placed on the side of the exchanger *closest* to the rotameters.
- The connections labeled T2 and T4 are *outlet* streams and should always be placed on the side of the exchanger *farthest* from the rotameters.

Lab Operation Procedures

1. Students will perform a few experiments with the small plate heat exchanger.
    a. The Lab Preparation Instructions above prepare for this.
2. Once the students are finished with the small plate heat exchanger, they will move to the large one and then the shell and tube exchanger.
3. You, as the TA, will move the connections with the following procedure.

Procedures for Switching Heat Exchangers

1. Ensure the valves on the three rotameters are *fully closed*.
2. Close the valve on the PCHWR wall connection.
3. Put on gloves.
4. Place a container below the PCHWR wall connection.
5. Place a few layers of paper towels down around the exchangers, both on the diamond-plate metal and the plastic cart. These will help catch spills and make cleanup easier.
6. Unhook the tube with the T1 label from the current exchanger and move it to the *inlet* of the desired exchanger. The fluid in the line will spill out as this is done.
7. Unhook the tube with the T2 label from the current exchanger and move it to the *outlet* of the desired exchanger.
8. Unhook the tube with the T4 label from the current exchanger and move it to the *outlet* of the desired exchanger. The fluid in the line will spill out as this is done.
9. Unhook the tube with the T3 label from the current exchanger and move it to the *inlet* of the desired exchanger. The fluid in the line will spill out as this is done.
10. Dispose of the paper towels and clean up any remaining spills.
11. Remove and dispose of gloves.
12. Open the valve on the PCHWR wall connection.

The students can now proceed with the experiments.

Shutdown Procedures

1. Move the T1, T2, T3, and T4 connections to the smaller plate heat exchanger following the procedures in the section entitled "Procedures for Switching Heat Exchangers."
2. Ensure the valves on the rotameters are *fully* closed.
3. Put on gloves if needed.
4. Turn off all four wall valves (IHW, ICW, PCHWS, PCHWR). Remember that the chilled water valves have a locking mechanism that must be lifted before turning.

TAs will not have to prepare the apparatus for moving or long-term storage. This will be done by the lab or assistant lab manager.