MET 466 – THERMAL PROCESSES LAB

LAB #3 – Groups 1 & 2 Concentric Tube Heat Exchanger

Assigned: Group 2 - 3/5/08 Group 1 - 3/19/08Due: Group 2 - 3/19/08 Group 1 - 3/26/08

Location of Equipment:

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

Description of Experiment:

A concentric tub heat exchanger consisting of a standard ¹/₂" type L copper tube (0.625" O.D., 0.545 I.D.) inside a schedule 40 iron pipe of 1" nominal size has been constructed. The heat exchanger is made in three sections and can be operated in either a parallel flow or a counterflow configuration. Each section of the heat exchanger has an effective length of 17' 4". Water is used in both the annulus and inside the ¹/₂" type L copper tube. The hot fluid is inside the tube and is pressurized by the building water line to approximately 65 psig. The boiling point of the liquid water used as the hot fluid is, therefore, elevated to approximately 210 °F. Operation at temperatures higher than the approximately 210 °F is, however, not recommended. Cold water flows in the annulus after passing through a filter and pressure regulator which is set at approximately 25 psig.

Flow rates are measured by turbine flowmeters. The frequency outputs of the turbine flowmeters are converted to corresponding DC voltage outputs by frequency-to-voltage converters.

Type T thermocouples are used to measure the temperature of the hot and cold fluid at the inlet and outlet of each section (see diagram below). Flow rates of both the hot and cold fluid can be controlled manually or by a pneumatically operated control valve which is interfaced with the data acquisition system via a 4 to 20 mA current loop.

All data for flow rates and temperatures must be obtained by the data acquisition system. During the experiment, the flow rate of the cold fluid must be controlled by the data acquisition system via the pneumatically operated valve.

Select additional instrumentation as needed.

See attached operating instructions.

Operating Instructions:

The instructor will provide an introduction to the heat exchanger and demonstrate safe operation of the system. After the introduction, students should be able to identify the components discussed below.

Instrumentation installation including the frequency-to-voltage converters, frequency counter, and all connections tot the data acquisition system should be completed before starting any fluid flows in the heat exchanger.

Since the position of the various valves my be adjusted by other users, initiate the start-up of the heat exchanger by placing the various valves in the following initial positions: all 5 steam inlet valves on heat exchanger (blue handles) closed, all 5 condensate valves on the heat exchanger (red handles) closed, globe valve at inlet of cold water system (red handle) closed, all three supply for hot water system, air bleed off for hot water system), bypass valve near hot fluid circulating pump (green handle, 1" vertical pipe) fully open, cold fluid drain valve closed, hot fluid drain valve closed, 1" ball valve for water supply to the room (yellow handle, on North wall about 7' above floor) open. Also set the valve positions for counterflow or parallel flow operation as desired. For counterflow open, two gate valves (green handles) at North and South ends of apparatus fully open, two gate valves (green valves) at North and South ends of apparatus closed, two gate valves (yellow handles) at South end of apparatus fully open.

Fill the hot fluid loop by opening the $\frac{1}{2}$ " ball valve at the North end of the apparatus which is not associated with the water filter. Most of the air in the loop can be removed by opening the $\frac{1}{2}$ " ball valve above the circulating pump for a few seconds. The circulating pump can be turned on and the flow rate in the hot fluid loop adjusted by use of the bypass valve (green handle) near the circulating pump.

Fill the cold fluid system by opening the ¹/₂" ball valve at the North end of the apparatus which is associated with water filter. Open the globe valve (red handle) downstream of the pressure regulator until the desired flow rate of water is obtained. The flow rate can also be regulated by opening the globe valve fully and using the pneumatically operated valve to restrict the flow as required.

With fluid flowing in both the hot fluid loop and the cold fluid system, steam can be supplied to the steam condensers in quantities needed to maintain the desired operating temperature. Open the four steam supply and condensate return valves on the North wall. There are five steam condensers on the West wall each of which can be operated by opening a steam inlet valve (blue handle) and a condensate valve (red handle). Operate as many steam condensers as necessary to attain the desired operating temperature in the heat exchanger.

Normally, the maximum temperature indicated by any of the thermocouples should be maintained below 210 °F. The maximum temperature in the heat exchanger will be measured at thermocouple 8 for counterflow operation and at thermocouple 5 for parallel flow operation.

To discontinue operation of the heat exchanger, shut off the steam supply to the condensers first. After the highest temperature in the system drops below 100 °F, shut off the hot water circulating pump and the water supply to the cold fluid system. Shut off all water supply and steam supply valves to the heat exchanger.

Figure 1: Heat Exchanger Thermocouple Locations

Results:

Operate the heat exchanger in counterflow and in parallel flow modes. Use consistent flow rates for the hot fluid and cold fluid loops.

- 1. The heat transfer rate from the hot fluid to the cold fluid for all three sections of the heat exchanger separately.
- 2. The heat transfer rate from the hot fluid to the cold fluid for all three sections of the heat exchanger combined.