CHE 478 Chapter 1 Assignment

Problem 1

Draw a PFD for the process described below. You may use Visio, or you may neatly draw by hand. You may assume that the process is Unit 200, and you should identify and number all the equipment appropriately. Emulate the topology and equipment descriptions of Figure 1.3 and the PFD examples in Appendix B.

In a process to separate and purify propane from a mixture of propane and heavier straight-chain saturated hydrocarbons (e.g., n-butane, n-pentane, etc.), the feed stream is fed to the 18th tray of a 24-tray distillation column. The overhead vapor stream (P=15 bar, T=44 °C) from the column is totally condensed in a water-cooled heat exchanger prior to being fed to an overhead reflux drum. The liquid product from the drum is sent to the reflux pump (which has a spare), and the discharge from the pump is split into two streams. One of these streams is the overhead reflux to the column and is fed back to the column on Tray 1. The second liquid stream from the pump discharge is the overhead product and is sent to storage.

The bottom of the distillation column is used to store the liquid leaving the bottom plate. From the bottom of the column a liquid stream leaves and is immediately split into two. One stream is the bottom product, which is sent for further processing in Unit 400. The other stream is sent to a thermosyphon reboiler where a portion of the stream is vaporized by condensing medium pressure steam on the other side of the exchanger. The partially vaporized stream from the reboiler is returned to the column just below the twenty-fourth tray. The two-phase mixture separates, with the vapor portion passing upward through the bottom plate to provide the vapor flow in the column. The liquid portion returns to the liquid accumulated at the bottom of the column. The reboiler pressure is 16 bar, the entering liquid is at 136 °C, and the exiting liquid and vapor are at 141 °C.

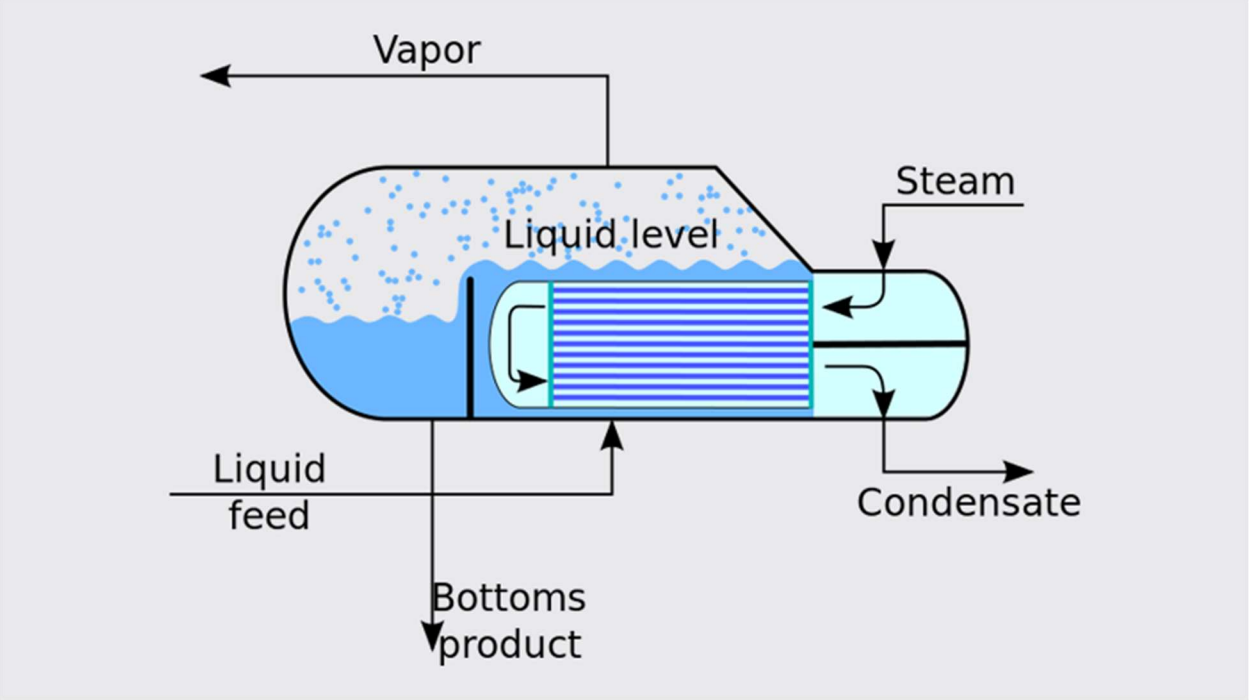
Checklist for Problem 1:

- All equipment items shown
- Proper icons used (see Fig. 1.4 in text)
- All equipment items properly labeled (see Table 1.2 in text)
- All streams are properly numbered and have arrowheads indicating direction of flow
- Short equipment descriptions are shown on PFD (see top of Fig. 1.3)
- Flowsheet is properly organized (inputs on left, outputs on right)
- Flowsheet is neat
- Control loops are correctly configured and labeled
- Utility streams are included and properly labeled
- T and P flags are included and properly labeled

Problem 2

Estimate the footprint for the reboiler in Problem 1. Assume a kettle reboiler with 8 ft, 1.25 in tubes on a 1.5 in square pitch, and an additional 2 ft of length at each end of the exchanger for tube header and bottoms product overflow. The steam is inside of the tubes and the boiling hydrocarbons are in the shell. Assume that the tubes are completely immersed in hydrocarbon liquid, and that the shell diameter is twice the diameter of the tube bundle. Assume the hot side temperature is that of saturated

steam at 5.0 barg (see Table 1.3). The vapor flow rate is 1,000. kmol/hr, and the heat of vaporization is 20.8 MJ/kmol. An estimate for the overall heat transfer coefficient can be found in Table 11.11.



Problem 3

Mark up the P&ID below to identify and correct errors.