Engineering Economics and Problem Solving, 4N4, 2012

Tutorial/Assignment 7

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AIM: *To confirm your understanding of process drawings and to get introduced with process operability.*

Engineers use process drawings to efficiently and clearly describe process designs. Here, we will gain experience in reading these diagrams by answering questions on the drawing PID-2A in Woods PDEP. This drawing is more complicated than those we have seen in the past, but it is typical of drawings used in engineering practice.

1. General
   (a) What is the meaning of PFD?
   (b) What is the meaning of P&ID? (Note that this is not the PID algorithm in process control.)
   (c) Why do engineers give numbers to all equipment?
2. Overview of the process - *What's going in and coming out*?
   (a) Identify the main feed and product streams on the drawing.
   (b) Why are the distillation towers called "depropanizer" and "debutanizer"?
   (c) What utility streams are used, and in which units, in the process (e.g., water, steam, hydrogen, nitrogen, etc.)?
3. Piping and valves - *Keeping the materials in the plant and away from us!*
   (a) With what symbols are the pipes represented in the drawing?
   (b) What symbols are used for pumps? What general class of pumps is used in this process?
   (c) Why does the pipe size change from the inlet and outlet of `E-25`?
   (d) Find valve `FV-1`.
      - Is this an automated control valve or a "hand" valve?
      - Why are all of the other valves located around `FV-1`?
   (e) What is the size of the pipe between `F-26` and `FV-1`? - How is the "best" pipe size determined? - What is a rule of thumb for the velocity in a liquid-filled pipe?
   (f) What is `PSV-1`?
   (g) What type of valve body is used in `FV-4`? (Globe, ball, needle, etc.)
4. Pumps - *Getting to the heart of the matter*
   (a) Find pump `F-26`.
      - What is the equipment in the feed pipe to the pump?
      - What is the equipment at the outlet pipe from the pump?
      - What provides the power to the pump?
   (b) Pump `F-27` is located after `V-30`. Why does the drawing specify that `V-30` must be 4.5 m above ground level?
5. Sensors - *The eyes of the operators*
   (a) Where are the displays located?
      - To read `PI3`, where would you look?

- To read TI4, where would you look?
- To read PT6, where would you look?
- Could you find historical data for FC4? For TI-6?

(b) What is the meaning of the lines with cross-hatching?

(c) What is the purpose of PS7?

- Why are so many instruments linked to it?
- What process variable does dPI 1 display?

(d) What type of flow sensor is used for FC-4?

(e) What type of temperature sensor is used in TC-12?

(f) What type of analyzer is used for AI-1?

6. Process equipment – the reason for the plant.

(a) How many theoretical trays exist in the debutanizer?

(b) Explain the principles of the condenser E-28, specifically how the pressure is controlled by changing the heat transfer duty.

(c) Why is TC12 controlling the temperature of a tray in the debutanizer?

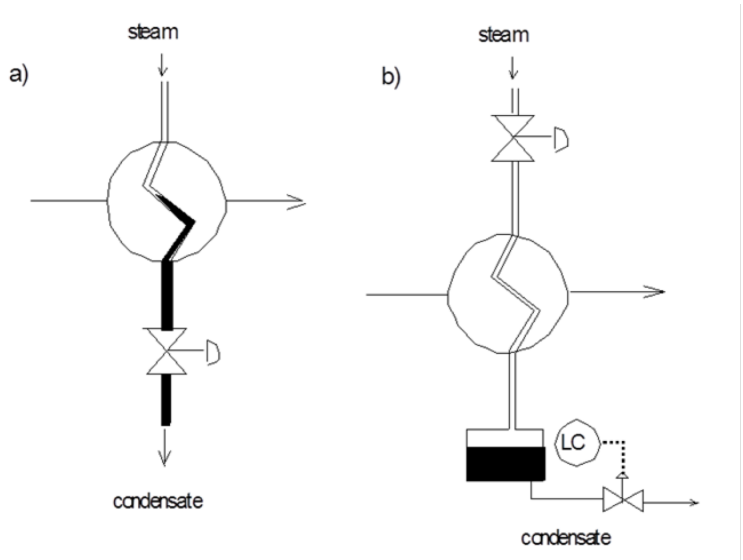
(d) What type of reboiler is provided in the debutanizer? (kettle, thermosyphon, pumped circulation, etc.)

(e) Find heat exchanger E-24.

- Why is steam entering and water leaving?
- What is the meaning of the box with "T" inside?

7. *To consider*: How will your group draw your process drawings?

8. Two designs for adding flexibility to a heat exchanger are shown below. The hot stream is steam that condenses. Explain each of these designs (how they work) and give strengths and weaknesses of each.



9. Observe vessel V-29, the feed drum in the P&ID. Determine if anything is missing. If yes, sketch the drum and add the needed equipment.

10. The trays function properly when the vapour and liquid flows vary within 65-105% of their design values. We have learned that we need to operate the tower at 45% of the design feed rate for the next month. Determine whether this lower feed rate is possible and explain your decision. If possible, explain how to operate the tower. If not possible, what design change would make the low feed operation possible?

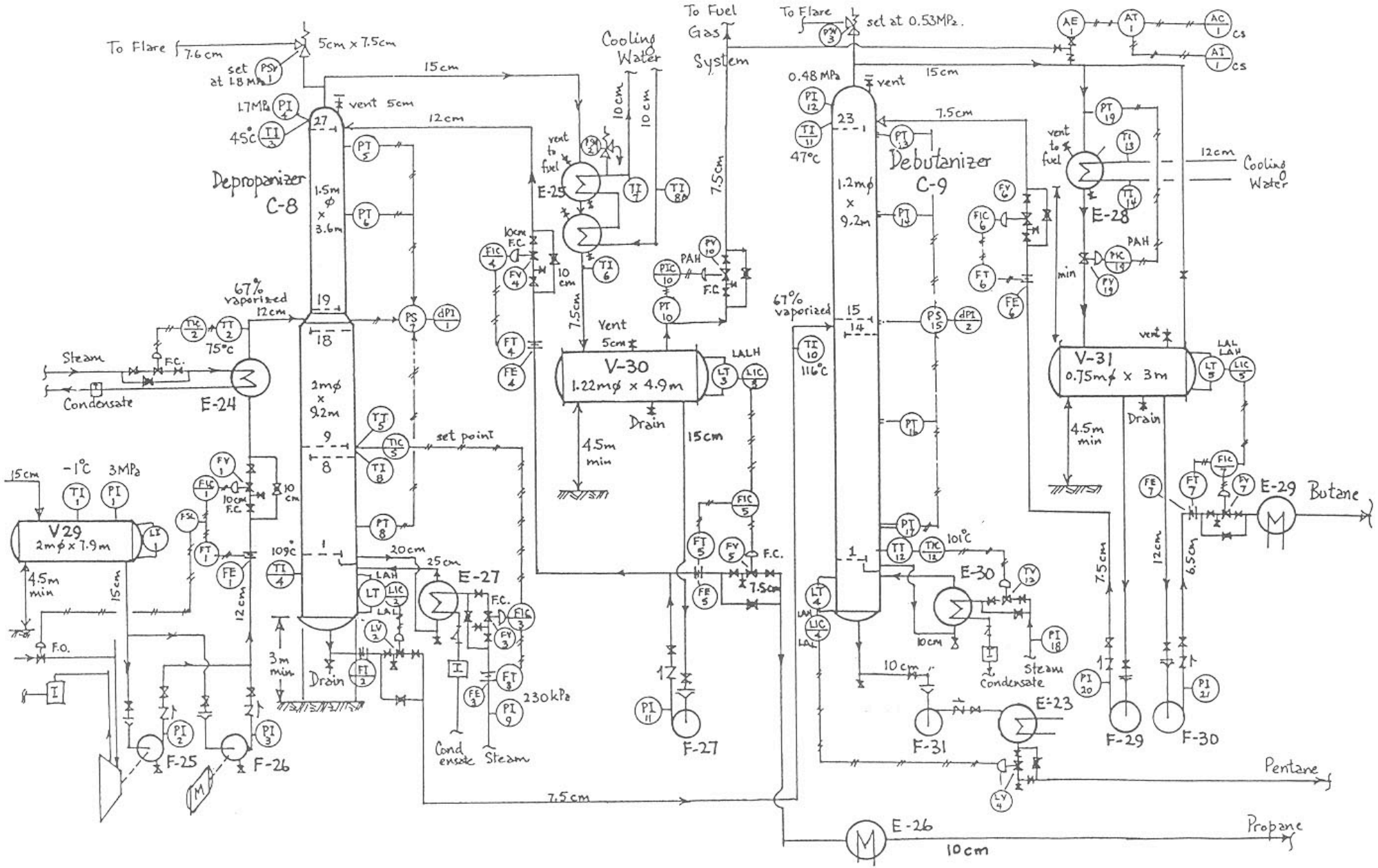
11. The tower is running at 100% of the design feed rate. It is a very hot day and the cooling water temperature is 7 °C higher than anticipated in the design operating window. Describe the effects on the plant operation. Specifically,

    (a) can it operate safely and

    (b) what is the effect on the product compositions?

12. The tower is specified to be 3m above ground level (grade). Why?

13. The level in `V-30` is low but within its 0-100% range. The pump `F-27` has a lower than expected outlet pressure, and the reflux and propane product flows cannot be achieved. Propose reasons for these symptoms. (*Hint*: Look up the term "vortex breaker")



PID–2A Depropanizer/Debutanizer