

Laboratory and Homework Assignment 6

Reading Assignment

1. "Chapter 10: Binary Continuous Distillation Column" from Jana, Amiya K. Chemical process modelling and computer simulation. PHI Learning Pvt. Ltd. 2011.
2. "Chapter 9: Distillation" from Treybal, Robert E. Mass-Transfer Operations. McGraw-Hill Book Company (Third Edition).

Laboratory Assignment (Due after laboratory session)

1. [50 points] The equilibrium y - x data for benzene/ethylene-diamine at 1 atm can be fitted to the following correlation:

$$y_{benzene} = \frac{ax_{benzene}}{1 + (a - 1)x_{benzene}} + bx_{benzene}(1 - x_{benzene}), \quad (1)$$

where $a = 9$ and $b = -0.6$. Use McCabe-Thiele diagram in **Matlab** to compute the theoretical number of stages (i.e., for $r = 1.5r_{min}$) for the two cases: **(a)** When the feed contains 40% benzene and is saturated liquid. Assume 99.9% of the purity of the products is desired. **(b)** When the feed contains 20% benzene and is saturated liquid. Assume that 99.9% purity of the product is required at the bottoms and 90% purity of the product is desired at the top.

2. [50 points] Imagine that you are hired by a process design company and it is the first day of your job. You are meeting new people and understanding the working of the company. Suddenly in the evening, just when you are planning to leave, you are told to do a column design to separate methanol and water. The feed has about twice as much water as it has methanol and there are about 1000 kg/hr to process. The cost estimates which needs to be prepared require the outlet methanol stream to be fairly dry, e.g. less than 0.5 wt% water. You are told to recover most of it. Your first reaction is to ask for more information, but your supervisor has just left for an overseas trip, is now in plane with no access to internet or phone for another 12 hours. To add to it none of your colleagues know about this problem, as this area is something which is very new for the company itself. Of course as a professional you are expected to be self-reliant. You decide to go home and think about the problem.
 - (a) Next morning: You find an email from your boss, marked Extremely urgent, asking for an immediate response to her question as she was meeting the client in the afternoon and need the data with her by then. You are tensed but then you remember to have kept Prof. Kallol Garg's class notes who taught you modeling and simulation course. He seemed to have come as a messiah for you. You quickly browse through his notes and decide to make a really quick estimate using matlab of the following based on Raoult's law VLE, plus the Fenske and Underwood expression and whatever else you need.
 - i. The number of theoretical stages.
 - ii. The reflux and reboil ratios.
 - iii. The total energy needed for heating and for cooling.
 - iv. The production rate of methanol.
 - (b) You make an estimate and send it to your boss. Once you reach your office, you find another email from your boss saying "I could have worked that out myself...You better get serious about this!". According to her the estimates doesn't make sense and looks too high. Your first impulse is to call her but you realize because of the time zone difference she might be asleep by now. Again, Prof. Garg's notes came to your rescue. You sit down and work on a better solution and send it to your boss.
 - (c) You then decide to check your estimates in ASPEN. How good are your estimates?