

# CLL 371 Chemical Process Technology and Economics

Major: May 02, 2019

30 marks

Closed Book / Closed Notes

2 hours

- Please display your IDENTITY CARD prominently and keep it on your desk for inspection. Please do not write this exam unless you are carrying the i-card.
- No mobile phones or tablet PCs or laptops allowed during the exam. Only scientific calculators are allowed.
- There are 15 questions in this test.
- Please provide brief and to-the-point answers. However, do pay attention to the sub-parts and answer all of them to earn complete marks on a question.

1. Why does weeping in tray towers lead to loss of efficiency? Which weeping is worse: that which occurs in the inlet half of any given tray (near the liquid inlet downcomer), or that which occurs at the exit half of the tray (near the exit weir)? In which half is it more likely to occur and why?

2. Why is it that in laminar flow through tubes, the friction factor is not a function of wall roughness, while in turbulent flow through tubes, it is?

3. In a counter-current packed tower for gas-liquid mass transfer, when liquid flow is gradually increased (in steps, giving sufficient time for steady state to be reached at any condition), first the pressure drop per unit length of bed (log) as function of gas mass velocity (log) follows straight lines parallel to the dry bed pressure drop curve. Beyond a certain point (of liquid flow), the curves deviate and develop slopes higher than the dry pressure drop curve (on the log-log plot). What is this point and what happens physically which causes this trend?

At a much higher liquid velocity, the slope becomes even higher (almost vertical or parallel to the y-axis). What is this point and what happens physically to cause this trend?

Explain with the help of simple sketch of the pressure drop behavior.

4. Packed towers for gas absorption are mostly counter-current while packed bed reactors for gas-liquid reactions are mostly co-current. Why? What else is a distinct difference between the two kinds of packed structures: packed bed absorbers and packed bed reactors?

5. Explain the working of a Fluidized Catalytic Cracker (FCC) system. Why is it advantageous to use fluidized beds for this process? What controls the energetics of this process?

6. What is meant by depreciation of process equipment? What is the difference between physical depreciation and functional depreciation? From a cash flow perspective, is it better to depreciate early or depreciate late in the lifetime of a process equipment or plant? Why?

7. Explain the working of a crude oil desalter. Why is desalting necessary? What is the purpose of the "mixing valve" of the desalter assembly and why is its design crucial?

8. Marshall and Swift Cost Index, and similar cost indices in the process industry, serve what purpose? Explain in the context of profitability analysis.

9. What is the difference between inorganic commodity chemicals and petrochemicals? Name two petrochemicals that are not polymer materials or materials made out of polymer materials.
10. Explain the process of Enhanced Oil Recovery (EoR). On what principle does EoR work? How is EoR engineered in an oil field?
11. A hot fluid (higher temperature) and a cold fluid (lower temperature) flows through the tube side and shell side of a double pipe heat exchanger, respectively. When the two fluids concurrently, or countercurrently, the LMTD is found to be the same. What can be said about the fluids and the kind of heat transfer?
12. The Haber-Bosch process *has been found* is considered energetically very inefficient. Why? It is also believed that manufacturing urea to deliver nitrogen to the soil is overall energetically very inefficient as a concept – why is that the case? (Two parts to this question: Why is the process (HB) inefficient? Secondly, why is the philosophy of getting nitrogen to the soil by urea route inefficient?)
13. Why is “deep” hydrodesulphurization considered a challenging process? What makes it so? Why is it essential to remove sulfur to the maximum extent possible (less than 10 ppm in BS VI standards), as a way of addressing air pollution? What harm will happen if more sulfur stays in the diesel fuel?
14. Why is distillation of crude done in two sets of columns: atmospheric distillation and vacuum distillation? In general, what kind of products does one get out of the ADU and what kind of products out of VDU? Why do we have CR (Circulating Reflux) in these columns (like Kero CR, HSD CR, etc.)?
15. What is meant by platforming? What reactions are involved? What is the implication of coking reactions during platforming?