

National Exams December 2016

04-Chem-B6, Petroleum Refining and Petrochemicals

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is AN OPEN BOOK EXAM.
Any non-communicating calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper.
The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Question 1 is a multiple choice type, and the questions 2 to 5 require an answer in essay format. Clarity and organization of the answer are important.

Question Number I (10 Marks)

Below you have 10 multiple-choice questions, read each question carefully and circle only **one** answer?

1. The crude oil gravity ($^{\circ}\text{API}$) _____ as its content of sulphur increases.
 - a. increases
 - b. decreases
 - c. remains the same
 - d. varies sinusoidally

2. Which of the following fractions of a crude oil will have the maximum gravity (i.e., $^{\circ}\text{API}$)?
 - a. Diesel
 - b. Gasoline
 - c. Atmospheric gas oil
 - d. Vacuum gas oil

3. In the characteristic of petroleum products, as the average carbon number increases the H/C ratio
 - a. Increases
 - b. Decreases
 - c. Remains the same
 - d. Varies sinusoidally

4. Pour point and freezing point are equal for
 - a. Diesel
 - b. Crude oil
 - c. LGO
 - d. Water

5. A crude oil of Watson factor, $K_w = 15$ indicates that this oil is
 - a. Highly paraffinic
 - b. Highly aromatic
 - c. 50% paraffinic
 - d. Highly naphthenic

6. Hydrodesulfurization, is the process of
 - a. Removing sulfur from the gas or oil stream
 - b. Adding sulfur to the gas or oil stream
 - c. Removing water from the oil stream
 - d. Adding hydrogen to only improve the octane number of the oil

7. Octane number of gasoline is a measure of its
 - a. Knocking tendency
 - b. Ignition delay
 - c. Smoking point
 - d. Ignition temperature

8. Which of the following has the lowest viscosity (at a given temperature) of all?
 - a. Naphtha
 - b. Kerosene
 - c. Diesel
 - d. Lube oil

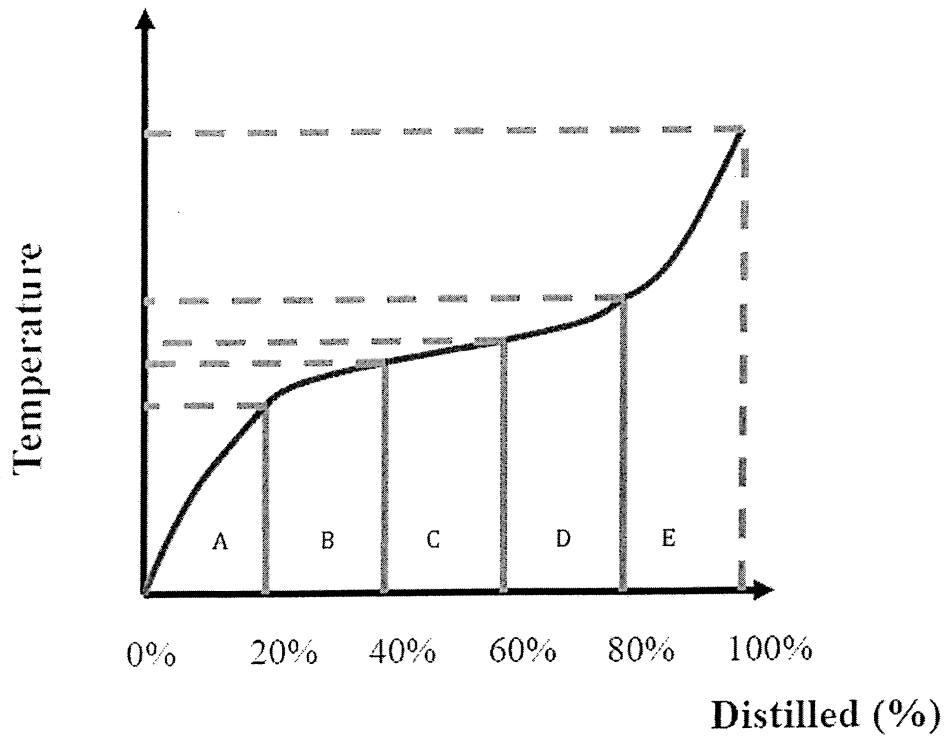
9. Molecular weight (MW) of crude oil products varies from one to another, and its an indication of the product complexity. The values of MW has the following order
 - a. Asphaltenes > Resin > Olefin
 - b. Olefin > Resin > Asphaltenes
 - c. Asphaltenes > Olefin > Resin
 - d. Resin > Asphaltenes > Olefin

10. In a typical petroleum refinery, the principles of vacuum distillation unit (VDU) resemble those of fractional atmospheric distillation (CDU), except that
 - a. Larger-diameter columns are used in the VDU to maintain comparable vapor velocities at the reduced pressures
 - b. Smaller-diameter columns are used in the VDU to maintain comparable vapor velocities at the reduced pressures
 - c. Taller-height columns are used in the VDU to maintain comparable vapor velocities at the reduced pressures
 - d. Shorter-height columns are used in the VDU to maintain comparable vapor velocities at the reduced pressures

Question Number II (10 Marks)

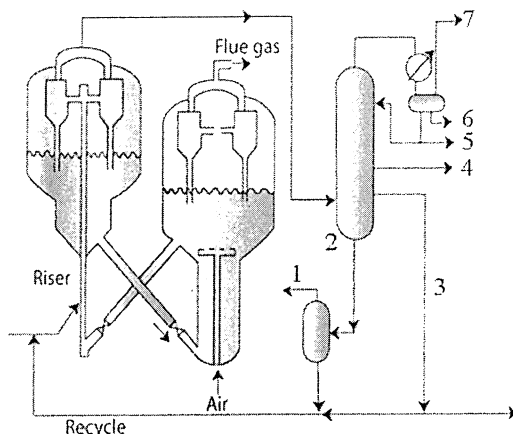
Below is a schematic representation of the TBP curve for a typical crude oil.

- Name the pseudo-component products listed as A, B, C, D, and E?
- Show the IBP and the EP points of this crude?
- Show the cut points of product D?



Question Number III (10 Marks)

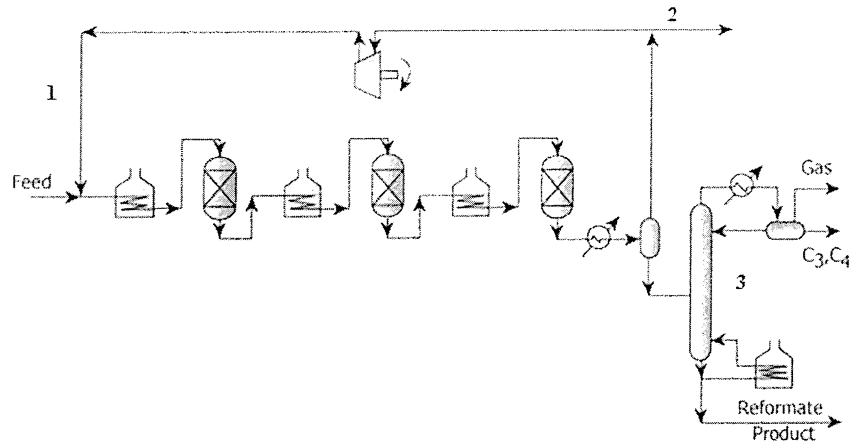
The following schematic drawing represents the flow sheet of the FCCR process in a typical crude oil refinery. Briefly and qualitatively, answer the following:



1. What does FCCR stand for?
2. What is the main feed of this process?
3. Why the feed has to go through a desulfurization process before entering the FCCR unit?
4. What is the main purpose of this process?
5. What type of catalysts is used in this process?
6. What are the reaction temperature, pressure and time in this process?
7. In which phase does the reaction occur?
8. Why at some point steam is required in this process?
9. Why cyclones are used in the first unit?
10. Name the streams number 1, 3 and 7?

Question Number IV (10 Marks)

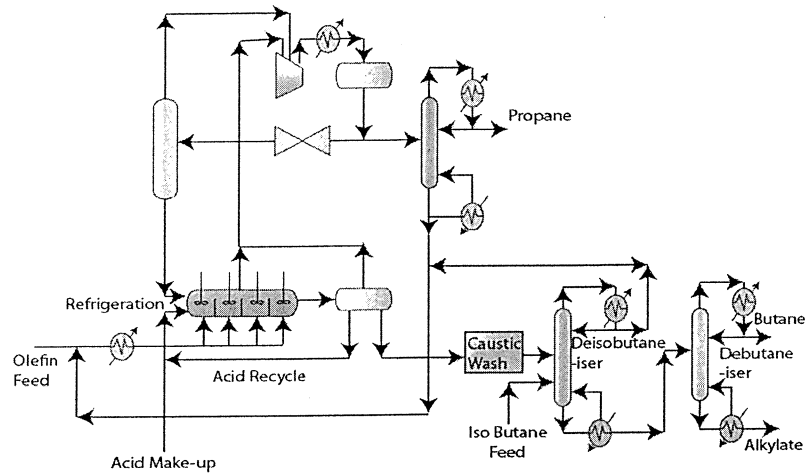
Let's assume that you got a job in a refinery. Your boss gives you the following flow sheet and asks you to provide answers for the following questions:



1. What is the name of this process and why we use it in the refinery?
2. What is the source of the feed?
3. What are the main product and the significant by-product?
4. How many reactors are in the process?
5. Why a compressor is used in this process?
6. What is the purpose of the last column (no. 3) in this process?
7. Once the catalysts are spent in this process how it can be regenerated?
8. Your boss told you that due to high demand on our product we cannot stop the process for any reason, even for catalysts regeneration. How can you maintain the process continuous?
9. Again, your boss told you that to save cost on the process you need to use only one furnace for the process placed at the beginning of the first reactor only. How you can convince your boss that his suggestion is not right and should not be considered? "Remember he is your boss!"
10. What are the other alternates for this process?

Question Number V (10 Marks)

The following diagram is a typical flow sheet for the sulphuric acid alkylation process in the petroleum refinery. Answer the followings:



1. Why we are using the sulphuric acid in this process?
2. What types of reactors are used in this process?
3. Why compressor is used in this process?
4. What is the job of the refrigeration or the condenser in this process? Explain?
5. Your boss asked you to replace the deisobutanizer after the debutanizer? Is this thermodynamically possible? Why not doing it?