

BITS PILANI, K. K. BIRLA GOA CAMPUS, FIRST SEMESTER 2022 – 2023

COMPREHENSIVE EXAMINATION
PETROLEUM REFINING TECHNOLOGY (CHE F422)

DATE: 26/12/2022

TIME: 3 HRS (10 AM – 1 PM)

MAX. MARKS: 80

ALL QUESTIONS ARE COMPULSORY. MAKE SUITABLE ASSUMPTIONS WHEREVER NECESSARY

The question paper consists of two parts, PART – A (Closed Book) of 40 marks and PART – B (Open Book) of 40 marks. PART – B question paper and answer-sheet will be provided only after submitting PART – A answer sheet.

PART A (CLOSED BOOK) (40 Marks) – Max Time: 90 minutes

- [Marks]**
1. State True or False in each of the following cases **[2]**
- a. Aromatics have lower viscosity and higher viscosity index than paraffins
 - b. H_2SO_4 Alkylation operates at relatively higher temperature than HF Alkylation
 - c. Water can be added in Phenol extraction process
 - d. Butane is considered as the best solvent for Deasphalting process
2. Write the correct option for each of the questions given below. **[2]**
- i. Low Aniline point of diesel indicates presence of _____.
A. High aromatics B. High naphthenes C. Low aromatics D. Low paraffins
 - ii. In polymerization (gasoline) process, the catalyst life
A. Is longer for low pressure operation C. is less for low pressure operation
B. does not depend on pressure
 - iii. Two solvents are used in this _____ process of gasoline treatment
A. Dualayar B. Unisol C. $CuCl_2$ D. Merox
 - iv. Bromine number represents _____ content
A. Paraffinic B. Olefinic C. Naphthenic D. Aromatic
3. Answer the following questions **[1 x 6 = 6 Marks]**
- a. What is smoke point? For which fractions of crude oil it is an important property?
 - b. What is Reid Vapor pressure? How is it typically different from true vapor pressure?
 - c. What leads to the gum formation? How is this gum classified?
 - d. What are the typical operating conditions for hydrocracking process?
 - e. What are the three important main sections of any of extraction process?
 - f. What are the important criteria to select a solvent for extraction process? Write any four.

4. Answer the following questions

[2 x 4 = 8 Marks]

- a. What is salty crude? Why is Desalting of crude required? What are the typical Crude Desalting methods?
- b. Name two licensors for each of the following processes
 - i. FCC unit (side by side arrangement of reactor and regenerator)
 - ii. Isomerization process
- c. What are the challenges to pump the waxy crude oil? What is done to handle these challenges and effectively pump such crude oil? (Explain the relevant process).
- d. What are the typical disadvantages of sulfuric acid treatment of gasoline process? Why is not preferred?

5. Explain the following processes briefly with the help of PFD

[3 x 2 = 6 Marks]

- a. Fluid Coking.
- b. HF Alkylation

6. Answer the following questions

[5 x 2 = 10 Marks]

- a. What is the process flow diagram of a typical CCR Reforming (Platforming) unit (Draw it along with important operating conditions)? Explain the operation (feed to product) with the help of this PFD.
- b. Explain the ethanolamine treatment with the help of a PFD? (show all important sections of the unit)

7. In relation to Propane dewaxing process

[6 Marks]

- a. Draw a complete process flow diagram (locate all important units with their input and output streams and mention important operating conditions)
- b. Explain the operation with the help of the PFD (the specific function of each of the important units must be explained)

PART B (OPEN BOOK) (40 Marks) (Max Time – 90 minutes)

Question 1 Answer the following

[2 x 3 = 6 Marks]

- a. Why the residence time of the feed and catalyst is very less in the riser section of the FCC unit? How can the performance of riser be improved?
- b. Write the specific answer for each of the following
 - i. Major issues in the FCC operation that needs to be addressed for its effective performance
 - ii. Function of combustor/fired heater in the flexi coking process
- c. What specific properties/specifications does ASTM D-86 method (used for gasoline) provide? How each of these specifications is important for the performance of gasoline (Explain briefly the effects of any two of them).

Question 2 Answer the following

[4 x 3 = 12 Marks]

- a. What are the effects of each of the following actions on the respective overall process? Explain
 - i. If the Hydrogen to hydrocarbon ration in the hydrocracking process is increased
 - ii. If the air blowing time in Asphalt manufacturing process is reduced
- b. Give the reasons for the following statements
 - i. Why are ignition accelerators added in diesel?
 - ii. Why is higher pressure used in Hydrocracking process?
 - iii. Why is the Reforming unit not recommended to operate at much lower pressure (i.e. < 10 atm)?
 - iv. Why is liquid SO₂ preferred over other solvents in extraction for kerosene treatment?
- c. Name the processes/units for each of the following given details
 - i. A unit which is used to separate H₂, NH₃, H₂S from hydrocarbons
 - ii. Any process in which froth floatation is used for separation requirements
 - iii. Any process where Re-run columns are used for the recovery of catalyst
 - iv. Any process where RDC columns are used

Question 3 For the following cases, justify your answers with appropriate reasoning

[4 x 2 = 8 Marks]

- a. In HF Alkylation unit, if it is found that the octane number of the alkylated gasoline (product of the unit) started decreasing suddenly and bromine number was also found to be increasing at the same time. What can be the possible reasons and what actions need to be taken?
- b. In lead doctoring process, the sulfur present in the gasoline (treated product) is continuously not meeting the specification. It is also observed that the demand for air for regeneration is also increasing. Find out the possible reasons and propose actions that needs to be taken.

Question 4**[4 Marks]**

A thermal cracking operation of heavy gas oil (52 °API) was carried out at 450 °C. The composition of products and respective properties are given below.

Sr No	Component	Amount (wt %)	Average calorific value (kJ/kg)	°API
1	Gases	15	50.16×10^3	95
2	Gasoline	35	42.22×10^3	—
3	Furnace oil	10	40.12×10^3	30
4	Residuum	15	35.53×10^3	19
5	Uncracked feed	25	39.29×10^3	52

- Find out the specific gravity of gasoline
- What is the heat of decomposition per kg of gasoline produced?

Question 5**[10 Marks]**

Straight run naphtha (80 C – 100 C) from ADU has been reformed over a platinum catalyst. Four reactors in series are used to treat the feed. The reformer capacity is 8200 BPSD. The feed, product (reformate) and catalyst properties are:

Feed:

°API gravity = 51

Average boiling point = 455 K

% of S = 0.05

Product:

°API = 57

% Sulfur = 0.0005

Reformate RON = 97

Molecular weight of C₄ = 58 kg/kmol

Using the data given above, estimate the following: (Use approximate yields of all fractions in Reforming unit) [1 bbl = 0.16 m³]

- Find the specific gravities of the feed and the product
- Find the K (characterization factor) of the naphtha feed
- Volume fraction C₅₊ gasoline (reformate) yield
- The net amount of hydrogen produced (using a sulfur balance)