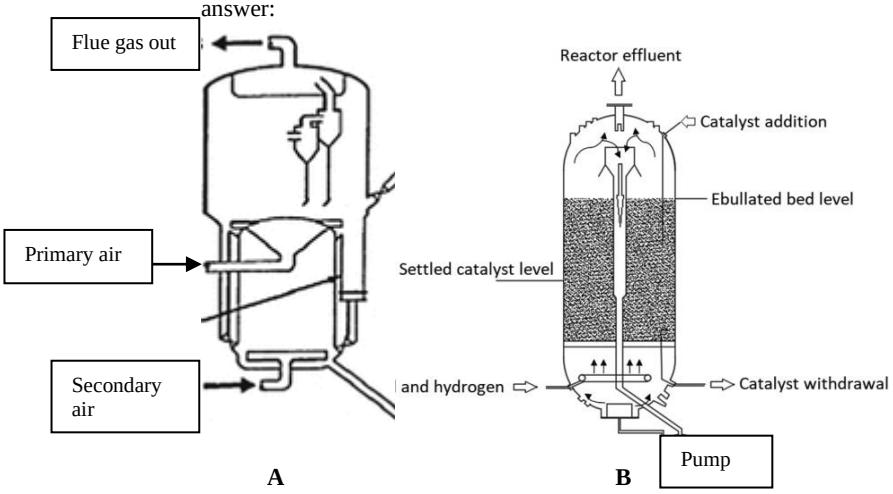
BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
First Semester 2023-2024 (9/12/2023)
Comprehensive Examination **(PART A-Closed book-45 marks, suggested time 130 min)**

Course No. : CHE F422 Total time: 180 min
Course Title: PRT Total Marks: 60

Instructions: *Number each main question correctly*
Start each new main answer on a fresh page
Part B (open book) answer booklet may only be taken once part A answer booklet is submitted.
Time distribution for Part A and B is up to the student.

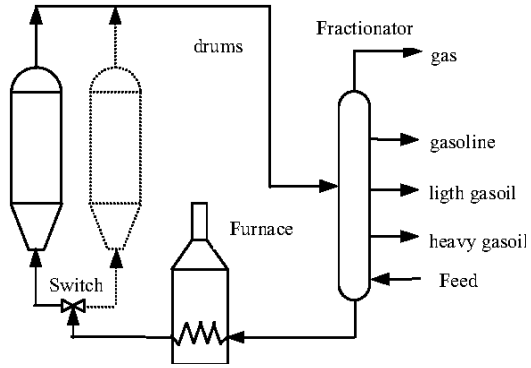
Q1. The following fig. A & B are important components of two refinery processes. For **each case (separately)** answer:



(a) Name the component or vessel, and the process to which it belongs
(b) Give the operating T, P of the process
(c) What special features of the component enhance the process?
(d) Indicate the purpose and main reactions of the process
(e) What is typical feedstock to the process

[5x2=10]

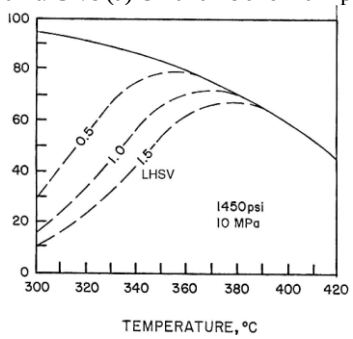
Q2. Carefully observe the figure below. It is a simplified flowsheet of a refinery process. Answer the given questions:



(a) Give the exact industrial name of the process and the main product.
(b) Why feed enters the fractionator and not furnace?
(c) What is typical cycle time for the drums?
(d) What are the effects of reducing cycle times?
(e) Which lab test will decide suitability of feed for the process? Explain.

[5x2=10]

Q3. The following graph of **aromatics hydrogenation% (y-axis)** Vs T (x-axis) shows reaction effects for a processing unit. Give (a) Unit name and main purpose. (b) Operating T, P (c) catalyst (d) Explain trend of given graph. **[5]**



Q4 the following conventional box-type furnace (cabin heater) is being used to heat feed for an ADU. Now the daily feed volume rate increases by 50%. If the main construction of the furnace (volume) cannot be changed, what other modifications can be done to accommodate the increased daily capacity requirement? Assume that the temperature requirement of the furnace output is required to be the same as before. **[4]**

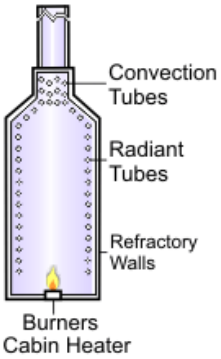


Figure: Furnace

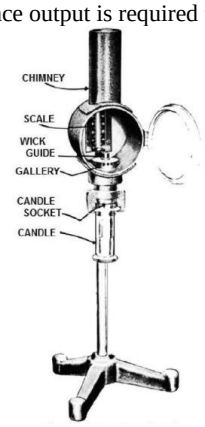


Figure: Test 1

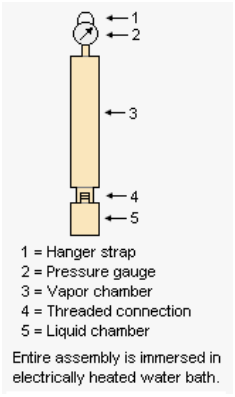


Figure: Test 2

Q5) Give the complete name of Test 1 and Test 2 from the schematic of the test set-up for crude fractions, and briefly describe purpose of each test and the fuel for which it is usually used. **[2+2=4]**

Q5. **Give *only* the significance** of these properties for the fuel that they define: (a) Pour point (b) Viscosity Index (c) Octane number (RON & MON) (d) Wobbe Number. **[4]**

Q6. What is the difference between the two terms on the basis provided in brackets? **Go directly to the point (4×2=8)**

1) Shale fracking, oil drilling (**process**)
2) Organic theory, peak oil theory **(evidence for these theories)**
3) Resin, asphaltene/ Bitumen (**end use in our country**)
4) Gasoline, Hydrogen (**explosive limit range, i.e. difference in upper and lower explosive limits, volume% in air**)

**********End of PartA**********

(PART B-Open book-15 marks, suggested time 50 min)

Instructions*:* ***Write all the steps of the solution procedure and quote all data sources. Show at least one sample calculation for each column data.***

(i) TBP data for a Brent blend (°API= 41.1) is reported in Table-1. Find K for the whole crude, and comment on the value. [5]

(ii) For the four separations made in ADU, the TBP cut temperatures (T_{cut}) and separation capacities (F) are reported in Table-2. In an attempt at heat integration within the petroleum refinery complex, lights from another column were injected into the bottom cut (B) to add heat (in place of reboiler). The resultant local mixing caused the bottom cut to become slightly lighter, with a $t_{50\%}$ value of 735 °F (the injected lights had very less flowrate and did not affect anything else in the column). For each separation, the $\Delta t_{50\%}$ and ASTM Gaps/ Overlap (use -/+ to indicate which) as indicated in Table-2. [10]

Table-1

Vol. %	0	5	10	20	30	40	50	60	70	80
TBP, ° F	-130	148	213	327	430	534	639	747	867	1013

Table-2

Sl. No	Separation	T_{cut} (°F)	F for section	Find each $\Delta t_{50\%}$	Find each Gap/overlap
1	D_3-(D_4+V_4)	255	40	a	A
2	D_2-D_3	365	30	b	B
3	D_1-D_2	545	10	c	C
4	B-D_1	650	10	d	D

**********End of Part B**********