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University of Petroleum & Energy Studies, Dehradun

Examination : End Semester Examination Dec. 2017
Program Name : B. Tech Chemical (Spl. Refining & Petrochemicals)
Semester : VII
Subject Name : Petroleum Process Systems Design
Duration : 3 hrs.
Subject Code : CHEG 438
Max. Marks : 100
Pages : 2

Instructions:

1. **Put your Roll No. immediately on the question paper, and accompanying charts. Do not put any other comments on the question paper.**
2. **All questions are compulsory. Answer all parts of a question at one place only. Mark question number and part number clearly in the left margin. Assume data if necessary, and justify your assumptions.**
3. **No student is allowed to leave exam hall in the first hour of exam.**
4. **Use of unfair means will lead to immediate disqualification.**

Section A: Answer All [60 marks]

Q1. Discuss the differences in flow patterns on shell side in Kern's original method, and in Tinker flow model. How does flow bypassing affect the Heat transfer coefficient. Show all the flow patterns with appropriate figures. **[10 Marks]**

Q2. Catalytic cracking is the most important and widely used refinery process for converting heavy oils into more valuable gasoline and lighter products, with over 1 million tons/day of oil processed in the world. Originally cracking was accomplished thermally but the catalytic process has almost completely replaced thermal cracking because more gasoline having a higher octane and less heavy fuel oils and light gases are produced. To maintain the catalyst activity at a useful level, it is necessary to regenerate the catalyst by burning off this coke with air. Distinguish between moving bed units and Fluidized bed units and discuss some configurations of fluidized bed units. Discuss primary reactions, process variables and catalyst types, and prominent licensors. Note that the light gases produced by catalytic cracking contain more olefins than those produced by thermal cracking, and the cracking process produces carbon (coke) which remains on the catalyst particle and rapidly lowers its activity. **[10 Marks]**

Q3. What is meant by Flooding. How to calculate flooding velocity. Show regions of good performance on L-G diagram. **[10 Marks]**

Q4. What is the importance of column internals. How many type are there. Show with some neat sketches. Explain the physical principles behind them. A new packing SR-PAC has following parameters. Explain each of them. **[10 Marks]**

arrangement	(d x h x s) [mm]	specific area [m^2/m^3]	void volume [%]	weight [kg/m^3]	packing density [$1/m^3$]
Stacked/ dumped	63 x 50 x 5	115.8	78.3	478	4600

Q5. What is meant by FUG method. Give full equations. What is the application of FUG Method. Compare FUG method with other methods. **[10 Marks]**

Q6. What is CCR. Explain in detail with important reactions and sketches. **[10 Marks]**

OR

Draw a well labeled sketch of Typical Fixed Bed Downflow Trickle Bed Reactor used in Hydrocracking and explain reactions. **[10 Marks]**

Section B: Answer All [40 marks]

Q7. 3 kg/s of saturated MEK vapor, $\dot{\mathbf{m}}_{\mathbf{MEK}}$ is available at 84 °C, and is to be heat-exchanged against $\dot{\mathbf{m}}_{\mathbf{CW}}$, 45 kg/s of cooling water available at 30 °C, and leaving out at 40 °C. Determine the heat duty, and the area required for heat-exchanger. Assume λ(Water) = 2257 kJ/Kg, λ(MEK) = 438 kJ/Kg, Cp(Water) = 4.18 kJ/kg-°C, Cp(MEK) = 2.298 kJ/Kg-°C. What kind of heat exchanger will be most suitable to perform this duty? Justify your answer, and in case of lack of suitable data, assume relevant data. **[10 marks]**

Q8. A multi-component feed mixture for distillation column has C3 to C6 hydrocarbons, with individual components molar flow rate shown in the table. Fix the operating pressure of distillation column, and find the product compositions. Also provide definitions of bubble points. Justify your answer. **[15 Marks]**

Component	Molar Flow rate (kmol/h)
C3 (n-Propane)	35
C4 (n-Butane)	18
C5 (n-Pentane)	17
C6 (n-Hexane)	30
Total	100

Q9. Calculate minimum-utility requirements and pinch point for a HEN problem by using the problem table algorithm of Linnhoff and Flower. Select the value of ΔT_{min} = 10 °C. In addition to above four process streams, there is a single hot utility available at a temperature above 260 °C and a single cold utility available at a temperature below 60 °C. Also draw a graph of 'Grand Composite Curve'. **[15 Marks]**

Table showing stream data for a given HEN problem

Stream	Type	Inlet Temperature (T_{in}), °C	Outlet Temperature (T_{out}), °C	Heat Capacity Flow Rate ($\dot{m}C_P$), kW/°C
1	Hot	250	130	10
2	Hot	160	90	8
3	Cold	60	160	7
4	Cold	110	260	6

Table 6.2 *Constants for Eq. (6.1)*

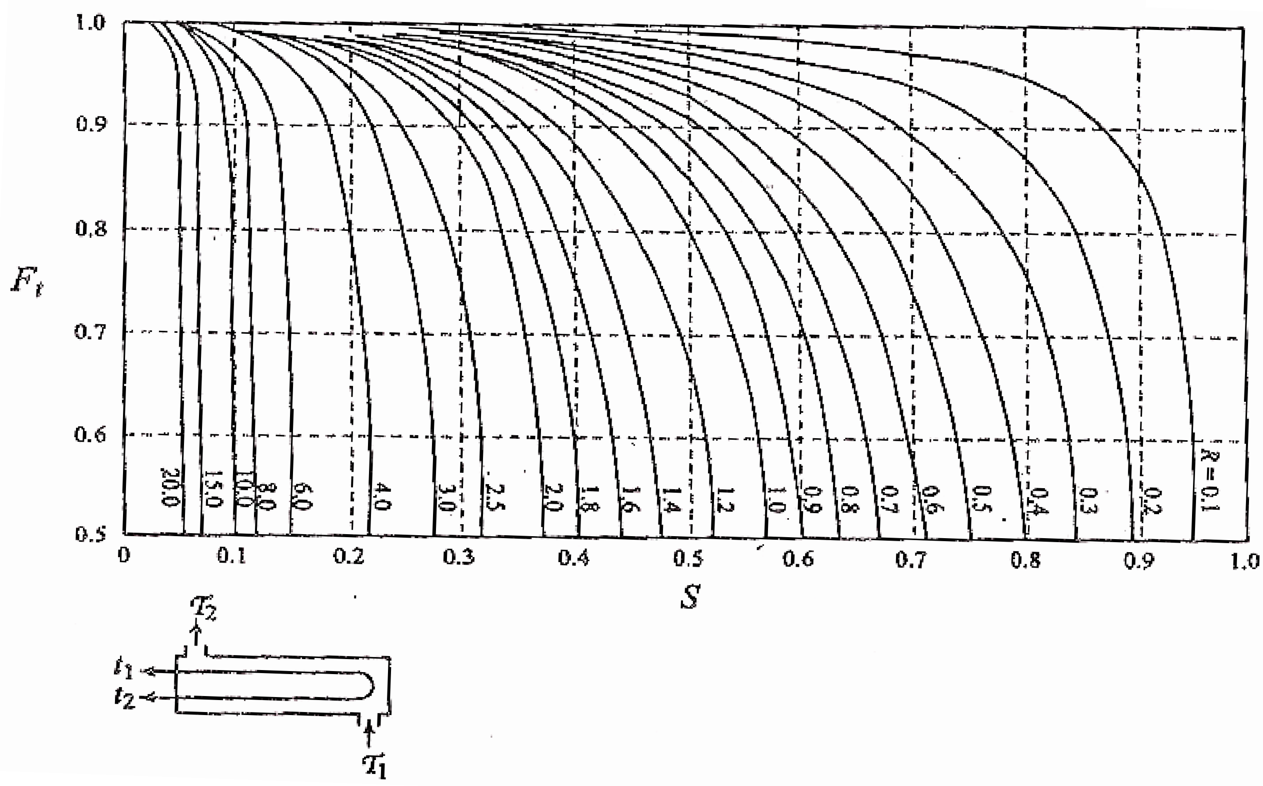
A. For $P/d_o = 1.25$, Triangular Pitch

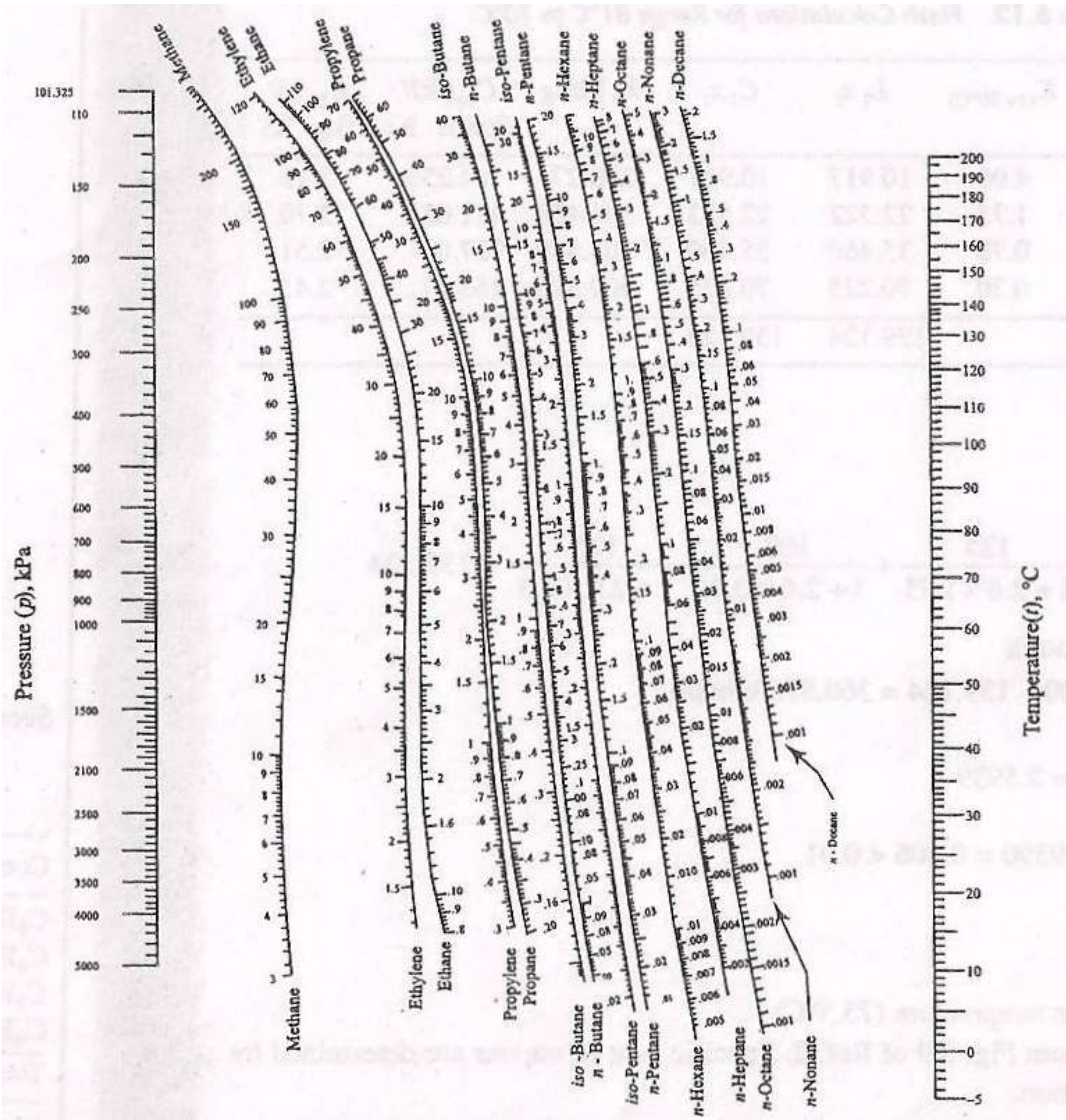
No. of tube side passes	1	2	4	6	8
k_1	0.319	0.249	0.175	0.0743	0.0365
n_1	2.142	2.207	2.285	2.499	2.675

Table 6.3 *Constants for Eq. (6.1)*

B. For $P_t/d_o = 1.25$, Square Pitch

No. of tube side passes	1	2	4	6	8
k_1	0.215	0.156	0.158	0.0402	0.0331
n_1	2.207	2.291	2.263	2.617	2.643




Pressure (p), kPa
Temperature(t), °C
Methane
Ethylene
Ethane
Propylene
Propane
iso-Butane
n-Butane
iso-Pentane
n-Pentane
n-Hexane
n-Heptane
n-Octane
n-Nonane
n-Decane

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