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SF-8317

B. E. - III (Sem. VI) (Chem.) Examination

May / June - 2011

Process Equipment Design - I

(New Course)

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ B. E. - 3 (SEM. 6) (CHEM.)

Name of the Subject :

☛ PROCESS EQUIPMENT DESIGN - 1 (NEW)

☛ Subject Code No. : 8 3 1 7 ☛ Section No. (1, 2,.....) : NIL

Seat No. :

Student's Signature

(2) Question 1&4 are compulsory and carries 20 marks and 18 marks respectively.

(3) Assume suitable data wherever necessary and mention them clearly.

(4) Figures to right indicate full marks.

(5) Wherever necessary draw neat and clean sketch.

1 (a) Do as directed : **10**

(i) List out the types of flow meters.

(ii) Draw the neat figure of orifice meter showing all the tapes on it.

(iii) Write any two limitations of vacuum distillation.

(iv) Show the equation of Rm for feed liquid at bubble point.

(v) What is significance of Hegstebeck Gedde's equation ?

(vi) Explain heavy key and light key component.

(vii) What do you mean by distillation operation ?

(viii) Explain relative volatility.

(ix) Define minimum wetting rate.

(x) Explain hold down plate in absorption tower.

(b) Design an orifice meter based on following data : **10**

- Name of fluid = chlorine gas
- Flow rate = 1500 Nm^3/hr
- Operating pressure = 1.2 atm.a
- Operating temperature = 30°C
- Viscosity of chlorine gas at 30°C = 0.0145 MPa.s
- Inside dia of pipe = 154 mm (6 inch SCH-40)
- Specific heat ratio for Cl_2 gas = 1.355

2 Answer the following : (any two) **8×2=16**

(a) Determine the minimum reflux ratio for binary distillation at standard atmospheric pressure based on following data.

- feed = 100 kmol/hr
- Feed mixture = Benzene - toluene
- Mole fraction of C_6H_6 in feed = 0.4
- Condition of feed = feed is at room temp (Take = 30°C)
- Mole fraction of benzene in distillate required = 0.99
- Mole fraction of benzene in residue required = 0.02
- Average relative volatility = 2.25

(b) Sulphur dioxide produced by the combustion of sulphur in air is absorbed in water. Pure SO_2 is then recovered from the solution by steam stripping. Make a preliminary design for the absorption column. The feed will be 5000 kg/hr of gas containing 8% (V/V) SO_2. The gas will be cooled to 20°C. A 95% recovery of the SO_2 is required. (Use Cornell's method).

Solubility data of SO_2 in water

SO_2	% W/W Solution	0.05	0.1	0.15	0.2	0.3	0.5	0.7	1.0	1.5
	Partial Pre gas mm Hg.	1.2	3.2	5.8	8.5	14.1	26	39	59	92

Use 38 mm ceramic Intalox saddles as packing material.

(c) Feed mixture to a distillation column contains 30% n-nexane, 32% n-propane, 20% n-butane and 18% n-pentane (by mole). The flow rate of the feed is 100 kmol/hr. If butane and pentane are selected as light key and heavy key components, respectively then

(i) fix the operating pressure of column

(ii) Find the product composition

3 Answer the following (any two) **7×2=14**

(a) Explain falling film absorber in detail with its advantages and disadvantages.

(b) Explain the factors to be considered for selection of tray type.

(c) Explain selection of equipment for distillation and selection criteria of distillation columns.

4 (a) Answer the following : **1×10=10**

(i) Give equation of power required for pumping incompressible fluid.

(ii) Write equation for calculation of Heat duty for condensation with subcooling.

(iii) Define selectivity in case of liquid-liquid extraction.

(iv) What is available differential head in case of thermosyphon reboiler ?

(v) Write Dittus Bolter equation.

(vi) State different parts of shell and tube heat exchanger.

(vii) Define Pump

(viii) Give names of different types of baffles.

(ix) State different types of reboilers used in chemical industries.

(x) Give full forms of HTRI and HTFS.

(b) Write a note on Air cooled Heat exchangers and Air Heaters. 8

5 Answer the following (any two) **8×2=16**

(a) A three stage reciprocating compressor is used to compress 306 Sm^3/h of methane from 0.95 atm a to 61.3 atm a. The inlet temperature is 26.7°C specific heat ratio of methane K = 1.31.

Calculate

(i) Power required for compression, if mechanical efficiency is 80% and

(ii) Discharge temperature of gas after 1st stage.

(b) Describe with neat sketch Tinker's flow model.

(c) Write about important industrial applications of liquid - liquid extraction.

6 Attempt the following (any two) **8×2=16**

(a) Write about NPSH requirement for liquids saturated with dissolved gases.

(b) Design counter current Multistage extractor.

(c) Process design of Thermosyphon Reboilers.

	Size		Bulk density (kg/m^3)	Surface area a (m^2/m^3)	Packing factor $F_p m^{-1}$
	in.	mm			
Raschig rings	0.50	13	881	368	2100
ceramic	1.0	25	673	190	525
	1.5	38	689	128	310
	2.0	51	651	95	210
	3.0	76	561	69	120
Metal	0.5	13	1201	417	980
(density for carbon steel)	1.0	25	625	207	375
	1.5	38	785	141	270
	2.0	51	593	102	190
	3.0	76	400	72	105
Pall rings	0.625	16	593	341	230
metal	1.0	25	481	210	160
(density for carbon steel)	1.25	32	385	128	92
	2.0	51	353	102	66
	3.5	76	273	66	52
Plastics	0.625	16	112	341	320
(density for polypropylene)	1.0	25	88	207	170
	1.5	38	76	128	130
	2.0	51	68	102	82
	3.5	89	64	85	52
Intalox saddles	0.5	13	737	480	660
ceramic	1.0	25	673	253	300
	1.5	38	625	194	170
	2.0	51	609	108	130
	3.0	76	577		72

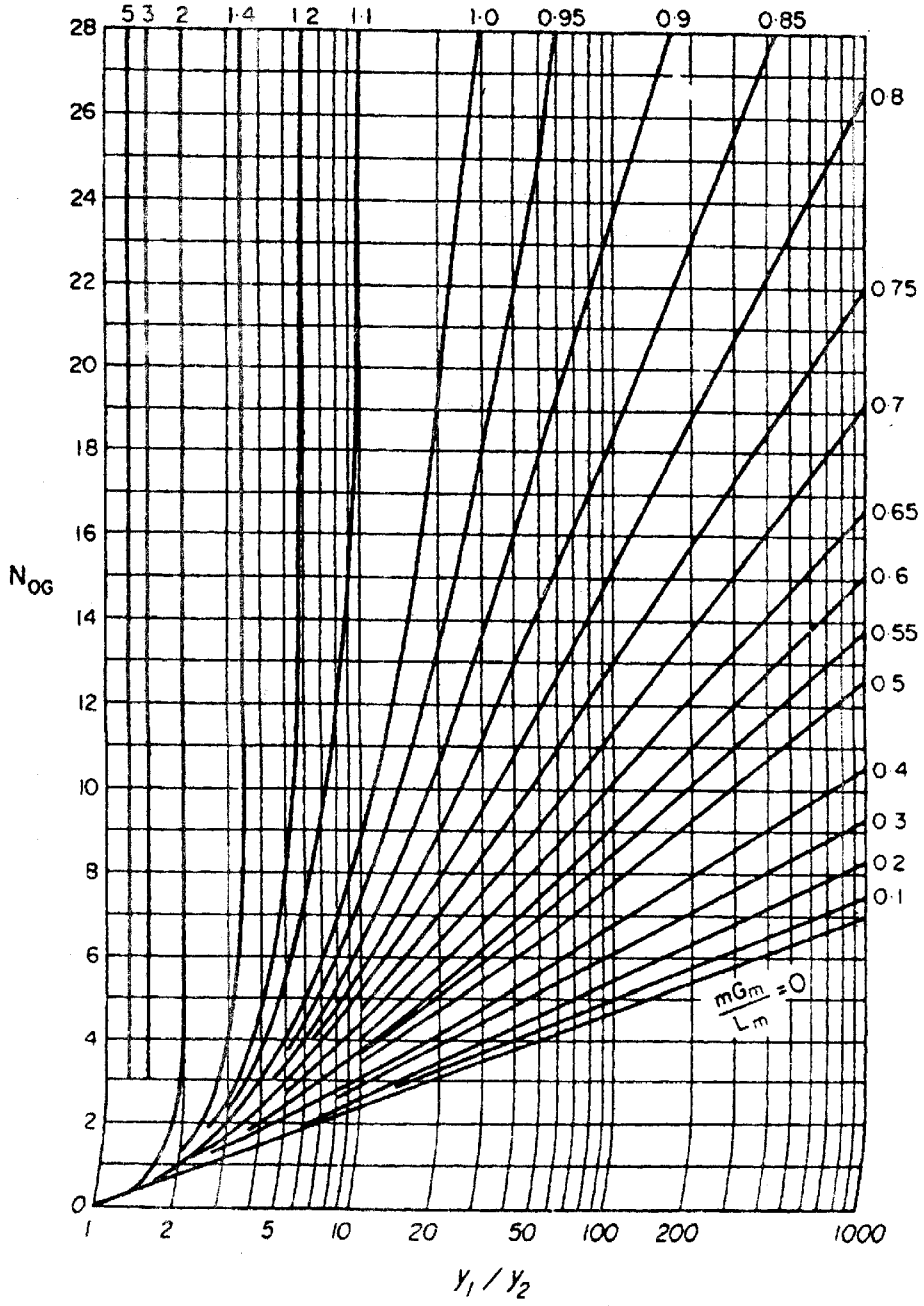


Figure 11.40. Number of transfer units N_{OG} as a function of y_1/y_2 with mG_m/L_m as parameter

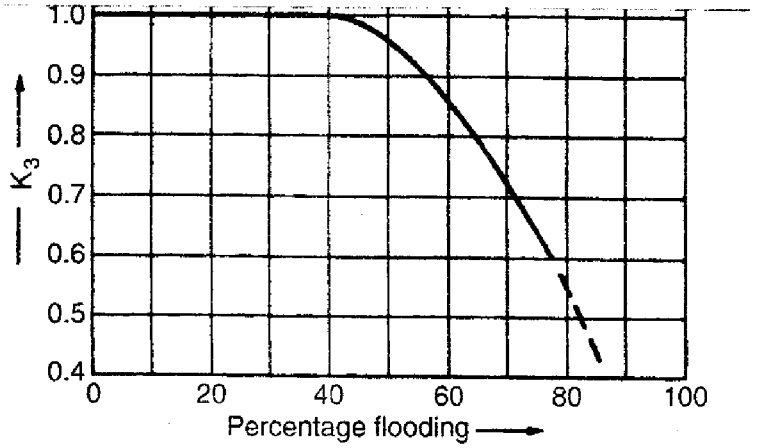


Figure 11.41. Percentage flooding correction factor

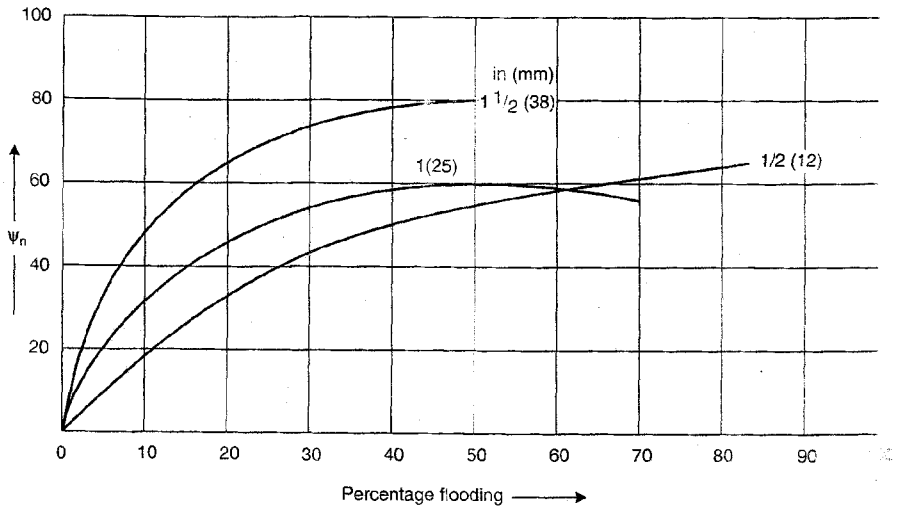


Figure 11.42. Factor for $\mathbf{H}_G$ for Berl saddles

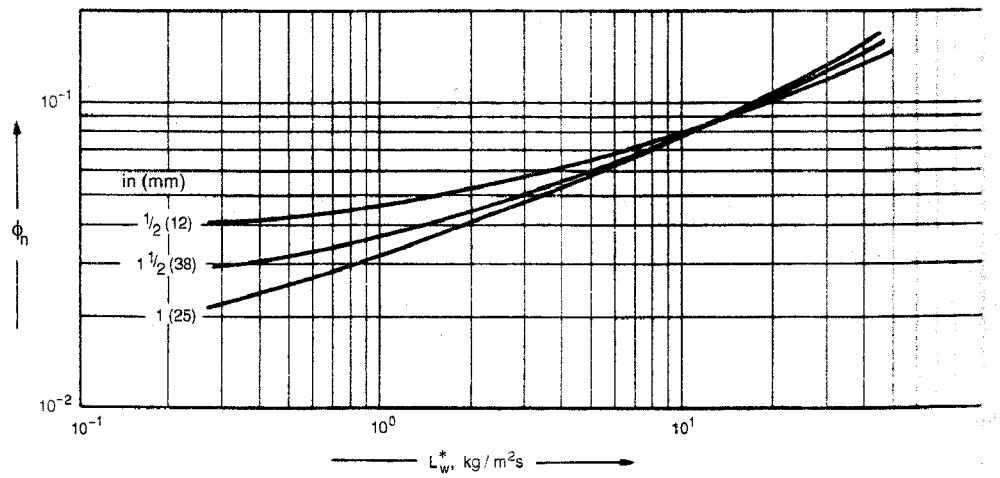
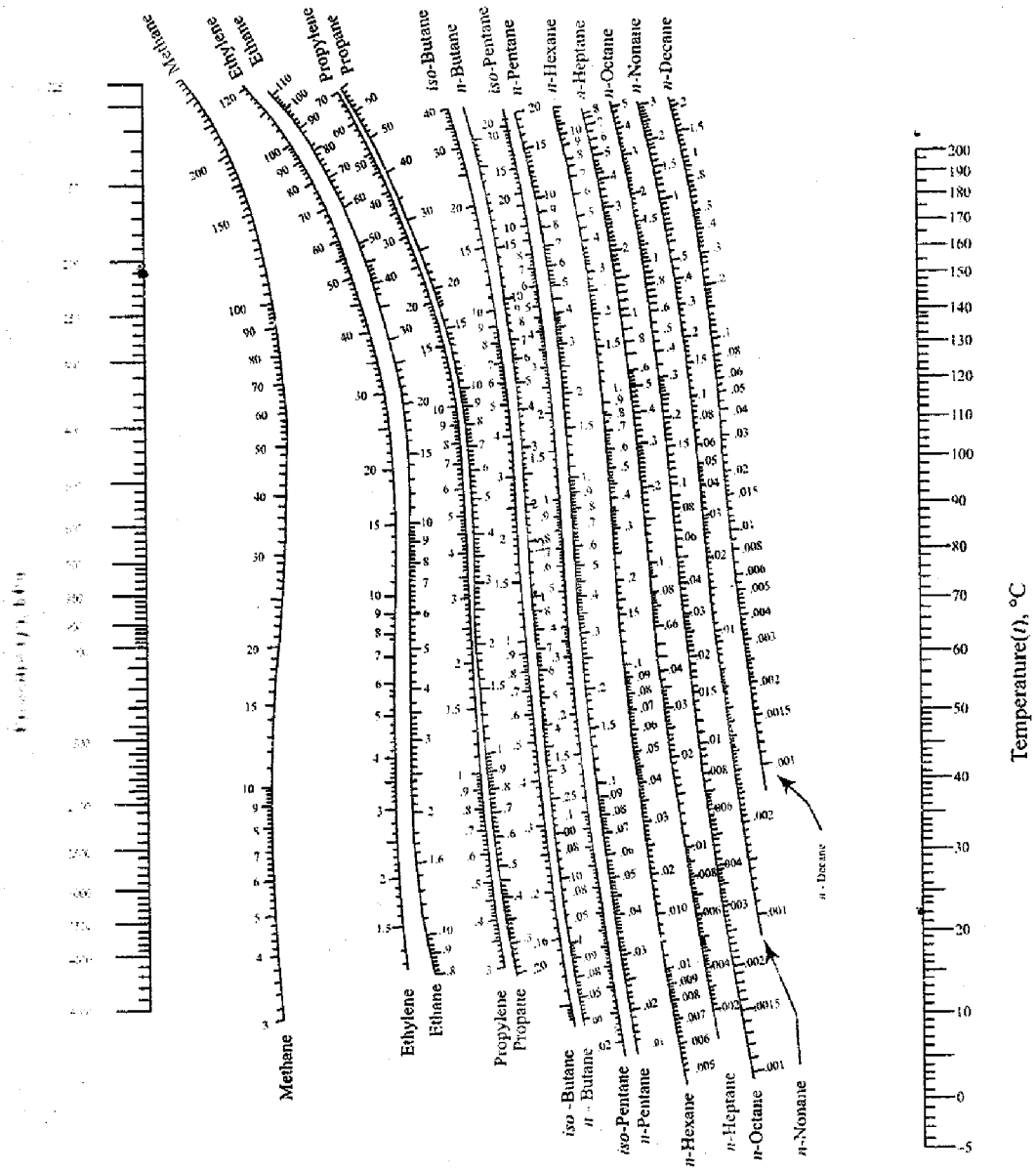


Figure 11.43. Factor for $\mathbf{H}_L$ for Berl saddles



5.20 *K_i Values for Hydrocarbons at High Temperatures*[8]
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= Total molar flow rate of saturated vapour mixture entering to condenser
= 500 kmol/h.

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