National Institute of Technology Hamirpur (H. P.)

B. Tech. (Chemical Engineering) – 7th Semester

End Semester Examination 2020-21

CHD-413 Process Equipment Design II

Duration: 2 hrs. **Max. Marks: 50**

- This question paper consists of three questions and one page.
- Attempt all questions. Make suitable assumptions if necessary, by clearly stating them.
- Marks will be deducted for omitting steps.
- Draw the figure wherever needed.

1 (25 marks)

Design a sieve tray tower for the distillation of acetic acid - water system, as per following specifications. Maximum feed flow rate is 12000 kg/h and minimum feed flow rate is 8400 kg/h.

Given data	Feed composition: 54.55 % Acetic acid and 45.45 % water (mol) Mol fraction of water: in distillate = 0.9302 and in residue = 1.666×10^{-4}
q = 1.272	No of theoretical stages required for the desired separation, N = 25
Slopes of top and bottom operating lines are 0.8 and 1.182 respectively.	
Reflux Ratio R = 4.2	Operating pressure (top of column) = 1 atm; Plate Spacing = 0.45 m

	Unit	Distillate	Bottoms
Average density (liq)	kg/m^3	967.97	1000
Average density (vap)	kg/m^3	0.598	2.1
Surface tension	mN/m	55.5	21.34

h_w = 50 mm; d_h = 5 mm; t = 5 mm

A_d = 12% A_c; A_h = 10% A_a

Plate pressure drop = 120 mm water; Efficiency of the plate is 50%

Find out the column diameter and provisional plate design and check weeping.

2 (15 marks)

A looped (1:1 pass) flow arrangement plate heat exchanger is to be used for cooing viscous liquid from 95°C to 60°C, the mass flow rate of viscous hot liquid is 2.6 kg/sec. Water is available is 18°C is to be used as cooling medium. Maximum water outlet temperature is 44°C.

Plate are made up of stainless steel with thickness t = 1.0 mm and thermal conductivity = 17 W/(m.°C), Project heat transfer area of plate = 0.2 m^2, Effective width between the plates = 0.4 m, Distance between the centers of inlet and outlet ports = 0.8 m, and pate spacing = 3 mm. Port diameter may be taken as 125 mm. Suggest a suitable design of a plate heat exchanger.

Sr. No	Item	Unit	Hot fluid	Cold fluid
1	U_{trial}	W/ (m^2. C)	250	
2	Specific Heat	J/(kg.°C)	2512	4180
3	Viscosity	N.s/m^2	0.1230×10^{-3}	0.078
4	Thermal conductivity	W/(m.°C)	0.1731	0.62
5	Fouling Factor	W/ (m^2. C)	5000	5000

No need to optimizing the design and calculate pressure drop.

3 (10 marks)

a. How the flooding velocity and operating vapor velocity determined in sieve tray column?
b. Briefly discuss different type of plates (distillation).
c. Briefly discuss different column efficiencies.
d. Explain the advantages, disadvantages and uses of a removable bundle, internal split ring floating head (AES, BES, etc) type heat exchanger.