CHL 427

Name :— Gr. No. :—

Design a single-pass cross-flow sieve-tray tower for distillation of 70,000 $\frac{kg}{hr}$ (Fmax) of a binary feed containing 20% by wt. of A. The top & bottom products are almost pure. Reflux ratio is 2.5. Every mole of feed causes 0.15 mole of incoming vap. to condense at the feed plate. The pr. at the top is 3 psig. Ideal no. of stages ~~are~~ is 22.

(a) Cal. the internal flow rates of liq. and vap. at top & bottom in $\frac{kmol}{hr}$ and kg/s. Tabulate results.

(b) Choose/ estimate / cal. the following

(i) no. of actual ~~stages~~ trays, h_t, bottom pr., ρ_v at top and bottom

(ii) plate spacing, hole dia., weir height, $\frac{a_h}{a_a} = 0.09$, $\frac{a_d}{a_c} = 0.13$, $\frac{l_w}{\phi}$

(iii) Flooding & design velocities, vol. flow rate of vap. (Q) in m^3/s, col. dia. at top & bottom

(c) ⇒ Do the following cal. at the bottom only

(i) using single dia. tower, do the weeping check both for Fmin & Fmax. Fmin is 0.65 of Fmax.

(ii) Cal. the fraction of holes to be blanked off when weeping check fails.

(iii) Cal. dry plate pr. drop (hod) when orifice Coeff. = 0.75.

Sr. no.	Property	DATA A	DATA B
1.	Mol. wt.	60	20
2.	(n.b.p.) normal boiling pt. (°C)	54	96
3.	ρ_L at its n.b.p. (kg/m^3)	800	980
4.	σ_L at its n.b.p. (N/m)	0.018	0.06

$$u_f = K_1 \sqrt{\frac{\rho_L - \rho_V}{\rho_V}} \quad \text{... eq. (11.81)}$$

$$F_{LV} = \frac{L_w}{V_w}\sqrt{\frac{\rho_V}{\rho_L}} \quad \text{... eq. (11.82)}$$

$$\check{u}_h = \frac{\left[K_2 - 0.90\,(25.4 - d_h)\right]}{(\rho_V)^{0.5}} \quad \text{... eq. (11.84)}$$

$$h_{ow} = 750\left(\frac{L_w}{\rho_L\, l_w}\right)^{2/3} \text{ ... eq. (11.85)} \quad ; \quad h_{od} = 51\left(\frac{u_h}{C_o}\right)^2\left(\frac{\rho_V}{\rho_L}\right) \text{ ... eq. (11.88)}$$

(i) area ratio correc. factor is 1.0, 0.9 & 0.8 for $\frac{a_h}{a_a} = 0.10$, 0.08 & 0.06 respectively.

(ii) ρ_L and ρ_V in kg/m^3; L_w and V_w in kg/s; u_f and $\check{u}_h$ & u_h in m/s; l_w in m; d_h in mm; h_{ow} & h_{od} in mm H_2O.

Make any reasonable assumptions but state them clearly & justify them.