Mass Transfer – I (CH21202)

Tutorial Sheet No.: MT-I/NCP/2024/4

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1. A liquid mixture containing 50 mol% benzene and 50 mol% toluene is to be continuously fractionated at the rate of 8500 kg/hr. A distillate containing 95 mol% benzene and a bottom product containing 10 mol% benzene are to be obtained. The feed is liquid at its bubble point. A total condenser will be used and the reflux will be returned at the bubble point. Determine (i) the product rates, kg/h; (ii) the minimum reflux ratio, (iii) the number of theoretical trays required for a reflux ratio two times the minimum, and (iv) the optimum location of the feed tray. The benzene-toluene mixture is having an average relative volatility of 2.4.

Ans. (a) D = 3704 kg/h, W = 4796 kg/h; (b) R_m = 1.289; (c) 9.5; (d) 6th tray from top.

2. A solution of n-heptane and ethylbenzene containing 42 mol% *n*-heptane is to be continuously fractionated at 101.3 kPa pressure at the rate of 20696 kg/h to give a distillate containing 97 mol% *n*-heptane and a bottom product containing 1.1 mol% *n*-heptane. The feed enters the tower partially vaporized so that 60 mol% is liquid and 40 mol% is vapour. A total condenser will be used and the reflux will be returned at the bubble point. Determine (i) the product rates, kg/h; (ii) the minimum reflux ratio; (iii) the number of theoretical trays required at a reflux ratio 75% more than the minimum and (iv) the optimum location of the feed tray.

Equilibrium Data:

x	0.0	0.08	0.250	0.485	0.580	0.790	1.0
y	0.0	0.23	0.514	0.730	0.790	0.904	1.0

Ans. (a) D = 8545.35 kg/h, W = 12150.65 kg/h; (b) R_m = 1.425; (c) 12; (d) 8th tray from top.

3. A mixture of diethylamine (DEA) and triethylamine (TEA) containing 50 mol% of DEA is to be continuously fractionated at a rate of 8700 kg/h and at a total pressure of 113.3 kPa. The top product should have 98% more volatile component and the bottom product 2%. The feed will be 50 mol% vaporized before it enters the tower. A total condenser will be used and the reflux will be returned at the bubble point. Determine (i) the product rates, kg/h; (ii) the minimum reflux ratio; (iii) the number of theoretical trays required at a reflux ratio 1.5 times the minimum and (iv) the location of the feed tray.

The equilibrium data for the system are given below:

x	0.02	0.104	0.227	0.34	0.428	0.52	0.65	0.79	0.90	0.95
y	0.052	0.231	0.45	0.6	0.694	0.765	0.845	0.915	0.963	0.982

Ans. (a) D = 3678 kg/h, W = 5022 kg/h; (b) R_m = 1.34; (c) 14; (d) 7th tray from top.

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