

# CHE407: Separation Processes

## Example

### EXAMPLE 11.6-1. Distillation Using Enthalpy-Concentration Plot

A mixture of 50 wt % ethanol and 50% water which is saturated liquid at the boiling point is to be distilled at 101.3 kPa pressure to give a distillate containing 85 wt % ethanol and a bottoms containing 3 wt % ethanol. The feed rate is 453.6 kg/h (1000 lb<sub>m</sub>/h) and a reflux ratio of 1.5 is to be used. Use equilibrium data and enthalpy data from Appendix A.3. Do as follows.

- Calculate the amounts of distillate and bottoms.
- Calculate the number of theoretical trays needed using the enthalpy-concentration plot.
- Calculate the condenser and reboiler heat loads.

### A.3-22 Equilibrium Data for Ethanol-Water System at 101.325 kPa (1 Atm)\*

Vapor-Liquid Equilibria, Mass Fraction Ethanol				Vapor-Liquid Equilibria, Mass Fraction Ethanol				Temperature		Enthalpy (btu/lb <sub>m</sub> of mixture)		Enthalpy (kJ/kg of mixture)		
Temperature	°F	x <sub>A</sub>	y <sub>A</sub>	Temperature	°F	x <sub>A</sub>	y <sub>A</sub>	Temperature	°F	Mass Fraction	Liquid	Vapor	Liquid	Vapor
100.0	212	0	0	81.0	177.8	0.600	0.794	100.0	212	0	180.1	1150	418.9	2675
98.1	208.5	0.020	0.192	80.1	176.2	0.700	0.822	91.8	197.2	0.1	159.8	1082	371.7	2517
95.2	203.4	0.050	0.377	79.1	174.3	0.800	0.858	84.7	184.5	0.3	135.0	943	314.0	2193
91.8	197.2	0.100	0.527	78.3	173.0	0.900	0.912	82.0	179.6	0.5	122.9	804	285.9	1870
87.3	189.2	0.200	0.656	78.2	172.8	0.940	0.942	80.1	176.2	0.7	111.1	664	258.4	1544
84.7	184.5	0.300	0.713	78.1	172.7	0.960	0.959	78.3	173.0	0.9	96.6	526	224.7	1223
83.2	181.7	0.400	0.746	78.2	172.8	0.980	0.978	78.3	173.0	1.0	89.0	457.5	207.0	1064
82.0	179.6	0.500	0.771	78.3	173.0	1.00	1.00							

\* Reference state for enthalpy is pure liquid at 273 K or 0°C.

Source: Data from L. W. Cornell and R. E. Montonna, *Ind. Eng. Chem.*, 25, 1331 (1933); and W. A. Noyes and R. R. Warfel, *J. Am. Chem. Soc.*, 23, 463 (1901), as given by G. G. Brown, *Unit Operations*. New York: John Wiley & Sons, Inc., 1950. With permission.

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