Vapor-Liquid Equilibrium Data

Methanol and ethanol form an ideal solution. Compute vapor-liquid equilibrium data and prepare plots of *x-y* and T-*x-y* at 1 atm pressure. The following pure component vapor pressure data is given:

Vapor pressure, mm Hg	**200**	**400**	**760**	**1520**
Temperature °C for ethanol	**48.4**	**62.5**	**78.4**	**97.5**
Temperature °C for methanol	**34.8**	**49.9**	**64.7**	**84**

What value of relative volatility will you recommend for this system?

Calculations:

Boiling point for the solution will range from the pure component boiling point of low boiling component to the pure component boiling point of high boiling component.

In this case, the boiling point of solution will range from 64.7°C to 78.4°C.

According to Clasius-Clapeyron equation, for short ranges of temperatures ln P Vs 1/T (temperature in Kelvin) is a straight line.

This is verified by ploting P vs. T and ln P vs 1/T curves.

We can utilize this linear relationship fact, for interpolation of vapor pressure for various temperatures.

For methanol and ethanol we want to have the vapor pressure data for the temperature range of 64.7 to 48.4°C.

Interpolating equation for methanol: (using the data for T of 64.7 and 84°C)

$$(\ln 760 - \ln P_A) / (\ln 760 - \ln 1520) = (1/337.7 - 1/T) / (1/337.7 - 1/357)$$

Interpolating equation for ethanol: (using the data for T of 62.5 and 78.4°C)

$$(\ln 400 - \ln P_B) / (\ln 400 - \ln 760) = (1/335.5 - 1/T) / (1/335.5 - 1/351.4)$$

The vapor pressure data for various pressures are calculated using the above equations and tabulated as follows:

T, °C	T, Kelvin	ln P_A	P_A	ln P_B	P_B
64.7	337.7	6.6333	760	6.0839	439
68	341	6.7574	860	6.2203	503
71	344	6.8681	961	6.3420	568
74	347	6.9769	1072	6.4616	640
75.5	348.5	7.0307	1131	6.5206	679
78.4	351.4	7.1332	1253	6.6333	760

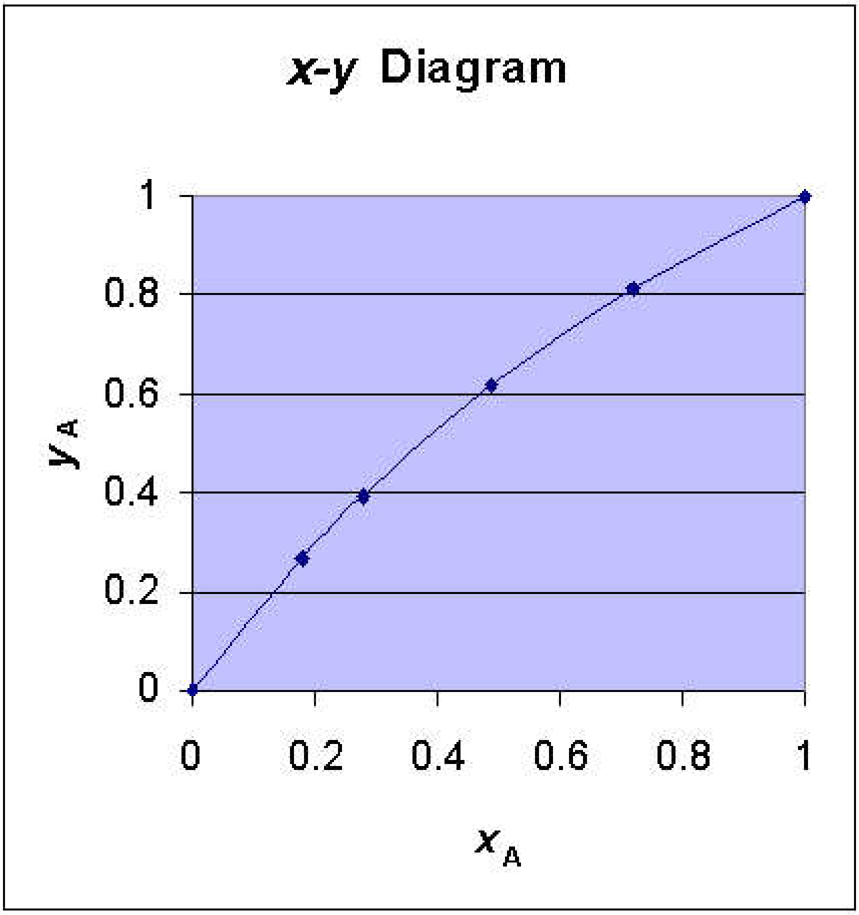
Using these vapor pressure - temperature data, and from the relation:

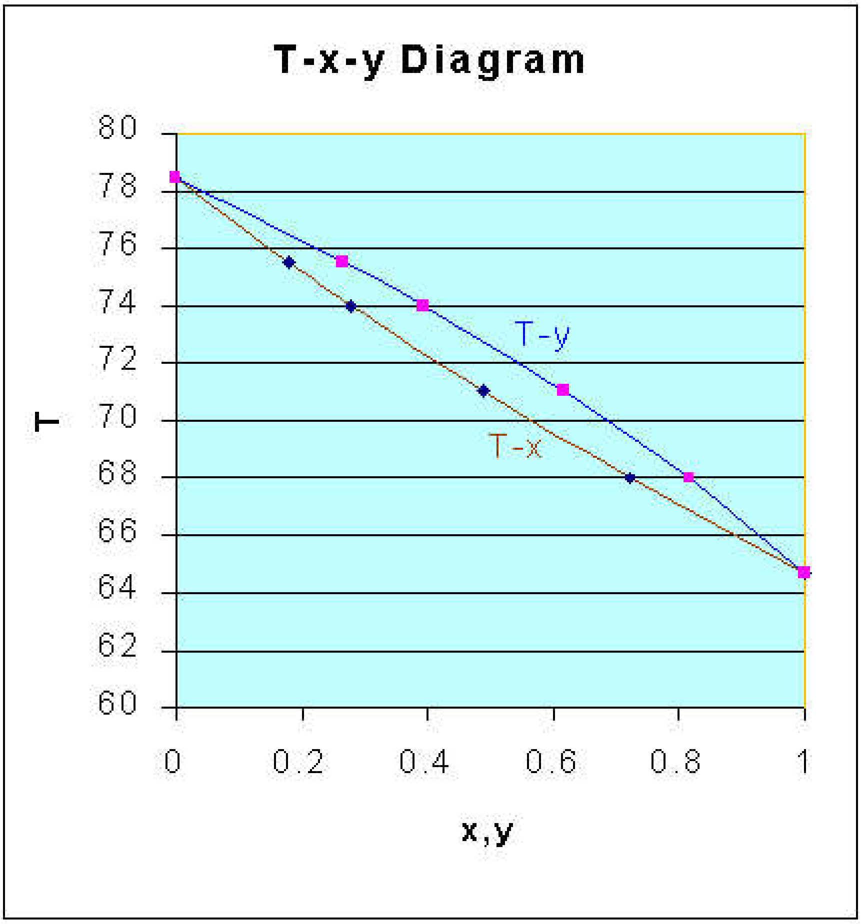
$x_A = (P_t - P_B)/(P_A - P_B)$ and $y_A = P_A x_A/P_t$

and Relative volatility, $\alpha = P_A/P_B$

x-*y* plot T-*x*-*y* plot data are calculated as follows:

T, ^oC	P_A, mm Hg	P_B, mm Hg	x_A	y_A	α
64.7	760	439	1	1	1.73
68	860	503	0.720	0.815	1.71
71	961	568	0.489	0.618	1.69
74	1072	640	0.278	0.392	1.68
75.5	1131	679	0.179	0.267	1.67
78.4	1253	760	0	0	1.65
					Average α = 1.69





The recommended relative volatility for the system is 1.69.

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