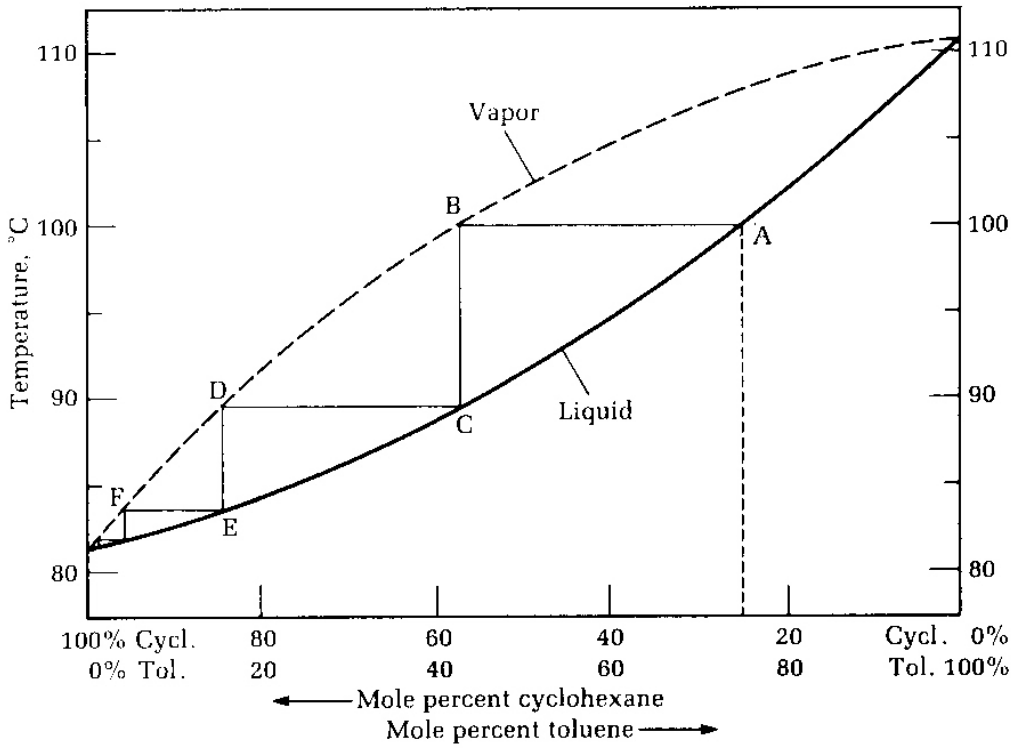
The Distillation of Cyclohexane and Toluene

Please visit these two sites for background information.

Distillation is the separation of two liquids with different boiling points. The lower boiling liquid can be selectively removed because it should have a relatively higher vapor pressure at a given temperature. Complete separation is often difficult to achieve and so an examination of the theory is of some moderate interest.

To examine distillation, we look at the relationship between temperature and mole fraction for both the liquid and vapor phases. These relationships are governed by Raoult's Law and Dalton's law of partial pressures.



Example: The Separation of Toluene and Cyclohexane by distillation.

Lets begin by looking at a mixture of 75% Toluene/25% Cyclohexane. This mixture will boil when the total vapor pressure equals 760 torr. Raoult's Law governs this relationship.

$P_{tot} = P°_C X_C + P°_T X_T$

This mixture boils at 100° C. I looked up the vapor pressure for cyclohexane at 100° ($P°_C$ = 1732 torr) and the vapor pressure for toluene at 100° ($P°_T$ = 436 torr).

760= (1732 torr)(.25) + (436 torr)(.75)
= 433 torr + 327 torr

Wait! There is more Cyclohexane than toluene in the vapors! Dalton's law of partial pressures governs the percentages.

$P_C = P_{tot} X_C$ $P_T = P_{tot} X_T$

$X_C = P_C/P_{tot}$ $X_T = P_T/P_{tot}$

.57 = 433/760 .43 = 327/760

The next thing we notice is that the two are not separated! How can we get a better separation? We can allow the vapors to condense and then re-vaporize them. The new 57/43 mixture boils at 90° and the vapors will be 85% Cyclohexane. The more vaporization/condensation sites we can create, the greater the separation.