Extractive Distillation of Toluene & MethylCycloHexane using Phenol

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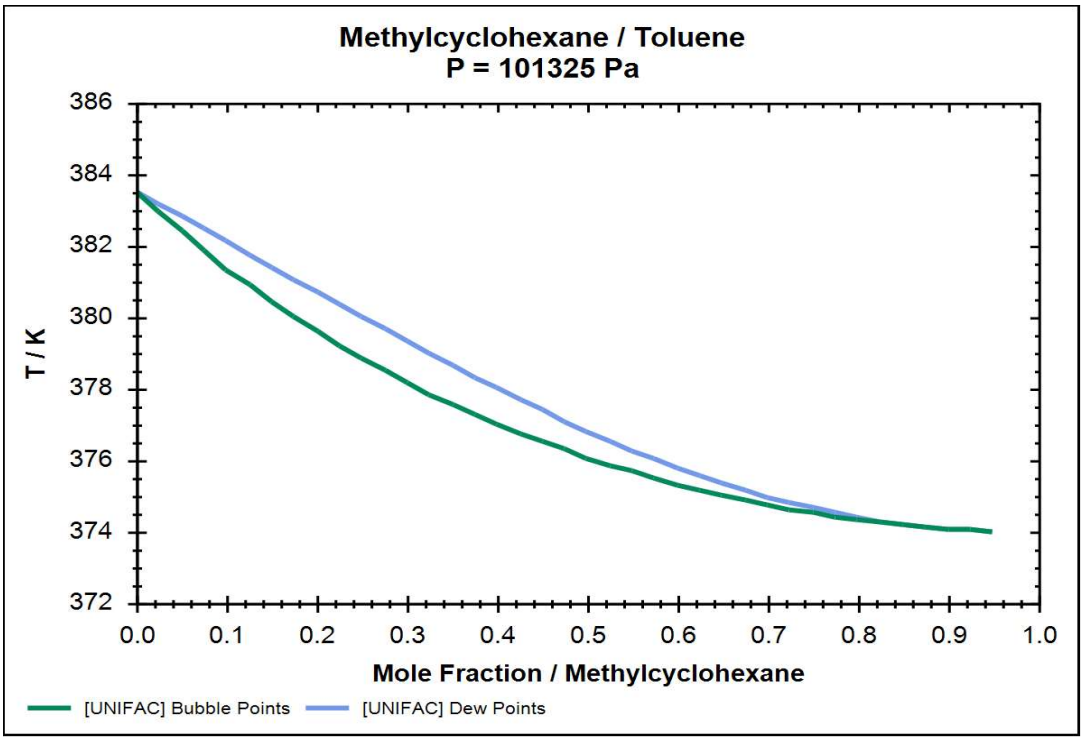
Background

Extractive distillation is the process of distillation using a high-boiling, miscible, non-volatile solvent that doesn't forms any azeotrope with the other components in the mixture. Solvent is chosen with a higher boiling point than that of feed mixture so that formation of newer azeotrope is impossible. MethylCycloHexane (MCH) along with toluene forms a close boiling mixture and therefore conventional method of distillation cannot be carried out to separate them. Hence, Phenol is used as a solvent to separate them.



T-x-y diagram for MCH-Toluene

Description of the Flowsheet

20 mol/s of Toluene and MethylCycloHexane (MCH) mixture in equimolar composition is fed to an extractive distillation column in its 25th stage. A stream of phenol with molar flowrate of 50 mol/s is fed to the 10th stage of the column. On separation, MCH is obtained as top product while mixture of toluene-phenol is obtained as bottom. The extractive column has 40 stages. Further, the toluene-phenol mixture is sent to another distillation column named solvent recovery to obtain toluene as top product and recover phenol from the bottom. The solvent recovery column has 20 stages and the feed enters at 12th stage.

The recovered phenol is then recycled to makeup mixer. A pure stream of phenol enters the make up mixer to act as excess phenol make up to maintain the constant molar flowrate of 50 mol/s as feed to the extractive column.

Results

Below displayed are the stream-wise results from the flowsheet:

	Toluene	Phenol-Toluene	MethylCyclo Hexane	Toluene-MCH	Phenol	Recycle Solvent
Temperature (K)	383.552	419.196	374.003	384	373	373
Pressure (Pa)	101325	101325	101325	101325	101325	101325
Mass Flow (kg/s)	0.918519	5.62307	0.985855	1.90329	4.70563	4.7048
Molar Flow (mol/s)	9.96802	59.9565	10.0435	20	50	49.9912
Volumetric Flow (m3/s)	0.00131243	0.00612764	0.00166562	0.630166	0.00467798	0.00467716
Mixture Density (kg/m3)	699.861	917.656	591.886	3.0203	1005.91	1005.91
Mixture Molar Weight (kg/kmol)	92.1466	93.7858	98.1585	95.1645	94.1126	94.1126
Molar Fraction (Mixture) / Phenol	0.001	0.833746	0.000154504	0	0.999801	0.999801
Molar Fraction (Mixture) / Toluene	0.998399	0.166154	0.00477399	0.5	0.0001993	0.00019933
Molar Fraction (Mixture) / Methylcyclohexane	0.00060149	0.0001	0.995072	0.5	2.71E-11	2.71E-11

References

Tiverios, Peter G., and Vincent Van Brunt. "Extractive Distillation Solvent Characterization and Shortcut Design Procedure for Methylcyclohexane - Toluene Mixtures." *Industrial & Engineering Chemistry Research* 39.6 (2000): 1614-623.

Flowsheet Source: http://www.chemsep.com/downloads/data/CScasebook_MCHT.png