EXTRACTIVE DISTILLATION OF ACETONE-METHANOL MIXTURE USING DIMETHYL SULFOXIDE AS ENTRAINER

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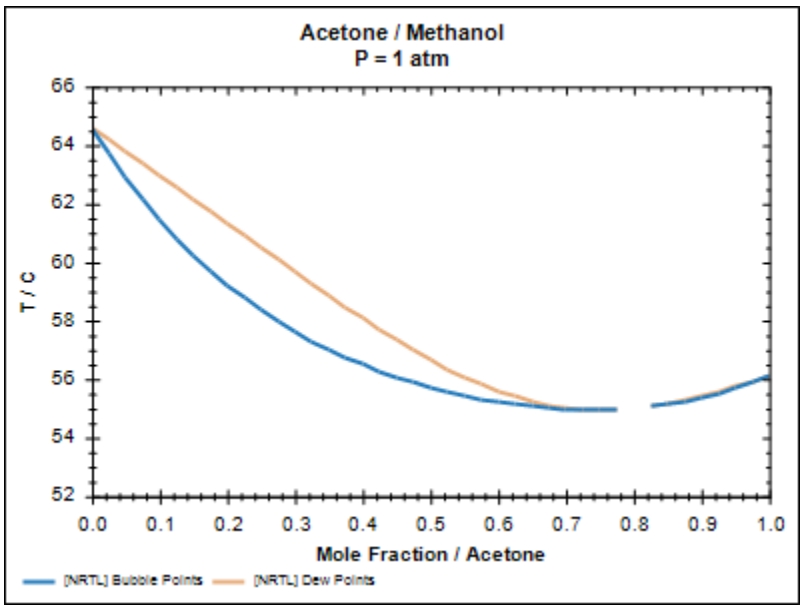
BACKGROUND:

Acetone is used as a direct solvent and as a pioneer to the production of Methyl Methacrylate (MMA), Methacrylic Acid, Bisphenol-A, aldol chemicals to name among many. The use of MMA in LCD, Polycarbonate dental fillings from Bisphenol play an indirect role of demand for acetone in consumer electronics and industrial chemicals. Acetone and methanol have very similar normal boiling points (329.2 and 337.5K) and form a homogeneous minimum-boiling azeotrope at 1atm with a composition77.6mol% acetone at 328K.



Three solvents are explored that have different normal boiling points (373K for water, 464K for DMSO, and 405K for chloro-benzene). The first and second solvents drive the acetone overhead while chloro-benzene drives the methanol overhead in the extractive column.

PROCESS OVERVIEW:

540 kmol/hr of an equal-molar Acetone -Methanol mixture is fed to 24th stage of a 36th staged extractive distillation column. The entrainer from the recovery column along with the makeup stream is fed to the 4th stage giving an overhead pure acetone. The DMSO, heavy key(methanol) along with traces of acetone is fed to 8th stage of a 16th staged entrainer recovery column. High purity methanol is obtained at the overhead with pure DMSO at the bottom which is recycled back to the extraction column.

RESULTS:

The extractive column has three design degrees of freedom once the total stages and feed locations are fixed:

1.Reflux ratio
2.Solvent flow rate
3. Reboiler heat input.

STREAM	PURE METHANOL	PURE ACETONE	MET-DMSO	MAKE UP	FEED	ENTRAINER RECYCLE	ENTRAINER	DMSO	COOLED DMSO
Temperature (°C)	64.0657	56.134	117.243	46.85	46.85	46.85	46.85	189.203	46.85
Pressure (atm)	1	1	1	1	1	1	1	1	1
Molar Flow (kmol/h)	269.973	270.033	1019.98	0.01	540	750.004	750.01	750.004	750
Molar Fraction (Mixture) / Acetone	0.000377808	0.9995	0.0001	0	0.5	5.20564E-12	9.99987E-13	5.20564 E-12	1E-12
Molar Fraction (Mixture) / Methanol	0.999622	0.000479299	0.26465	0	0.5	0.0001	0.000100089	0.0001	0.0001000
Molar Fraction (Mixture) / Dimethyl sulfoxide	8.36209E-14	2.07012E-05	0.73524	1	0	0.9999	0.9999	0.9999	0.9999

CONCLUSIONS AND RECOMMENDATIONS:

1. It can be difficult to achieve the desired acetone product purity in this extractive distillation because of the competing effects of solvent flow rate and reflux ratio. This problem becomes less severe as the volatility difference between the light key component and the solvent increases.

2. The acetone–water system does not have a large volatility, which leads to difficulty in attaining the desired acetone purity. Other solvents with higher boiling points should permit higher acetone purities (preferably with DMSO as compared to water).

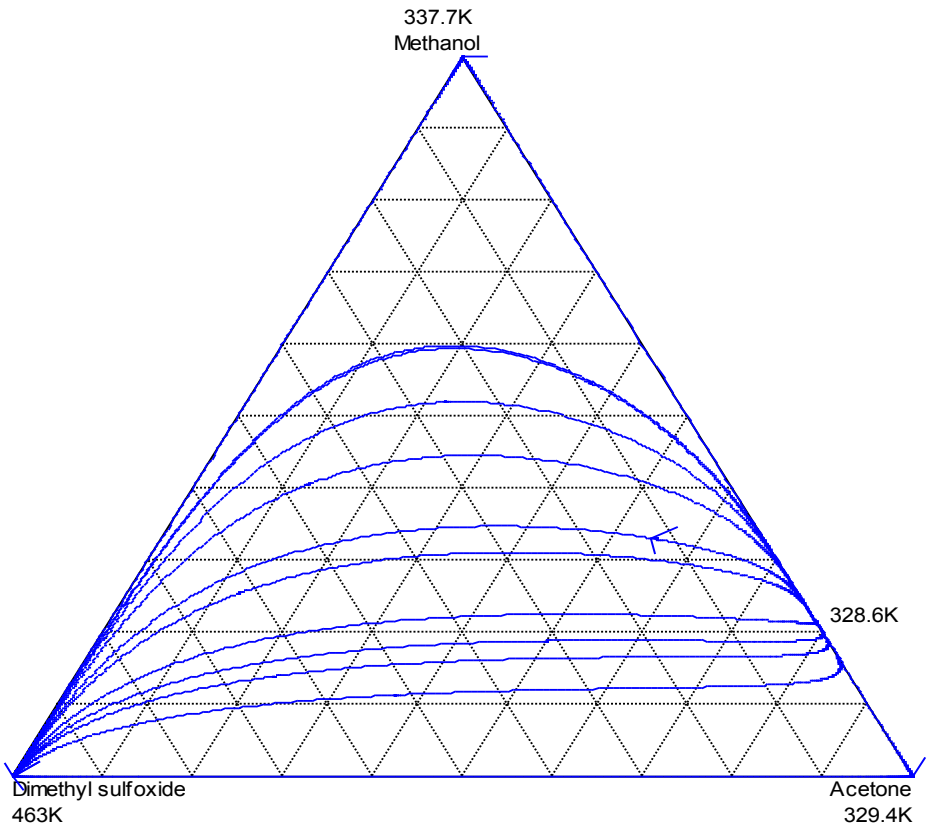
3. However, the base temperature in the solvent recovery column would be higher, which would require a higher-cost energy source. The non-monotonic relationship between acetone purity and reflux ratio can also lead to difficult operating problems, as pointed out by Knapp and Doherty.

4. This inherent problem of an extractive distillation should be compared to the ease of attaining higher purity levels in a pressure-swing distillation system. Very high product purities can easily be obtained with only modest increases in energy costs in the pressure-swing distillation system.

5. Residue curve - composition trajectory of the residue liquid in the still during open equilibrium evaporation.

Residue curve map - diagram that shows residue curves for different initial still composition for a given mixture in the composition space.

Saddle - singular point with finitely many paths both approaching and depart.



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