EXTRACTIVE DISTILLATION OF ISO PROPANOL - WATER MIXTURE USING DIMETHYL SULFOXIDE

INTRODUCTION:

The demand of Isopropyl alcohol (IPA) is projected to increase with respect to its applications as a solvent in automobile industries. It is also used along with propyl alcohol as a cleaning solvent. It forms a low boiling hetero-azeotrope with water. Methods for recovery of IPA were suggested which involves bringing the feed to near azeotropic conditions and subsequent separation through a decanter. However, this method involves multiple steady states, sensitivity in selection of thermodynamic models, longer time lag and non linear dynamics that interferes with controlling feed disturbances. Extractive distillation with Dimethyl Sulfoxide (DMSO) introduces a higher boiling mixture, increased separation factor which is feasible for separation.

PROCESS:

Equi molar mixture of "Isopropanol/Water" is fed to the 35th stage of 41 staged extractive distillation column with the solvent DMSO(Di-Methyl Sulfoxide) fed to the 7th stage. The presence of entrainer alters the relative volatility between the two, causing pure IPA to move towards the top and DMSO/Water mixture towards the bottom of the column.

The mixture is fed into the 9th stage of a 24 stage recovery column to produce almost pure water at the top and almost pure solvent at the bottom. It is recycled back to the extractive distillation column and merged with one additional pure make-up stream to account for the solvent losses

RESULTS:

OBJECT	WATER	RECYCLE	PURE IPA	FEED	DMSO-WATER	DMSO	
Temperature	99.4619	196.61	82.3485	79.05	142.487	189.233	C
Pressure	1	1	1	1	1	1	atm
Molar Flow	50.3903	102.5	49.9547	100	152.545	102.155	kmol/h
IPA Fraction	0.000999	8.15E-20	0.9999	0.5	0.00033	1.3005E-16	
Water Fraction	0.992155	5.56E-07	0.0001	0.5	0.327739	5.56E-07	
DMSO Fraction	0.00684554	0.999999	2.76258E-11	0	0.671931	0.999999	

CONCLUSIONS AND RECOMMENDATIONS:

1. In extractive distillation, infinite reflux does not always imply maximum separation. Separations which are infeasible at infinite reflux may be feasible at finite reflux. This is an important property of extractive distillation and plays an important role in the entrainer selection procedure.

2. DMSO has the largest separation factor ($\alpha = 5.108$) and also introduces no further azeotrope in the system. In comparison, the separation factor for ethylene glycol for this system is lower at 4.234.

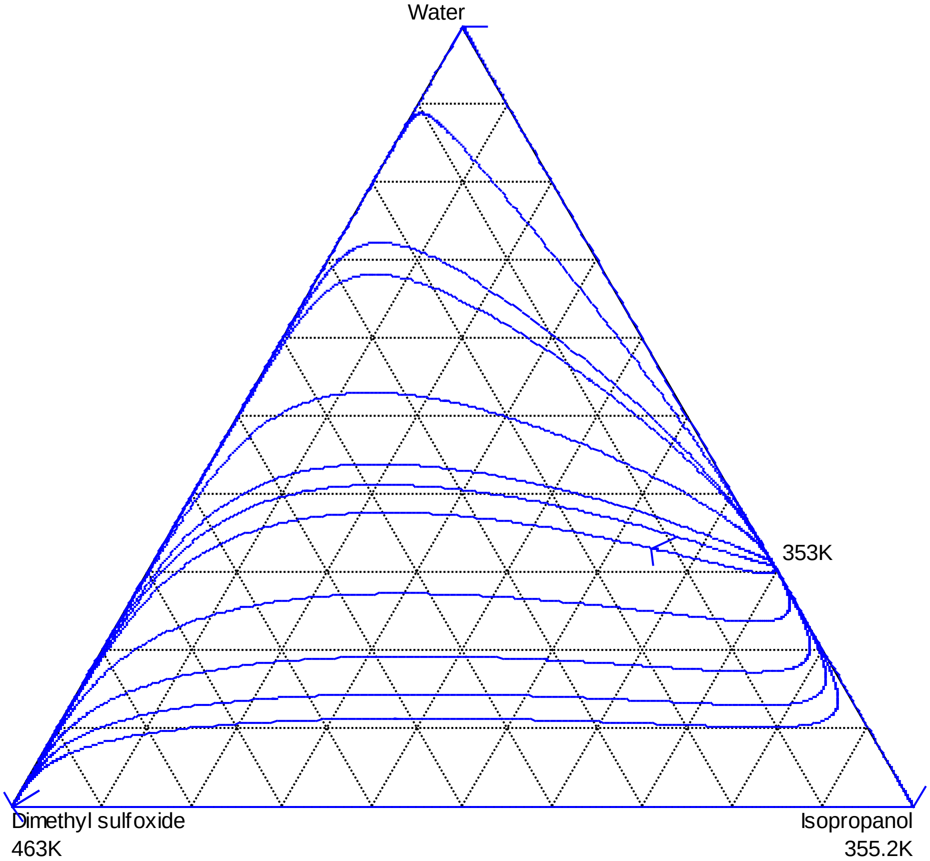
3. The NRTL model parameters of the IPA-H2O pair are taken from the work of Wang et al and the model parameters of the other two pairs are taken from Aspen Plus. This factor explains the robustness of the Chem-Sep model. Since an open source cant adopt these parameters; in built UNIFAC group contribution methods do give a reasonable approximations. The results with and without incorporation of interaction parameters is shown.

	IPA	WATER	DMSO
WATER (UNIFAC)	0.000999	0.992155	0.00684
WATER (PARAMETERS LOADED)	0.000999	0.999	0.0000001

4. 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 compositions for a given mixture in the composition space.

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



From the RCM, we can see that the IPA-H2O azeotrope is the unstable node, DMSO is the stable node, and both IPA and water are the saddles. For the equi-volatility curves, the relative volatility between IPA and water was calculated in the presence of DMSO and the equal values of the relative volatility at different compositions were collected. It is noticed that the IPA/water mixture can be separated easier in the presence of DMSO because of higher values of the relative volatility.

REFERENCES:

1. Design and Control of an Isopropyl Alcohol Dehydration Process via Extractive Distillation Using Dimethyl Sulfoxide as an Entrainer -- Saiful Arifin and I-Lung Chien.
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3.Market Research Future - Isopropanol.