Design and Control of a Complete Azeotropic Distillation System for Isopropyl Alcohol Dehydration

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Background

The heterogeneous azeotropic distillation systems are frequently encountered in the chemical process industry for separating mixtures of close boilers or breaking azeotropes. One often applies this technique in industrial dehydration processes, such as alcohol dehydration and acetic acid dehydration.

The study considers the design of isopropyl alcohol (IPA) dehydration system with a feed composition of 61.032 mol % IPA and 38.968 mol % water and a feed rate of 82.3848 kmol/h at 82.7°C. Cyclohexane is used as an entrainer for the system, and a decanter is employed to separate the aqueous phase and organic phase. Purities are set at 99.9 mol % IPA for the IPA product stream and 99.9 mol % H2O for the water stream.

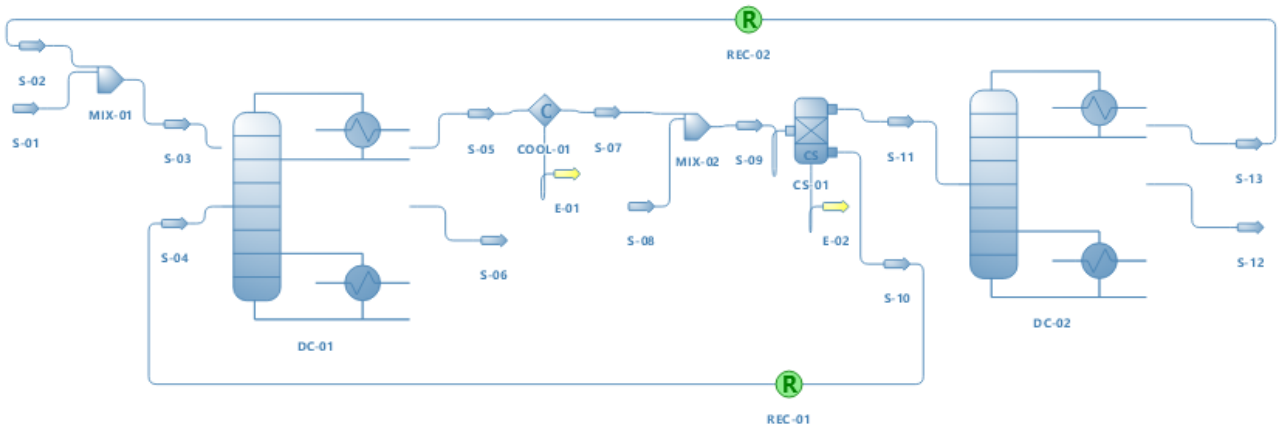
Description of the Flowsheet

The flowsheet has two distillation columns labelled "DC-01" and "DC-02." DC-01 comprises 20 trays, with the second tray serving as the feed site for feed S-03. DC-02 contains 9 trays, with the first tray serving as the feed site for the feed S-11. As an entrainer, cyclohexane has been employed. S-08 is a cyclohexane feed that modifies the relative volatility of isopropanol and water. COOL-01 serves column DC-01 as a condenser. In the reflux, a decanter is utilised to separate the isopropanol and water layers. DC-01 receives the isopropanol layer. DC-01 bottoms contain pure isopropanol of 99.9% purity, whereas DC-02 bottoms contain pure water of 99.9% purity. DC-02's top product is recycled and blended with the original feed to serve as feed for column DC-01.

System of Units

The system of units used was ‘C5’. The important parameter units are Temperature- °C, Pressure- Bar, Mass Flow Rate- kg/h, Molar Flow Rate- kmol/h.

Flowsheet



Results

Master Property Table						
Object	S-12	S-11	S-06	S-03	S-01	
Temperature	99.9561	40	82.3623	89.3546	82.7	C
Pressure	1.01325	1.01325	1.01325	1.01325	1.01325	bar
Molar Flow	28.6473	161.032	42.9242	214.769	82.3848	kmol/h
Molar Fraction (Mixture) / Cyclohexane	1.37556E-17	0.0398829	3.82793E-17	0.0299037	0	
Molar Fraction (Mixture) / Isopropanol	0.001	0.457848	0.999	0.577273	0.61032	
Molar Fraction (Mixture) / Water	0.999	0.502269	0.001	0.392823	0.38968	

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