

# Design and Control of Heterogeneous Azeotropic Column System for the Separation of Pyridine and Water

Anuj Desai & Bloch Sohil  
Sardar Vallabhbhai National Institute of Technology, Surat

## Background

Heterogeneous azeotropic distillation is commonly used in industry to separate mixtures of close relative volatility and breaking azeotropes. The advantage of this separation is to utilize a natural liquid-liquid separation in a decanter.

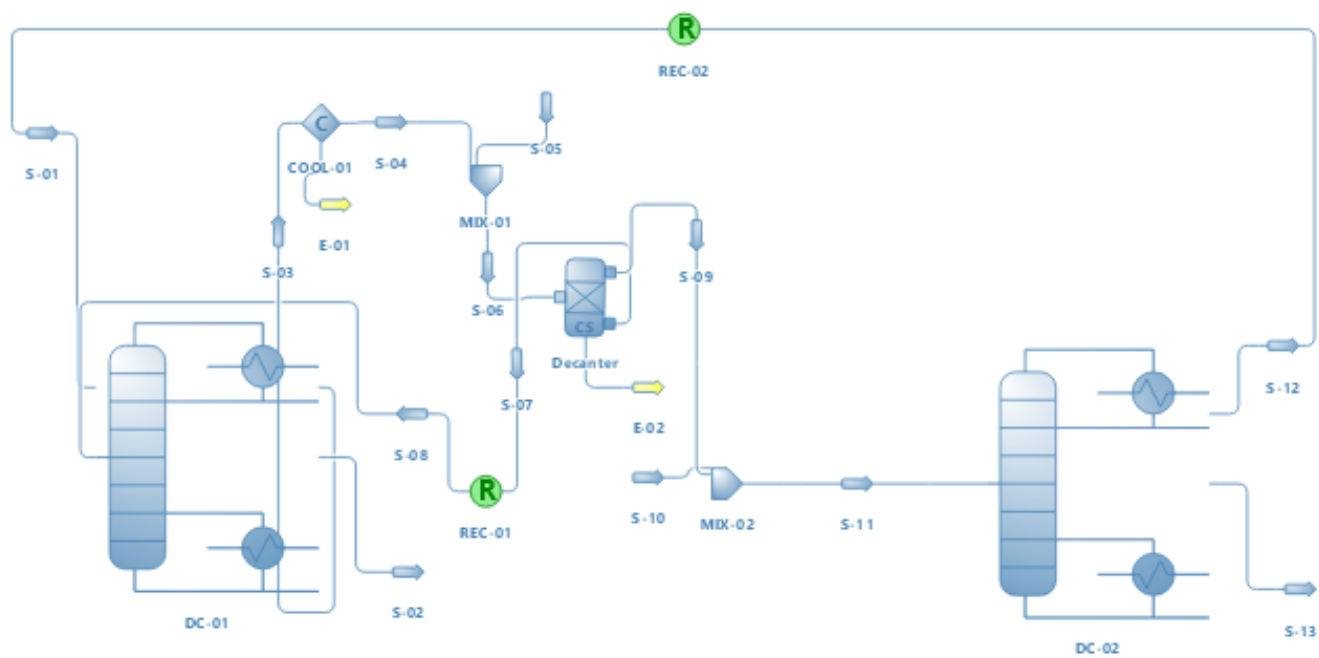
A pyridine-water mixture has an azeotrope with a composition of around 77 mol % H<sub>2</sub>O and azeotropic temperature of 94.89 °C. By adding toluene into the system, two additional azeotropes are formed. One desirable azeotrope (toluene-water) is heterogeneous with an azeotropic temperature of 84.53 °C, which is the minimum temperature for the entire ternary system. Another azeotrope between pyridine and toluene is also formed with a higher azeotropic temperature of 110.15 °C.

## Description of the flowsheet

The flowsheet contains two distillation columns named “DC-01” and “DC-02”. DC-01 has 14 trays and 6<sup>th</sup> tray is the feed location for feed S-01. DC-02 has 10 trays and 6<sup>th</sup> tray is the feed location for the feed S-11. Toluene has been used as an entrainer. S-05 is toluene feed which alters the relative volatility between pyridine and water. COOL-01 act as condenser for column DC-01. Decanter is used in the reflux to separate the pyridine and water layers. The pyridine layer is sent to DC-01 while water layer gets mixed with the S-10.

Pure pyridine of 99.96% purity is obtained as DC-01 bottoms and water of 99.9 % purity is obtained as DC-02 bottoms. The top product of DC-02 is recycled and act as feed for column DC-01.

## Flowsheet



## Results

Object	S-13	S-11	S-03	S-02	S-01	
Temperature	99.8363	24.8878	103.344	118.098	94.7984	C
Pressure	1.01325	1.01325	1.11458	1.11458	1.01325	bar
Mass Flow	16283.3	31414.2	37284.2	7844.05	15130.9	kg/h
Molar Flow	900.809	1391.21	761.076	99.1998	490.399	kmol/h
Volumetric Flow	16.9923	31.5705	21374	8.97265	14805.7	m3/h
Molar Fraction (Mixture) / Toluene	5.13222E-19	5.0615E-05	0.0749771	3.55914E-06	0.000143589	
Molar Fraction (Mixture) / Water	0.999	0.925274	0.508946	0.000437064	0.789848	
Molar Fraction (Mixture) / Pyridine	0.001	0.0746751	0.416077	0.999559	0.210008	

Reference: <https://pubs.acs.org/doi/abs/10.1021/ie901231s>