Separation of Toluene and 2,2,4-Trimethylpentane Using Phenol in a Dual-Column Extractive Distillation Process

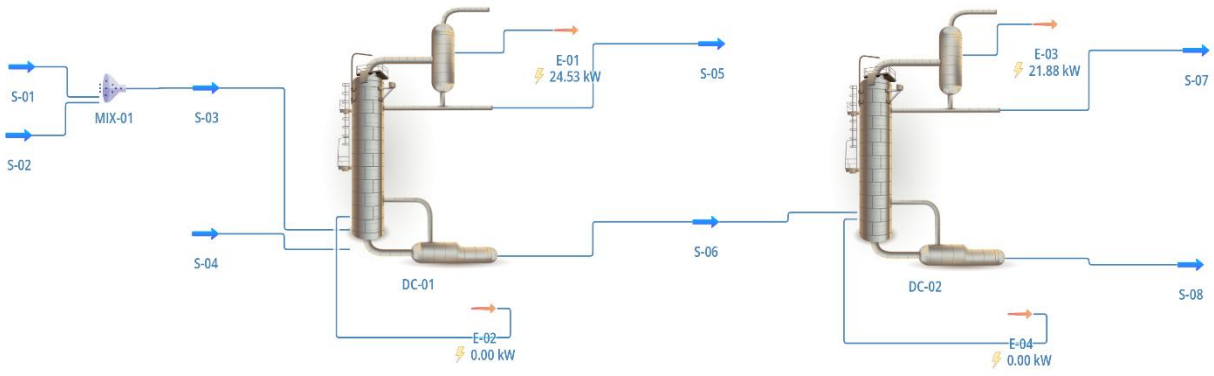
Samruddhi Vishnu Suryavanshi

AISSMS College Of Engineering Pune

Background & Description:

Toluene and 2,2,4-trimethylpentane (isooctane) exhibit close-boiling characteristics with a very small difference in relative volatility, making conventional distillation difficult, energy-intensive, and incapable of achieving high purity. To overcome this limitation, extractive distillation is applied, where a high-boiling solvent is fed to selectively modify component volatility. Phenol is commonly used as an extractive solvent for separating aromatic and aliphatic hydrocarbons due to its strong affinity toward aromatics such as toluene, along with its high boiling point, low vapor pressure, and good thermal stability that minimize solvent loss in the overhead stream. In the present process, a dual-column extractive distillation configuration is implemented. The first column performs the extractive separation by introducing phenol above the hydrocarbon feed, allowing phenol to preferentially associate with toluene and keep it in the liquid phase, while isooctane exits as the top distillate product. The second column (solvent recovery column) separates phenol from the toluene-rich bottoms stream, and toluene is obtained as a high-purity top product. This integrated configuration enhances separation efficiency.

Flowsheet:



Results:

Object	S-08	S-07	S-06	S-05	S-04	S-03	S-02	S-01	Unit
Temperature	155.365	109.371	116.918	100.091	25	34.8752	45	25	C
Pressure	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	bar
Mass Flow	55.7851	43.8925	99.6776	50.3224	50	100	50	50	kg/h
Energy Flow	-10.6693	2.65931	-16.6774	-28.1436	-24.4086	-29.192	2.31503	-31.507	kW
Mass Flow (Mixture) / 2,2,4-trimethylpentane	3.61565E-16	1.38859	1.38859	48.6114	0	50	0	50	kg/h
Mass Flow (Mixture) / Toluene	5.78508	42.5039	48.289	1.71098	0	50	50	0	kg/h
Mass Flow (Mixture) / Phenol	50	6.10609E-15	50	5.89895E-13	50	0	0	0	kg/h

Conclusion:

The dual-column extractive distillation using phenol successfully separates toluene and 2,2,4-trimethylpentane. Isooctane is recovered as a high-purity top product, while toluene remains in the bottoms. Phenol effectively enhances the separation by altering relative volatility, though it is consumed as fresh solvent. The process demonstrates that extractive distillation can efficiently separate close-boiling hydrocarbon mixtures.