An Extractive Distillation System for Benzene-Acetonitrile Separation Using Dimethyl Sulfoxide as an Entrainer

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Unit System: Pressure-Kpa; Molar Flow-kg/hr; Other-SI

Background

Hydrocarbons like Acetonitrile and Benzene are important raw materials in the manufacturing of polymeric products and as a solvent. They often require high-purity Acetonitrile and Benzene. Acetonitrile is widely used mainly as a solvent in the purification of butadiene in refineries it is widely used in battery applications because of its relatively high dielectric constant and ability to dissolve electrolytes. For similar reasons it is a popular solvent in cyclic voltammetry. Acetonitrile plays a significant role as the dominant solvent used in the manufacture of DNA oligonucleotides from monomers.Industrially, it is used as a solvent for the manufacture of pharmaceuticals and photographic film.The mixer of Acetonitrile and Benzene can not be seperated out by the simple distillation column because of the less difference between their boiling point (near 1.5 K) and same boiling point behaviour of azeotrope.

Extractive Distillation of Close Boiling Compounds

Extractive distillation is the method of separating close boiling compounds from each other by carrying out the distillation in a multiple columns in the presence of an added liquid or liquid mixture.1 This Liquid or Liquid mixture is known as extractive agent or entrainer. The presence of the entrainer alter the volatility of compounds and thus the degree of separation is increase with the same numbers of plate. This entrainer must have high boiling point than the compounds which are going to separated.

Description of Flow-Sheet

The flow sheet contain total two distillation columns named “Extractive distillation column" and “Entrainer recovery column".Here we use the DiMethyl Sulfoxide (DMSO) as entrainer and mixer of Acetonitrile and Benzene as feed.The presence of DMSO alters the relative volatility between Acetonitrile and Benzene and to make Benzene move toward the top part and Acetonitrile move to the bottom part of the column.The “Extractive distillation" take entrainer and feed and give the pure Benzene as top product and the bottom product which has the acetonitrile and DMSO are enter to the “Entrainer recovery" column; which separate out Acetonitrile and the DMSO, this recovered DMSO are recycled to the “Extractive distillation". Feed rate with the composition of compounds and the other necessary data for the column are shown in the table in Result section with the Top and Bottom products.

Result

Name	Extractive Distillation	Entrainer Recovery
Pressure (Kpa)	43.57	33.44
Total Stages	47	12
Feed (Kg/hr)	3500	10194.6

%(mol/mol) %(mol/mol) %(mol/mol)	Benzene(65.5%) Acetonitrile (34.5%)	Benzene (0.0%) Acetonitrile (13.80%) DMSO (86.20%)
Feed Stage	38	7
2nd Feed (Kg/hr) (%mol)	9009.03 DMSO (100%)	-
2nd Feed stage	4	-
Top (Kg/hr) (%mol) (%mol)	2314.45 Benzene (99.9%) Acetonitrile (0.09%)	1186.19 Benzene (0.08%) Acetonitrile (99.91%)
Bottom (Kg/hr) (%mol) (%mol) (%mol)	10194.6 Benzene (0.0%) Acetonitrile (13.80%) DMSO (86.20%)	9008.4 DMSO (99.99%)

References

https://pubs.acs.org/doi/abs/10.1021/ie4008425