Triple Column Extractive Distillation Process to Separate the Mixture (Ethyl Acetate-Ethanol-Water) using Dimethyl Sulfoxide as Entrainer

Charles Spurgeon S

Vignan's Foundation for Science, Technology and Research

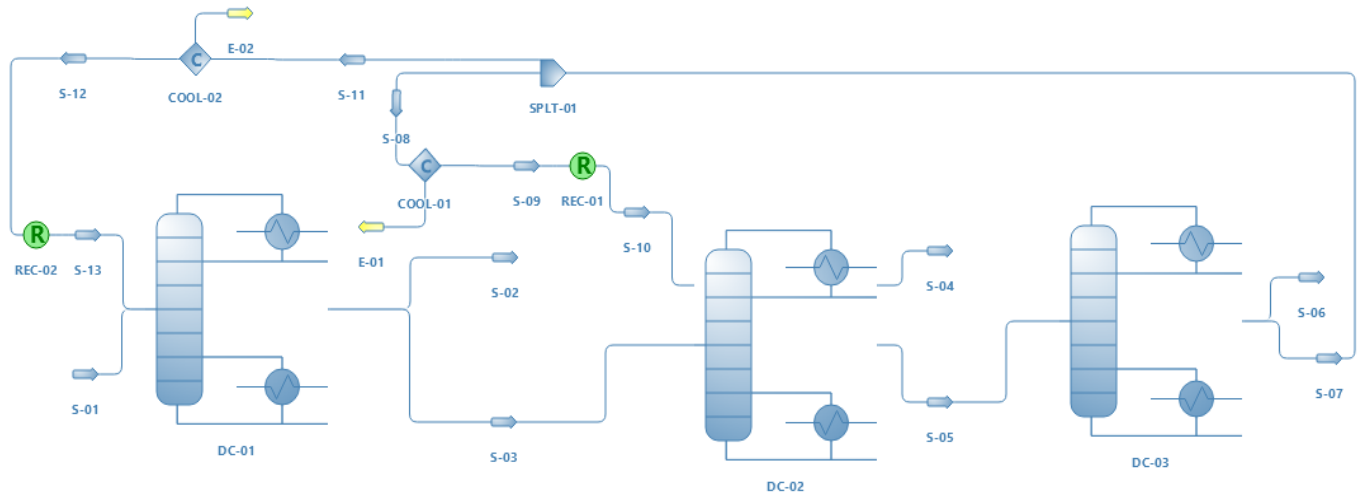
Background and Description:

Many biochemical and pharmaceutical industries frequently use Ethyl Acetate(EtAC) and Ethanol(EtOH) as organic solvent and raw materials. EtAC/EtOH/water mixtures are generated in the process of n-Butanol synthesis. Ethyl acetate is a widely used solvent, especially for paints, varnishes, lacquers, cleaning mixtures, and perfumes. Ethanol acts as an astringent to help clean skin, as a preservative in lotions and it also helps in ensuring that lotion ingredients do not separate, and it helps hairspray adhere to hair. Ethanol is good in killing microorganisms like bacteria, fungi and viruses, it is a common ingredient in many hand sanitizers.

Process:

Here the feed containing EtAC/EtOH/Water mixture and small tracers of Acetaldehyde and Butanol enters DC-01 and gives the top product with 99% Ethyl Acetate and tracers of other compounds through stream S-02. The bottom product of DC-01 then enters DC-02 and gives the top product with 99% of Ethanol and small tracers of other compounds through stream S-04. The bottom product of DC-02 then enters to DC-03 and gives the top product with 99% water and small amount of tracers of other compounds through stream S-06. The bottom product of DC-03 containing 99% of DMSO is then sent to splitter(SPLT-01) through stream S-07. The splitter then splits S-07 into S-08 and S-11. The material stream S-08 and S-11 are then connected to cooler COOL-01 and COOL-02. The outlet of the coolers are then fed to recycle block which is then fed back to DC-01 and DC-02 through the material stream S-10 and S-13 containing DMSO.

Flowsheet:



Results:

Master Property Table-Triple Column Extraction Distillation Process for Separation of Ethyl Acetate-Ethanol-Water mixture Using DMSO as Entrainer										
Parameters	S-01	S-02	S-03	S-04	S-05	S-06	S-07	S-10	S-13	Units
Temperature	70	16.0389	80.9837	38.4047	141.96	53.9347	177.798	50	50	C
Pressure	6.87E+06	8	43	20	81.325	15	75	24.5239	9.80879	kPa
Mass Flow	71350.1	53373.9	79074.7	14223	94945	3758.78	91186.2	30091.4	61094.7	kg/h
Molar Flow	1124	608.007	1297.97	308.011	1375.11	208.054	1167.06	385.129	781.928	kmol/h
Molar Fraction (Mixture)-Ethyl acetate	0.5381	0.992395	0.001111	0.004681	5.00E-16	3.31E-15	0	0	0	
Molar Fraction (Mixture)-Ethanol	0.2759	0.00742	0.235445	0.992172	2.50E-13	1.66E-12	3.18E-23	3.18E-23	3.18E-23	
Molar Fraction (Mixture)- 1-butanol	0.0001	7.73E-18	8.66E-05	2.01E-08	8.17E-05	0.00054	1.39E-10	1.39E-10	1.39E-10	
Molar Fraction (Mixture)-Water	0.1858	3.67E-14	0.160897	0.003147	0.151166	0.999114	3.01E-10	3.01E-10	3.01E-10	
Molar Fraction (Mixture)-Dimethyl sulfoxide	0	6.90E-12	0.602461	1.17E-06	0.848752	0.000346	1	1	1	
Molar Fraction (Mixture)-Acetaldehyde	0.0001	0.000185	4.88E-18	2.06E-17	2.83E-22	5.21E-19	1.48E-20	1.48E-20	1.48E-20	

Here we get almost 99% of Ethyl Acetate at stream(S-02), 99% of Ethanol at stream(S-04) and 99% of Water at stream(S-06). And the obtained entrainer i.e., DMSO from DC-03 is recycled back to DC-01 and DC-02 using a stream splitter.