

Separation of close boiling mixtures 1-butanol and 2-methyl-1-propanol

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Background & Description:

The boiling points of 2-methyl-1-propanol and butanol are 107.3 and 117.3 °C respectively. It is difficult to obtain them separately from their mixture because the boiling points of *n*-butanol and iso-butanol are very close. Therefore, to separate out, a conventional distillation process is used. Butanol has numerous applications as an automotive **fuel** and in the chemical industry. 2-methyl-1-propanol is used in lubricants and greases, coating products, adhesives and sealants, washing & cleaning products, finger paints, polishes and waxes, anti-freeze products, inks and toners, cosmetics and personal care products and perfumes and fragrances.

For the Conventional Distillation process, the feed stream flows at 5000 kg/h, composed of 55 wt% *n*-butanol and 45 wt% iso-butanol, at 130 kPa and 120 °C. The specifications for the purity of *n*-butanol and iso-butanol products are all set at 99.1 wt%. The top stage/condenser pressure is 100 kPa with the stage pressure drop of 0.75 kPa.

The simulation results of optimal feed stage is 27, total number of stages is 58, Condensor duty is 1683.92 kW and reboiler duty is 1676.47. 98.99% of 2-methyl 1-propanol is obtained at the reflux ratio of 5.57687, which increases to about 99.1% as we increase the reflux ratio from 5.57687 to 6. 99% butanol is obtained at the reflux ratio of 5.57687. We try to keep the reflux ratio as minimum as possible as the reboiler duty increases with increase in reflux ratio. This is the main part of the distillation column that consumes energy.

Flowsheet:

DWSIM - [conventional distillation of close boiling butanol and 2-methyl-1-propanol (C:\Users\NAVINETRA\Desktop\Fossee\conventional distillation of close boil)]

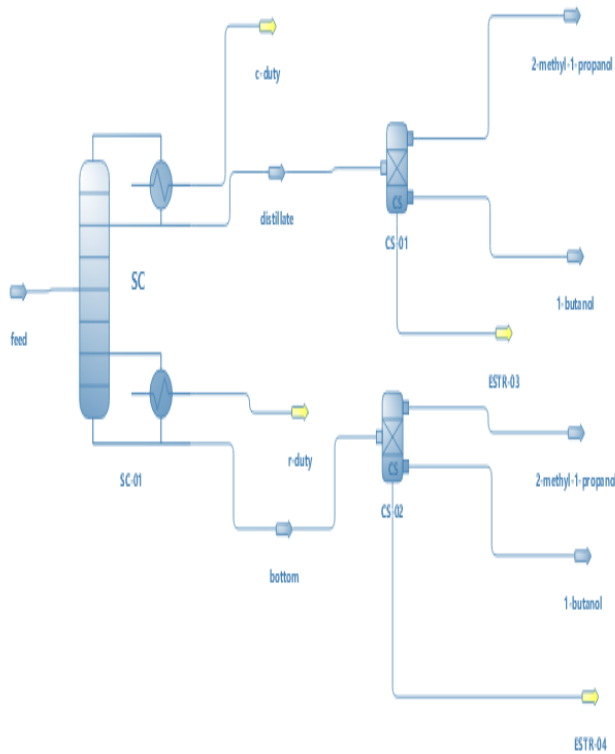
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Material Streams Spreadsheet Charts Flowsheet Dynamics Manager Script Manager

Control Panel Mode Search

90%



master table for conventional distillation

Object	feed	distillate	bottom	2-methyl-1-propanol	1-butanol	
Temperature	120	107.382	117.448	117.448	117.448	°C
Pressure	1.3	1	0.9925	0.9925	0.9925	bar
Mass Flow	3600	1616.26	1983.67	19.836	1963.84	kg/h
Molar Flow	48.5688	21.8064	26.7614	0.267614	26.4948	kmol/h
Volumetric Flow	5.02892	14.758	38.6766	8.75627	2.71766	m³/h
Density (Vapor)	0	2.34284	2.26535	2.26535	0	kg/m³
Molecular Weight (Vapor)	0	74.1216	74.1216	74.1216	0	kg/mol
Dynamic Viscosity (Vapor)	0	9.87059E-06	9.79166E-06	1.01369E-05	0	Pas
Heat Capacity (Vapor)	0	1.82262	1.8206	1.86	0	kJ/(kg.K)
Compressibility Factor (Vapor)	0	1	1	1	0	
Molar Fraction (Vapor)	0	0.0182139	0.0411639	1	0	
Mass Fraction (Vapor)	0	0.0182147	0.0411624	1	0	
Volumetric Fraction (Vapor)	0	0.851452	0.93194	1	0	
Density (Liquid 1)	715.86	723.856	722.53	0	722.621	kg/m³
Molar Weight (Liquid 1)	74.1216	74.1216	74.1216	0	74.1216	kg/mol
Dynamic Viscosity (Liquid 1)	0.000406365	0.000483773	0.000436024	0	0.000436323	Pas
Heat Capacity (Liquid 1)	3.50723	3.45534	3.42521	0	3.42394	kJ/(kg.K)
Molar Fraction (Liquid 1)	1	0.981786	0.958836	0	1	
Mass Fraction (Liquid 1)	1	0.98183	0.958801	0	1	
Volumetric Fraction (Liquid 1)	1	0.148548	0.0680604	0	1	
Molar Fraction (Vapor) / 1-butanol	0.439076	0.00685761	0.985855	0	1	
Molar Fraction (Liquid 1) / 1-butanol	0.55	0.010587	0.990178	0	1	
Molar Fraction (Vapor) / 2-methyl-1-propanol	0.540304	0.993142	0.014145	1	0	
Molar Fraction (Liquid 1) / 2-methyl-1-propanol	0.45	0.989941	0.00982169	1	0	

Results:

Results

Property	Value	Units
Minimum Reflux Ratio	4.93875	
Minimum Number of Stages	25.1971	
Actual Number of Stages	57.2277	
Optimal Feed Stage	27.3645	
Stripping Liquid	170.181	kmol/h
Rectify Liquid	121.612	kmol/h
Stripping Vapor	143.419	kmol/h
Rectify Vapor	143.418	kmol/h
Condenser Duty	1683.92	kW
Reboiler Duty	1676.47	kW

Simulation Report

DWSIM 6.4

Details

Title: MySimulation_15

Comments:

Temperature	117.448	C
Pressure	0.9925	bar
Mass Flow	1983.67	kg/h
Molar Flow	26.7614	kmol/h
Volumetric Flow	38.6766	m3/h
Mixture Molar Fraction		
1-butanol	0.990036	
2-methyl-1-propanol	0.01	
Density (Mixture)	51.2887	kg/m3
Molecular Weight (Mixture)	74.1243	kg/kmol
Specific Enthalpy (Mixture)	-404.605	kJ/kg
Specific Entropy (Mixture)	-0.974313	kJ/[kg.K]
Molar Enthalpy (Mixture)	-29991	kJ/kmol
Molar Entropy (Mixture)	-72.2203	kJ/[kmol.K]
Thermal Conductivity (Mixture)	0.135081	W/[m.K]
Molar Fraction (Vapor)		
1-butanol	0.985855	
2-methyl-1-propanol	0.014145	
Molar Fraction (Overall Liquid)		
1-butanol	0.990178	
2-methyl-1-propanol	0.00982169	
Molar Fraction (Liquid 1)		
1-butanol	0.990178	
2-methyl-1-propanol	0.00982169	
Molar Fraction (Liquid 2)		
1-butanol	0	
2-methyl-1-propanol	0	
Molar Fraction (Aqueous)		
1-butanol	0	
2-methyl-1-propanol	0	
Molar Fraction (Solid)		
1-butanol	0	
2-methyl-1-propanol	0	

Object: distillate

Type: Material Stream

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Property Value