Design and Control of Distillation Processes for Methanol – Chloroform Separation

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Abstract:

Methanol is the simplest alcohol, being only a methyl group linked to a hydroxyl group. It is a light, volatile, colorless, flammable liquid with a distinctive odor very similar to that of ethanol (drinking alcohol). However, unlike ethanol, methanol is highly toxic and unfit for consumption. At room temperature, it is a polar liquid. It is used as an antifreeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel by transesterification reaction. Methanol is used primarily as a feedstock for the manufacture of chemicals, and as a fuel for specialized vehicles. Chloroform, or trichloromethane, is an organic compound with formula $CHCl_3$. It is a colorless, sweet-smelling, dense liquid that is produced on a large scale as a precursor to PTFE. It is also a precursor to various refrigerants. In terms of scale, the most important reaction of chloroform is with hydrogen fluoride to give monochlorodifluoromethane (CFC-22), a precursor in the production of polytetrafluoroethylene. It is also used as an anesthetic, solvent and a reagent in several other chemical processes. The binary mixture of

methanol–chloroform exhibits a minimum-boiling azeotrope with ~34 mol% methanol at 327 K under atmospheric pressure. Therefore, we need to carry out Extractive Distillation to separate both methanol and chloroform. However, now a day's a new method known as Pressure Swing Distillation has come into picture and can be used. It is also found to be more economical than the Extractive Distillation method as no extra solvent is required to achieve the separation. Therefore, in this work Pressure Swing Distillation for the separation of Methanol and Chloroform has been carried out.

Process Description:

In this process first the feed stream containing 0.5 mole fraction Methanol and 0.5 mole fraction Chloroform is sent to a distillation column which has 24 stages. The feed is send to stage number 9 whereas the recycled feed is sent to stage number 18. The flow rate of the feed is around 100 kmol/hr., 300K and the recycle ratio of the tower is 0.55. The first distillation column produces bottom with 0.995 mole fraction methanol. The distillates of the first column are sent to a second distillation column. The second distillation column has a reflux ratio of 0.95 and it produces distillates which are recycled back to the first distillation column and the bottom product has a composition of 0.995 mole fraction Chloroform. The first distillation column is a low pressure distillation column maintained at a pressure of 1 atm whereas the second distillation column is a high pressure distillation column maintained at a pressure of 10 atm.

Results:

Property Table							
Object	B1	B2	D1	D2	Fresh Feed	Recycled Feed	
Temperature	337.51523	425.233	326.12399	404.85893	300	404.85893	K
Pressure	1	10	1	10	1	10	atm
Molar Flow	49.939817	49.95334	134.4035	84.450164	100	84.450164	kmol/h
Molar Fraction (Mixture) / Methanol	0.995	0.005	0.35538956	0.56264941	0.5	0.56264941	
Molar Fraction (Mixture) / Chloroform	0.005	0.995	0.64461044	0.43735059	0.5	0.43735059	

References:

1. Eda Hosgor, Tugba Kucuk, Ilayda N. Oksal, Devrim B. Kaymak, Design and control of distillation processes for methanol–chloroform separation, Computers & Chemical Engineering, Volume 67, 2014, Pages 166-177, ISSN 0098-1354, https://doi.org/10.1016/j.compchemeng.2014.03.026.