Pressure-Swing Distillation of Dimethyl Carbonate And Methanol System

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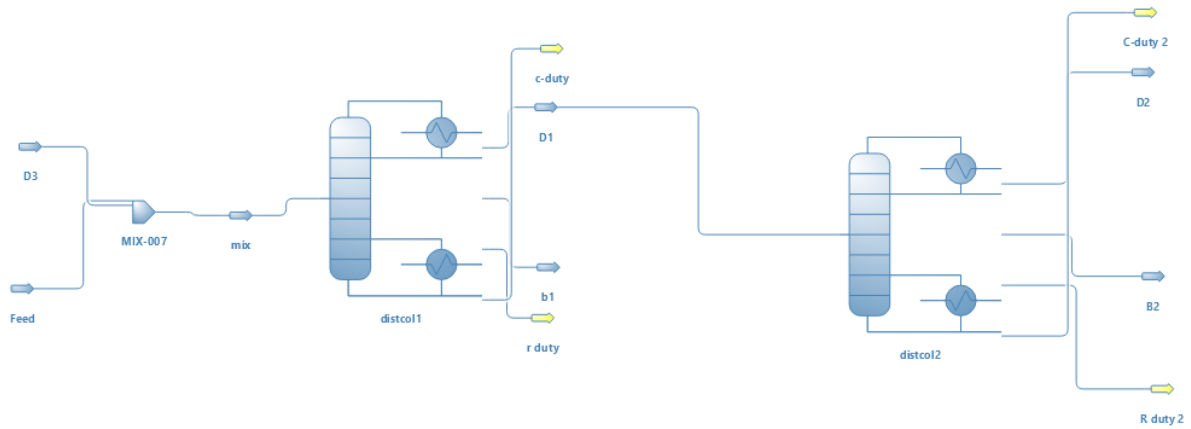
Background & Description:

Separation of dimethyl carbonate - methanol azeotropic mixture by using distillation process has been a serious concern while synthesis process of dimethyl carbonate by urea methanolysis method. separation of this azeotropic mixture is essential to obtain pure DMC product and pure methanol. Two of the most common methods for separating the binary homogeneous azeotrope are extractive distillation and pressure-swing distillation (PSD). Extractive distillation method is energy efficient if a suitable solvent can be found but may cause environmental problems. Pressure-swing distillation is used when the azeotropic temperature and composition are sensitive to the operating pressure. A two-column system can be used to achieve the desired separation. It may cause high energy cost, but it is an environmentally friendly process and does not require additional separating agents. So, it has been widely used in DMC industrial production. This flowsheet explores the design and control of pressure-swing distillation systems for separation of dimethyl carbonate-methanol. The simulations are carried out with DWSIM.

Consider a typical separation process wherein mixture of three component such as Methanol, DMC and Ammonia are required to be separated using a pressure-swing distillation (PSD). The thermodynamic package used in this simulation is NTRL. In this simulation we use two distillation columns as the name suggest one with the pressurized distillation column (distcol1) and another one with the atmospheric column(distcol2) both with 32 and 26 stages respectively. The distcol1 operates at 1.2MPa and the distcol2 operates at 0.2MPa.

The feed with a flow rate of 0.105 kg/s and at a composition of (DMC: 0.1089, Methanol: 0.8901, Ammonia: 0.000999). The feed is introduced at 10 stage in distcol1. After passing through the distcol1 we achieve distillate as mixture where fraction of Methanol is 0.8691 and bottom as mixture where fraction of DMC is 0.995. Distillate mixture is introduced as a feed to distcol2 at stage 7. The bottom gives us pure Methanol with fraction of 0.995.

Flowsheet:



Flowsheet for the pressure-swing distillation system: DMC/ME system

Results:

Master Property Table						
Object	**D2**	**D1**	**B2**	**Feed**	**b1**	
Temperature	302.891	388.854	358	298.15	459.641	**K**
Pressure	200000	1.2E+06	200000	101325	1.2E+06	**Pa**
Mass Flow	0.122267	0.291679	0.169411	0.105	0.0293213	**kg/s**
Molar Fraction (Mixture) / Methanol	0.843545	0.869592	0.893744	0.890109	0.005	
Molar Fraction (Mixture) / Dimethyl carbonate	0.000638717	0.0554413	0.106256	0.108901	0.995	
Molar Fraction (Mixture) / Ammonia	0.155816	0.0749665	8.21733E-16	0.00099001	2.46672E-23	

The design and control of a pressure-swing distillation process for separation of a DMC/ME azeotrope has been studied in this flowsheet. Bottom products of two distillation column has been studied. In distillation column 1 we got pure DMC and in Distillation column 2 we got 89% of Methanol.