Synthesis of DMC via Reactive Distillation using Extractive Distillation

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Introduction:

Dimethyl carbonate (DMC) is considered to be an environmentally benign chemical because of its negligible ecotoxicity and low bioaccumulation and persistence. It has been used as a substitute to replace dimethyl sulphate and methyl halides in methylation reactions and as a carbonylation agent to substitute phosgene for the production of polycarbonates and urethane polymers. Other applications of DMC have been evaluated, for example, as nonaqueous electrolyte component in lithium rechargeable batteries and as an oxygenate for internal combustion engine fuels. It is also used as an alternative of MTBE.

Description:

A flowsheet for the production of DMC using methanol (MeOH) and ethylene carbonate (EC) has been developed. NRTL thermodynamic package is used. All the Distillation columns are designed using Cape-Open. MeOH and EC are fed to the Reactive-Distillation (RD) Column of 45 stages at 43rd and 7th stage respectively. Reactive zone is from 7 to 45 stages. From bottom, ethylene glycol (EG) is obtained with 93.87% pure. The top stream is sent to the Extractive Distillation column of 32 stages at 27th stage. Aniline is used as the entrainer in place of phenol because of its high efficiency and separation at low reflux ratio and number of stages. The recycled aniline stream is fed at 5th stage. The top product is MeOH-DMC mixture is recycled back to the RD column. From bottom DMC-aniline mixture is fed to the simple distillation column where aniline is recovered from bottom while pure DMC 99.69% is obtained from top.

Flowsheet:

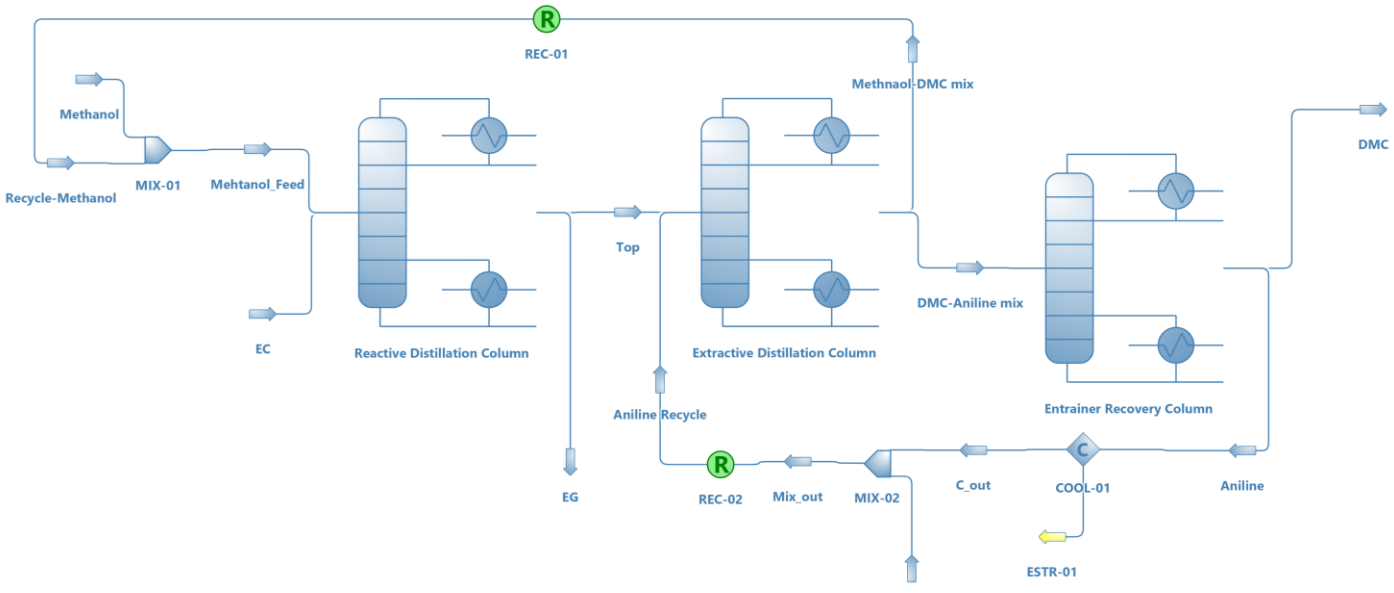

Figure 1: Synthesis of DMC via Reactive Distillation using Extractive Distillation

Result:

Object	Top	Recycle-Methanol	Methanol	EG	EC	DMC	Aniline	
Temperature	66.0925	64.0417	25	199.184	25	89.087	182.538	C
Pressure	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	bar
Molar Flow	178.557	152.219	50	25.1	25	20.8633	150.533	kmol/h
Molar Fraction (Mixture) / Aniline	0	4.74E-07	0	2.88E-06	0	2.79E-05	0.999996	
Molar Fraction (Mixture) / Methanol	0.85952	0.99	1	0.00396	0	0.003072	8.33E-16	
Molar Fraction (Mixture) / Ethylene carbonate	3.68E-18	4.29E-22	0	0.057289	1	1.28E-22	1.76E-18	
Molar Fraction (Mixture) / Dimethyl carbonate	0.14048	0.01	0	2.04E-05	0	0.9969	4.01E-06	
Molar Fraction (Mixture) / Ethylene glycol	9.69E-15	2.31E-22	0	0.938727	0	3.51E-17	4.14E-15	

Table 1: Streamwise Result for production of DMC

References:

Wang, San-Jang, Cheng-Ching Yu, and Hsiao-Ping Huang. "Plant-wide design and control of DMC synthesis process via reactive distillation and thermally coupled extractive distillation." Computers & chemical engineering 34.3 (2010): 361-373.

Hsu, Kai-Yi, Yuan-Chang Hsiao, and I-Lung Chien. "Design and control of dimethyl carbonate− methanol separation via extractive distillation in the dimethyl carbonate reactive-distillation process." Industrial & engineering chemistry research 49.2 (2010): 735-749.