PRODUCTION OF DIMETHYL ETHER VIA DEHYDRATION OF METHANOL USING COOLED REACTOR

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About flowsheet:

Here, simulation is carried out for the Dimethyl ether production which used for the manufacturing of Methyl Acetate followed by carbonylation. As process decribed by Luyben[1] and Diemer[1] here simulation carried out to get closer results towards process inputs.

Here cooled reactor used for the DME formation with following reaction;

$$2CH3OH \leftrightarrow CH3OCH3 + H2O$$

[Note: conversion reactor used in which 85% conversion of methanol assumed to form DME and water]

Feed stream contains 99 mole% methanol and 1 mole% water, which also merged with recycle stream of methanol found from the top product of methanol recovery column. Conversion reactor outlet temperature taken as 665K . However, feed stream is heated upto 628K using heat

integration loop. (Note: High temperature stream is used as heat source to reduce energy consumption also vaporizer used to heat feed stream which also used in heat integration loop to minimize energy consumption)

Molar Flow	587.128 kmol/h
Feed temerature	628K

- Outlet stream of reactor consists of 14.86 mole% methanol, 42.97 mole% water and 42.16 mole% DME which further cooled in heat integration loop also alternate cooler used in which stream is cool down to 351K temepature.
- Here two columns were used to separate DME and methanol.
- For the DME separation simple distillation used which has total 22 number of staged and reactor outlet stream fed up to sage 12 in column. [condensor operated at 10 atm and reboiler operated at 10.2 atm pressure]

DME Recovery column	
Feed stage	12
Mole fraction of top product	0.001 Methanol
Total stages	22

- From the column as top product 99% pure DME obtained with molar rate of 247 kmol/h and bottom product 74 mole% water and 25 mole% methanol obtained with molar rate of 339 kmol/h which futher fed up in methanol recovery column to separate water and methanol.
- For methanol separation simple distillation column used which has total 27 number of stages and feed stage located at stage 16. Here as top product 99% pure methanol obtained with molar rate of 87.12 kmol/h, recovered methanol further use in process and

recycled to intial satge. [condensor operated at 1 atm and reboiler operated at 1.38 atm pressure]

Mehtanol Recovery column	
Feed stage	16
Reflux ration	1.7
Total stages	27

- From methanol recovery column as bottom product 99% pure water removed from the methanol and water mixture.

Stream Data					
Object	pure DME	Water	Pure Methanol	For water removal	
Temperature	317.792	383.41	336.886	427.065	K
Molar Flow	247.257	252.264	87.1282	339.392	kmol/h
Molar Fraction (Mixture) / Methanol	0.001	0.001	0.994869	0.256145	
Molar Fraction (Mixture) / Water	8.23741E-08	0.999	0.00123569	0.742855	
Molar Fraction (Mixture) / DimethylEther	0.999	8.253E-23	0.00389531	0.001	

Figure 1: Stream composition data

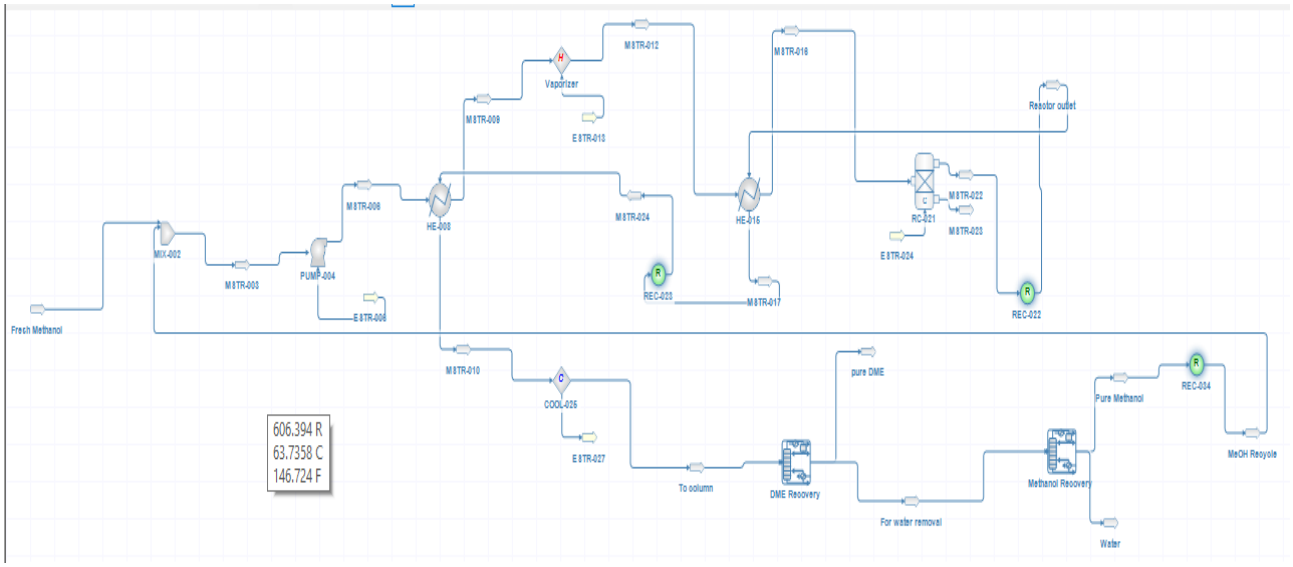

Figure 2: Simulated flowsheet

References:

[1] Diemer, R. B., & Luyben, W. L. (2010). Design and control of a methyl acetate process using carbonylation of dimethyl ether. *Industrial & Engineering Chemistry Research*, *49*(23), 12224-12241.