Pressure Swing Distillation for Methanol Recovery in TAME Reactive Distillation Process

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Background & Description:

In gasoline blending , TAME (tert-amyl methyl ether) has proved to be a better replacement for lead . The recent bans on methyl-tertiary butyl ether (MTBE) because of the environment issues , has increased the production and use of TAME. One of the most popular methods to produce is by reactive distillation process , which is basically an etherification process. The main raw materials required for the reaction are Methanol (MeOH) , 2-methyl-1-butene (2M1B) , 2-methyl-2-butene (2M2B) , while the pentanes and pentenes act as inert in the TAME reaction. The distillate from the reactive distillation column has a significant amount of methanol , which forms minimum-boiling azeotropes with isopentane at 4 bar pressure which is the optimum pressure for both reaction and vapor-liquid separation. Pressure Swing Distillation is therefore , used to recover the methanol from the distillate and recycle it back to the reactor to increase the productivity.

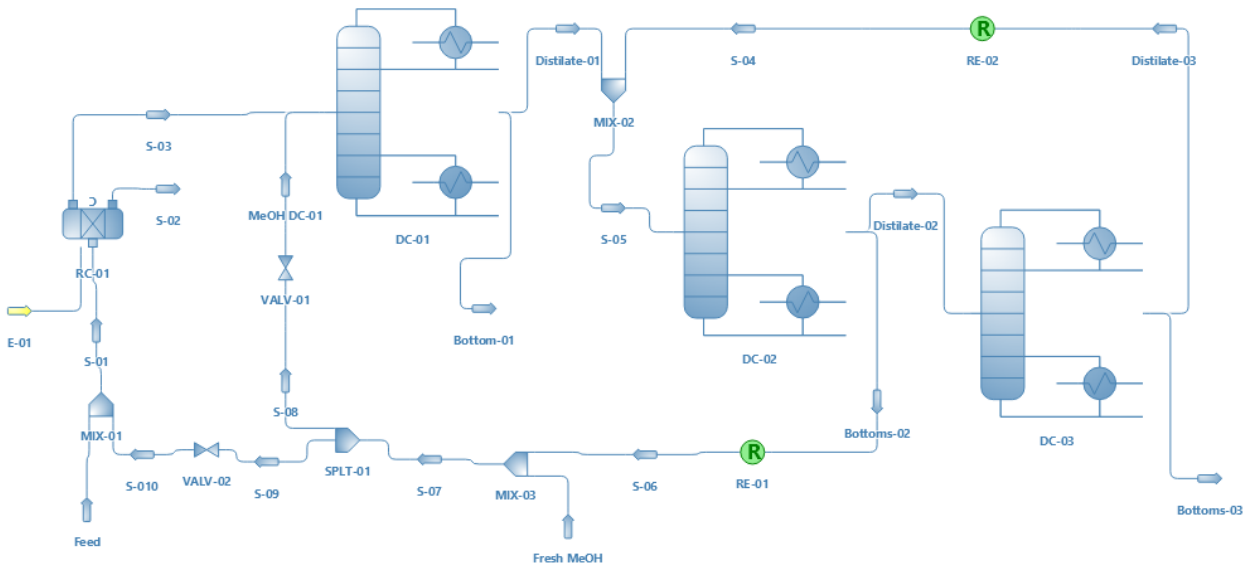
Process :

The following reactions are first carried out in a prereactor which is a cooled tubular reactor :-

2M1B + Methanol ↔ TAME (etherification)
2M2B + Methanol ↔ TAME (etherification)
2M1B ↔ 2M2B (isomerisation)

The outlet stream from the prereactor is then fed to the reactive distillation column at 28th stage along with a recycle methanol feed at stage 23. The reactive zone in the column is between 7 to 23 stages. The bottom product has a purity of 99.2 mol% TAME. The major step now is to recover the methanol from the distillate by using Pressure Swing distillation where the distillate is first sent to the second column operating at 2 bar and then the distillate of this column is passed to the third column which is operating at 10 bar pressure . The bottom product of the second column has a purity of 99.9 mol% methanol , which is recycled back , and mixed with fresh methanol feed , and sent to the prereactor and reactive column . The distillate from the third column is also, recycled back to the second column. The final bottom product of the last column has no significant amount of methanol .

Flowsheet :



Results :

Master Property Table									
Object	Fresh MeOH	Feed	Distilate-03	Distilate-02	Distilate-01	Bottoms-03	Bottoms-02	Bottom-01	
Temperature	325	343	375.876	318.672	357.257	391.438	356.107	411.121	K
Pressure	1.72253E+06	1.01325E+06	1E+06	200000	400000	1E+06	200000	400000	Pa
Molar Flow	63.8889	288.917	449.056	672.389	311.667	223.333	88.3333	64.9923	mol/s
Molar Fraction (Mixture) / Methyl tert-pentyl ether	0	0	3.08705E-07	1.13415E-05	2.56958E-05	3.35253E-05	5.87762E-06	0.992	
Molar Fraction (Mixture) / Methanol	1	0	0.324442	0.21668	0.279865	8.88618E-07	0.999994	0.00795828	
Molar Fraction (Mixture) / 2-methyl-2-butene	0	0.158639	0.00650933	0.0119567	0.0164606	0.0229099	3.88441E-12	1.66785E-05	
Molar Fraction (Mixture) / 2-methyl-1-butene	0	0.0822998	3.0144E-16	3.31172E-16	2.90835E-16	3.90953E-16	0	4.81321E-07	
Molar Fraction (Mixture) / N-pentane	0	0.0849918	0.0352569	0.0599701	0.078786	0.109661	2.78025E-12	8.79325E-06	
Molar Fraction (Mixture) / Isopentane	0	0.481684	0.523671	0.555523	0.446522	0.619568	3.66384E-12	1.19191E-05	

Table 1 : Streamwise Results for the Flowsheet .

Conclusion :

The methanol recovery process was successfully simulated using the Pressure Swing Distillation method . The final bottom product of the last column , Bottoms-03 , has a negligible amount of methanol which indicates good methanol recovery .