A Novel Intensified and Integrated Distillation Approach for Improving Manufacture of Propylene Glycol Monomethyl Ether Acetate (PGMEA)

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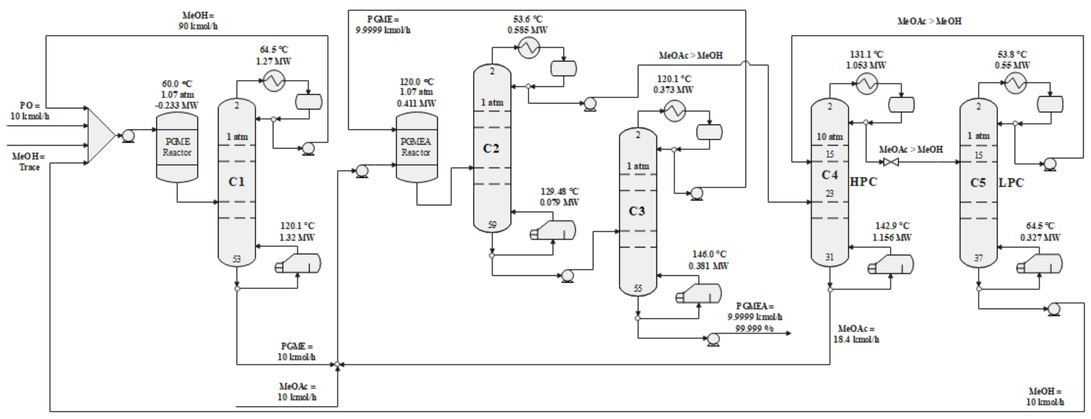
ABSTRACT

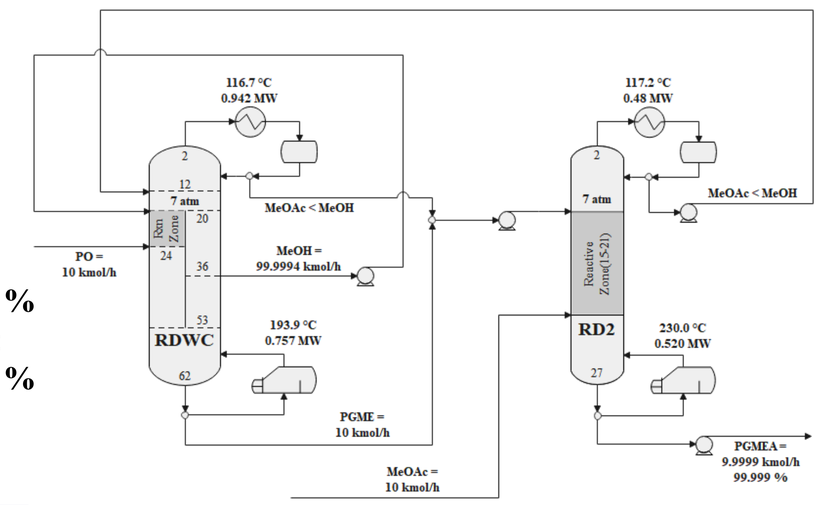
Propylene glycol monomethyl ether acetate (PGMEA) is a substantial and multipurpose solvent with a wide range of industrial applications. The high demand for ultra-high-purity PGMEA has created the need for an efficient, sustainable process for reducing energy consumption and satisfying tight waste management regulations. The base case of PGMEA manufacturing process has been proposed, and it intensified the process by applying a dividing wall column. Here, a potentially sustainable and novel process for producing PGMEA has been developed in this work. This advanced intensification of PGMEA manufacturing by combining the propylene glycol methyl ether(PGME) reactor and the dividing wall column has reduced energy consumption by 14.9 % compared to the base case, even without a heat integration. But still, there is a problem that has to be resolved. The liquid hold-up of the reaction trays required around 10 cum to have high PO conversion. So this work suggests that side-reactor column would be more appropriate than a reactive dividing wall column.

Historical Summary

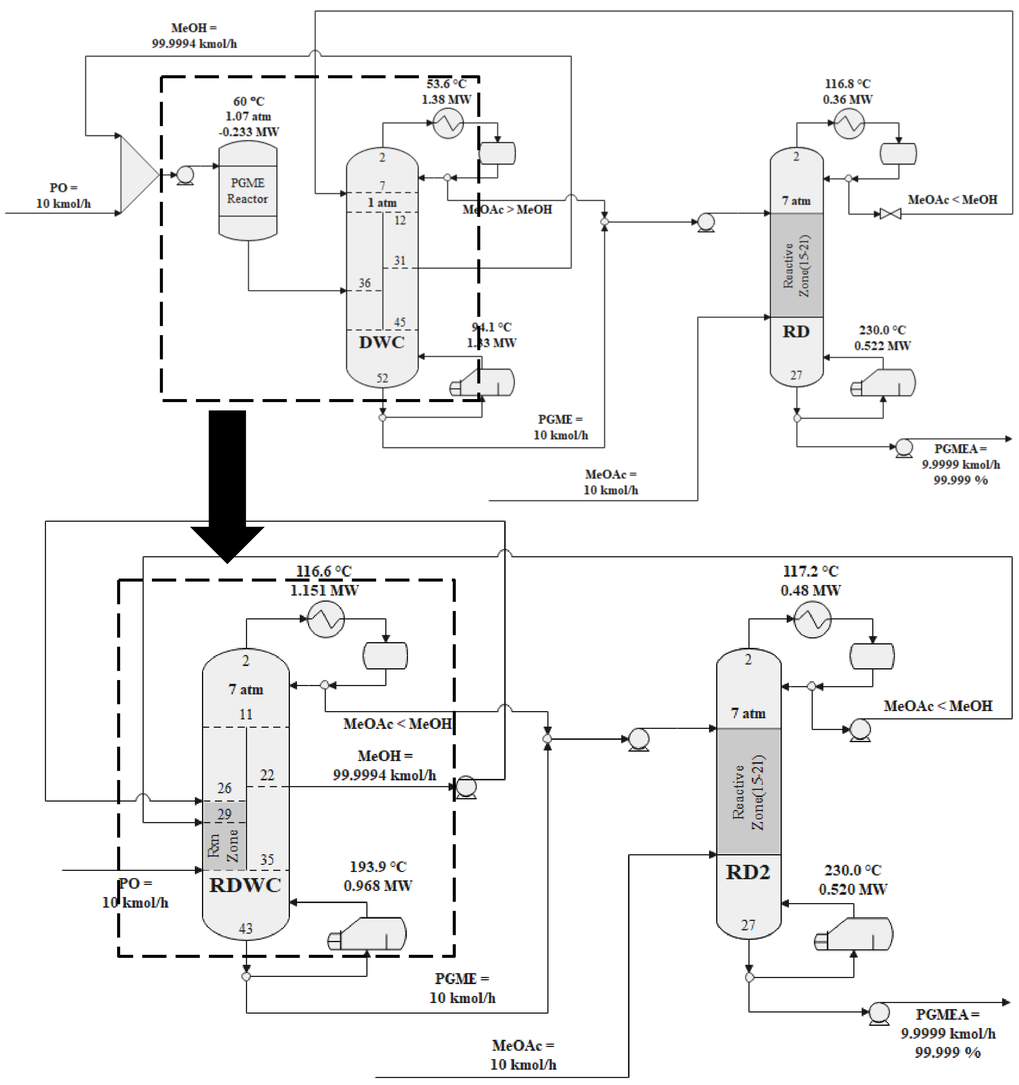


E Saving : **55.6 %**

CAPEX Saving : **70.8 %**

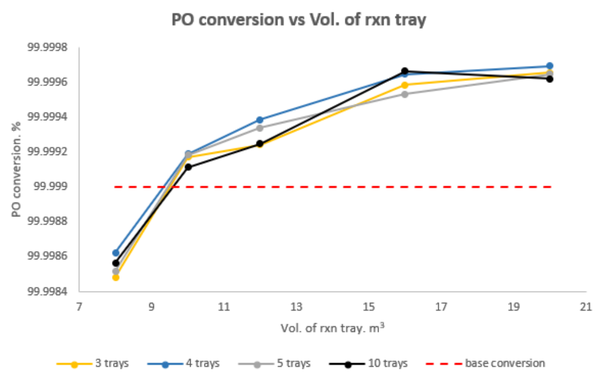


Reactive Dividing Wall Column

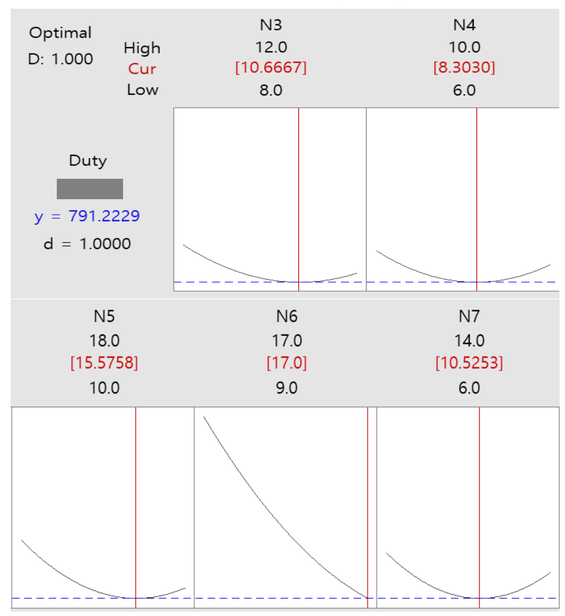


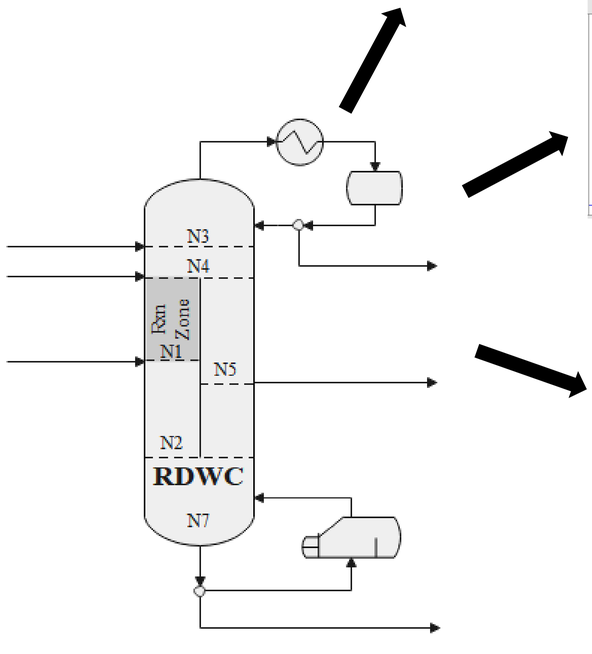
R-DWC Optimization

Reactive Trays Optimization

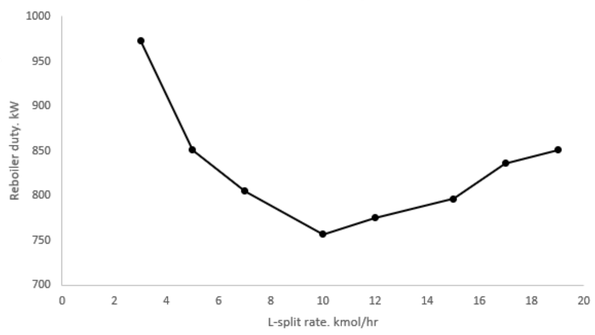


The No. of RDWC Trays Optimization





Split Ratio Optimization



Economic Analysis Results

	Base Case		Current Study	
Parameters	RD	DWC	RD	RDWC
Theoretical stages	26	51	28	63
Reflux ratio	0.42	6.78	0.88	5.29
Reboiler duty (kW)	522	1332	520	757
Condenser duty (kW)	359	1380	480	942
Reboiler temperature (°C)	230	94	230	194
Condenser temperature (°C)	117	56	117.2	116.7
CO_2 emission (kg/y)	4,141,213.30		3,537,344.07	
Saving on CO_2 emission			**14.58 %**	
Total capital cost (m$)	2.13		1.47	
Total operating cost (m$/y)	0.79		0.67	
TAC (m$/y)	1.21		0.96	
Saving on TAC			**20.66 %**	

Conclusion

Process intensification was studied using an advanced distillation process to synthesize and separate PGME from PO and Methanol. RDWC, a combination of reactor and DWC, was utilized in this work. The proposed novel configuration simulation has been successfully performed using Aspen Plus, which enabled the production of high-purity electronic-grade PGMEA while reducing energy consumption by 14.58% and TAC by 20.66%. There are still also several ways to enhance this study further. If there is kinetic data of the catalyst that can be operated at a lower temperature, heat integration with the second RD column can also be applied. This will also further reduce energy consumption. Suppose a side-reactor column is applied as an alternative to the reactive trays of RDWC's pre-fractionator. In that case, it may be an option that can overcome the limitation of requiring a quite large liquid holdup.

Acknowledgement

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