Ethylbenzene Production From Ethylene And Benzene

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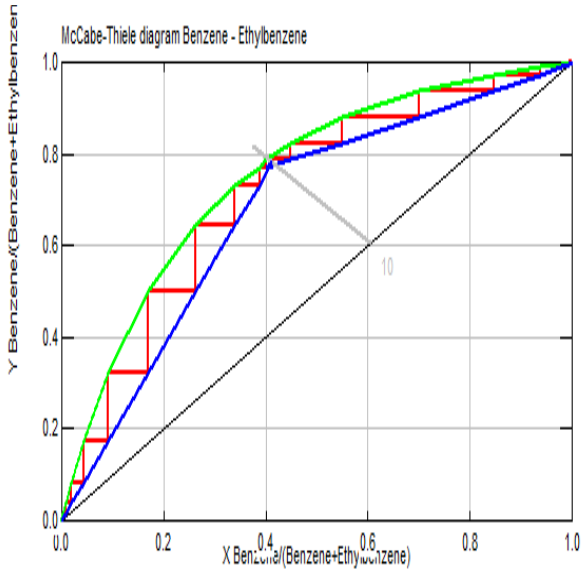
Background:

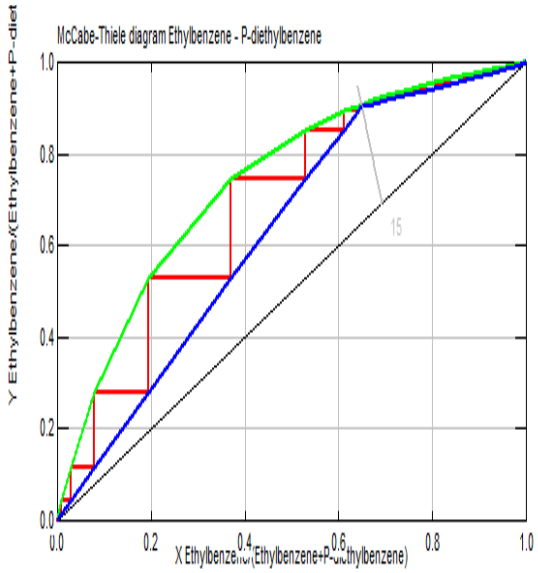
Ethylbenzene is almost exclusively (>99%) used as an intermediate for the manufacture of styrene monomer. Styrene production, which uses ethylbenzene as a starting material, consumes approximately 50% of the world's benzene production. Less than 1% of the ethylbenzene produced is used as a paint solvent or as an intermediate for the production of diethylbenzene and acetophenone.

Ethylbenzene was first produced on a commercial scale in the 1930s in Germany and United States. Almost all ethylbenzene is produced commercially by alkylating benzene with ethylene, either in the liquid phase with aluminium chloride catalyst or in the vapor phase with a synthetic zeolite.

Description of the Flowsheet:

The ethylbenzene process involves the reaction of benzene with ethylene to form desired Ethylbenzene (EB) product. Herein, process undesirable product DEB (di-ethylbenzene) also forms due to side reaction. Herein, process benzene stream is fed up at rate of 630.6 kmol/h at 320K in mixer in which ethylene stream also mixed with same molar flow rate at 1 atm pressure. The well mixed slurry is fed up in Conversion Reactor-1 at 20 atm pressure where EB and DEB forms. Further this slurry is fed up in Conversion Reactor-2 with recycle stream of DEB at 19 atm pressure where DEB reacts with benzene to give EB. Herein, process for the separation of EB two distillation columns are used, in first DC-1 column benzene is recovered as distillate and recycle to mixer and at bottom EB and DEB found in proportion which further separated in DC-2 column. In DC-2 column EB is found in top product at rate 630.6 kmol/h and DEB found as bottom product which recycled to reactor-2 at 281.9 kmol/h. From the simulation below graph and results obtained.





Results:

Reactor-1 Outlet		
Object	MSTR-013	
Molar Flow	1607.5945	Kmol/h
Molar Fraction (Mixture)/ Benzene	0.65704192	
Molar Fraction (Mixture)/ Ethylbenzene	0.28900542	

Reactor-2 Outlet		
Object	MSTR-019	
Molar Flow	1883.3291	Kmol/h
Molar Fraction (Mixture)/ Benzene	0.51505991	
Molar Fraction (Mixtue)/ Ethylbenzene	0.33516409	

DC-2 Bottom		
Object	MSTR-028	
Molar Flow	281.8547	Kmol/h
Molar Fraction (Mixture) / Ethylbenzene	0.001	
Molar Fraction (Mixture) / p-diethylbenzene	0.999	

DC-1 Distillate		
Object	MSTR-022	
Molar Flow	970.87241	Kmol/h
Molar Fraction (Mixture)/ Benzene	0.99880508	
Molar Fraction (Mixture)/ Ethylbenzene	0.001	

DC-2 Distillate		
Object	MSTR-027	
Molar Flow	630.60198	Kmol/h
Molar Fraction (Mixture) / Ethylbenzene	0.99900028	
Molar Fraction (Mixture) / p-diethylbenzene	0.0005	

Conclusion and Recommendation:

This work illustrates that open source simulator serves as a good platform for carrying out process development flowsheeting with ease. However, during the simulation it's examined that process has sensitivity towards temperature and pressure.

Unit of System used:

ETHYLBENZENE	
Temperature	k
Pressure	atm
Molar Flow	Kmol/h
Volumetric Flow	m^3/s

References:

Flowsheet Source: http://www.chemsep.com/downloads

- Coty, R.R., Welch, V.A., Ram, S. & Singh, J. (1987) Ethylbenzene. In: Gerhartz, W., Yamamoto,Y.'.S., Kaudy, L., Rounsaville, J.F. & Schulz, G., eds, Ullmann's Encyclopedia of Chemical Technology, 5th rev. Ed., Vol. A10, New York, VCH Publishers, pp. 35