Production of Ethyl benzene & Styrene from Hydrocarbons

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Background & Description:

Styrene is a colourless, toxic oily organic liquid that evaporates easily and has a sweet smell. It is an aromatic olefin. The Chemical formula for Styrene is C6H5CH=CH2. Styrene has IUPAC names vinyl benzene and phenyl ethene.Styrene is easily reactive to double bonds that undergoes polymerization reactions.It is one of the most important monomer in the polymer industry largely due to its production usage for polystyrene,EPS and ABS with Asia Pacific being its largest producers.

Ethyl benzene is a clear,colourless liquid with a characteristic aromatic odour. It is a single ring alkyl aromatic and is also used for production of styrene.

The feed containing equi-molar concentration of ethylene and benzene is passed through a heater and is preheated at a temperature of 95 ℃ and a pressure of 1.01325 bar. The product stream from the conversion reactor containing Ethyl Benzene and unreacted Ethylene and Benzene was sent to a shortcut distillation column. In this column, Ethyl Benzene was obtained as bottom product and the distillate stream contains smaller portion of Ethyl Benzene and as well as unreacted Ethylene and Benzene. The bottom product then goes through a heat exchanger and styrene,toluene,methane,hydrogen and carbon monoxide are formed in minimal quantities. Afterwards, it is split into two portions. One portion containing water is passed through several heaters and mixer and comes in contact with a plug flow reactor. The mixture containing all the products is recycled back to the heat exchangers. The remaining portion comes in contact with a vapour-liquid separator and the light liquid stream mixture reacts at an unit operation column at a temperature of 136.317℃ and the bottom product is passed through a final shortcut column to give 99.7% styrene as bottom product and 99.9% ethyl benzene as the top product.

Flowsheet:

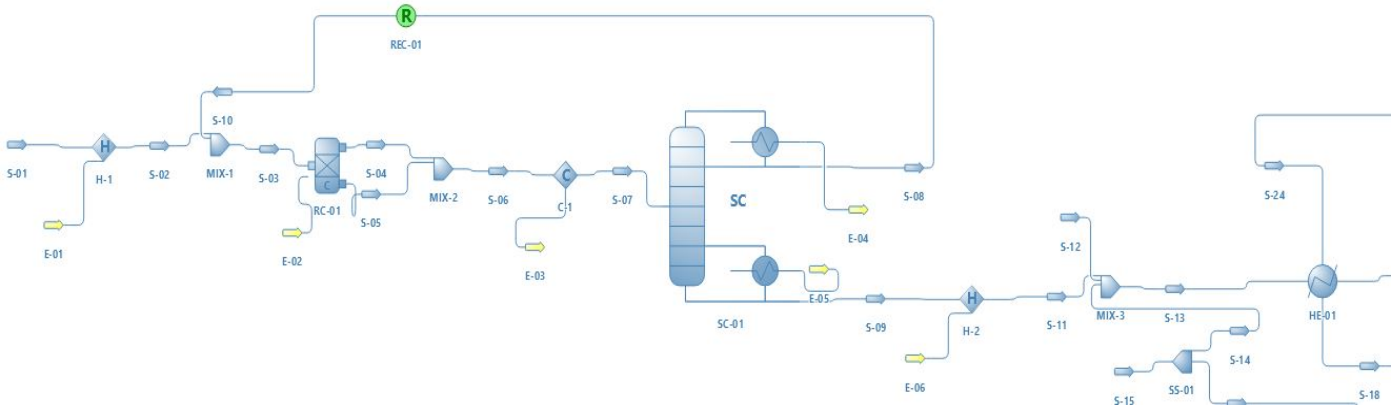

Fig 1- Flowchart Part 1

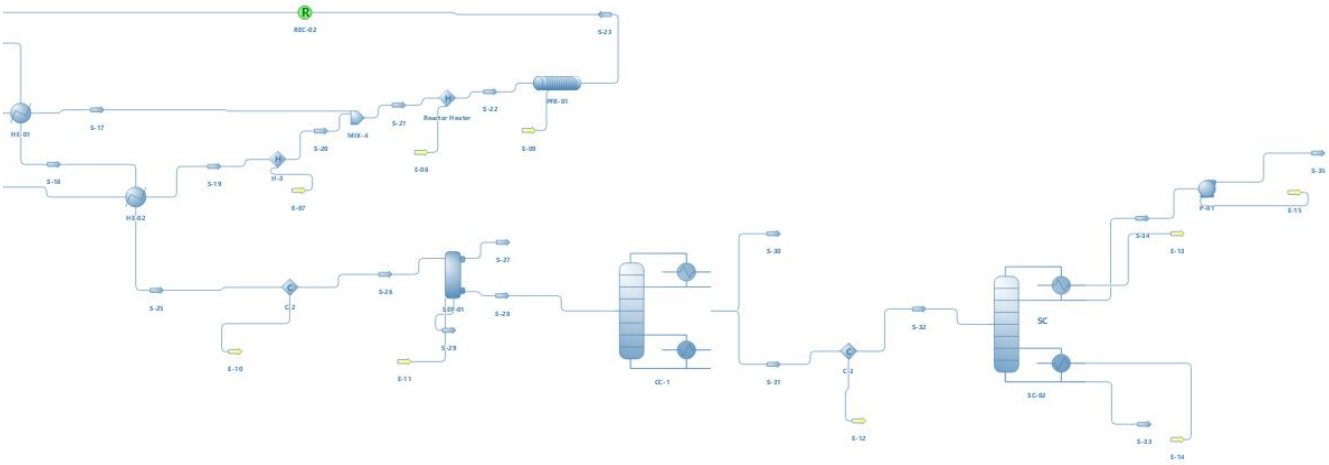

Fig 2- Flowchart Part 2

Results:

Master Property Table							
Object	S-35	S-33	S-18	S-05	S-04	S-01	
Temperature	66.553	120.546	619.642	65.6093	65.6093	25	C
Pressure	1.5	0.5	2.20663	1.01325	1.01325	1.01325	bar
Mass Flow	12590.5	21.2053	123343	1721.09	1266.12	2000	kg/h
Molar Flow	118.596	0.203838	3819.23	16.5563	34.2117	37.6772	kmol/h
Molar Fraction (Mixture) / Ethylene	2.17524E-23	1.60891E-156	1.11937E-05	0.00926416	0.872816	0.5	
Molar Fraction (Mixture) / Benzene	2.10833E-11	1.54496E-50	6.05146E-05	0.0530389	0.0349035	0.5	
Molar Fraction (Mixture) / Ethylbenzene	0.998995	0.001	0.16188	0.937697	0.09228	0	
Molar Fraction (Mixture) / Toluene	1.60335E-11	3.72503E-31	1.45232E-08	0	0	0	
Molar Fraction (Mixture) / Styrene	0.001	0.997841	9.18877E-05	0	0	0	
Molar Fraction (Mixture) / Water	7.07613E-06	1.36689E-71	0.837865	0	0	0	

Fig 3- Main Streamwise Results

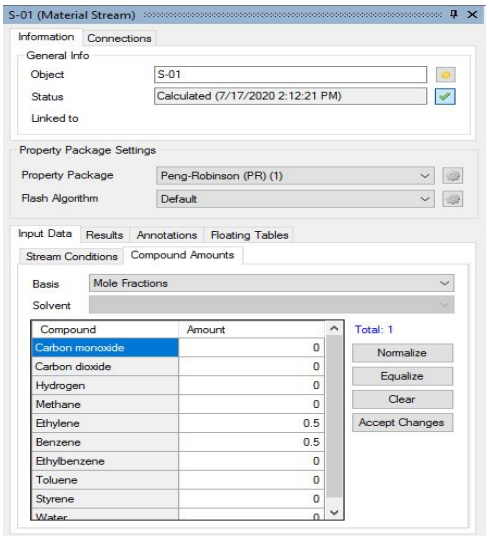

Fig 4- Stream Composition(HC Stream)

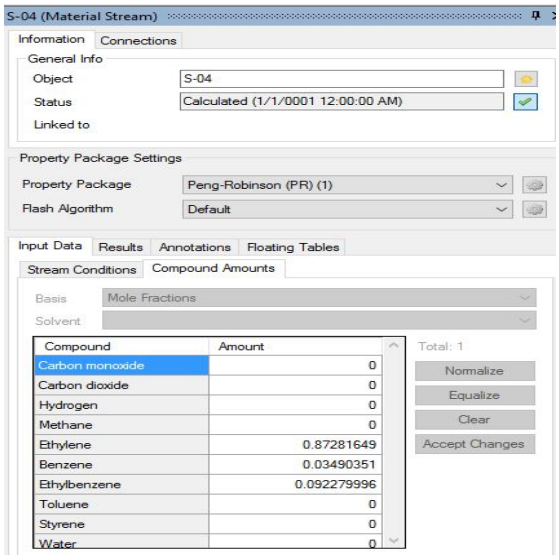

Fig 5- Stream Conversion(EB Stream Top)

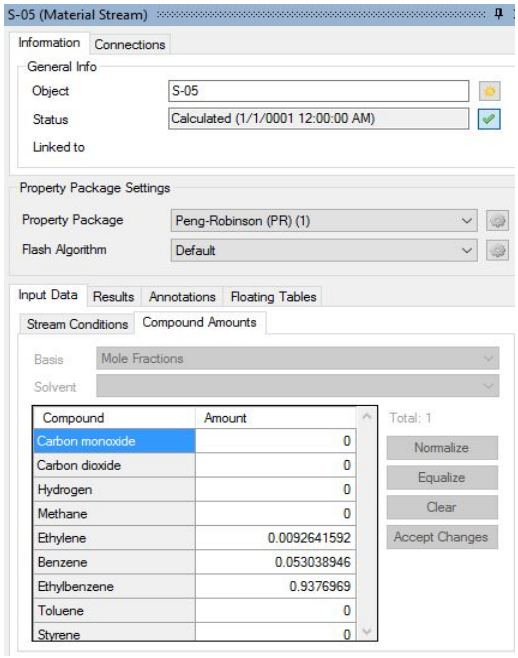

Fig 6- Stream Composition(EB Stream Bottom)

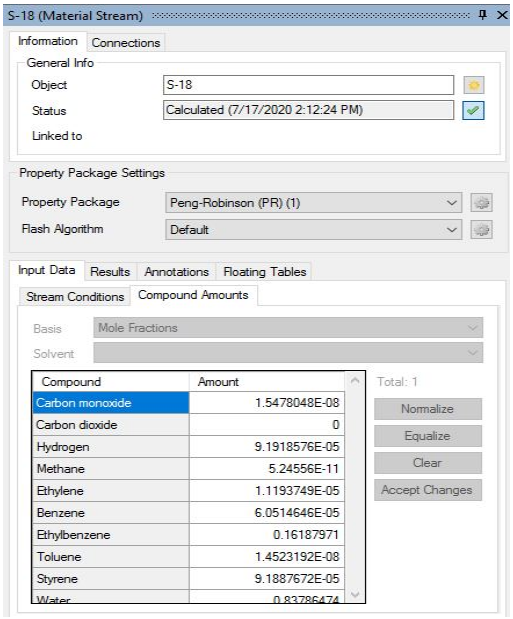

Fig 7- Stream Composition(Liquid Product)

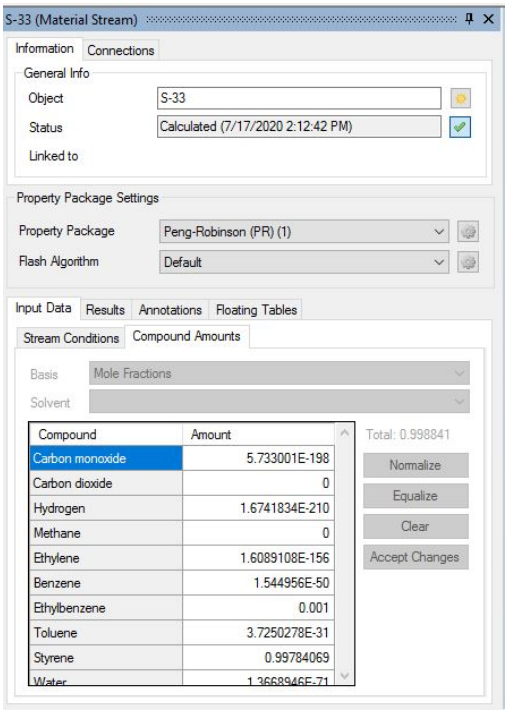

Fig 8- Stream Composition(Styrene Stream)

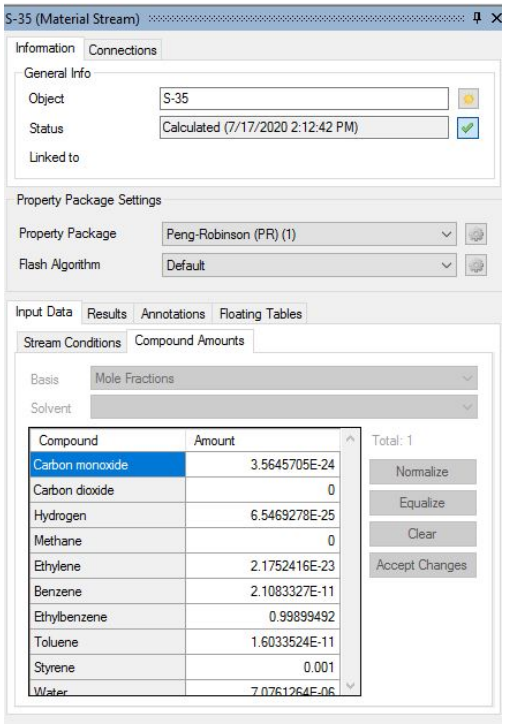

Fig 9- Stream Composition(Ethyl Benzene)