Production of Ethanol by Direct Hydration of Ethylene

S.Keerthi Raagav
National Institute of Technology Tiruchirappalli

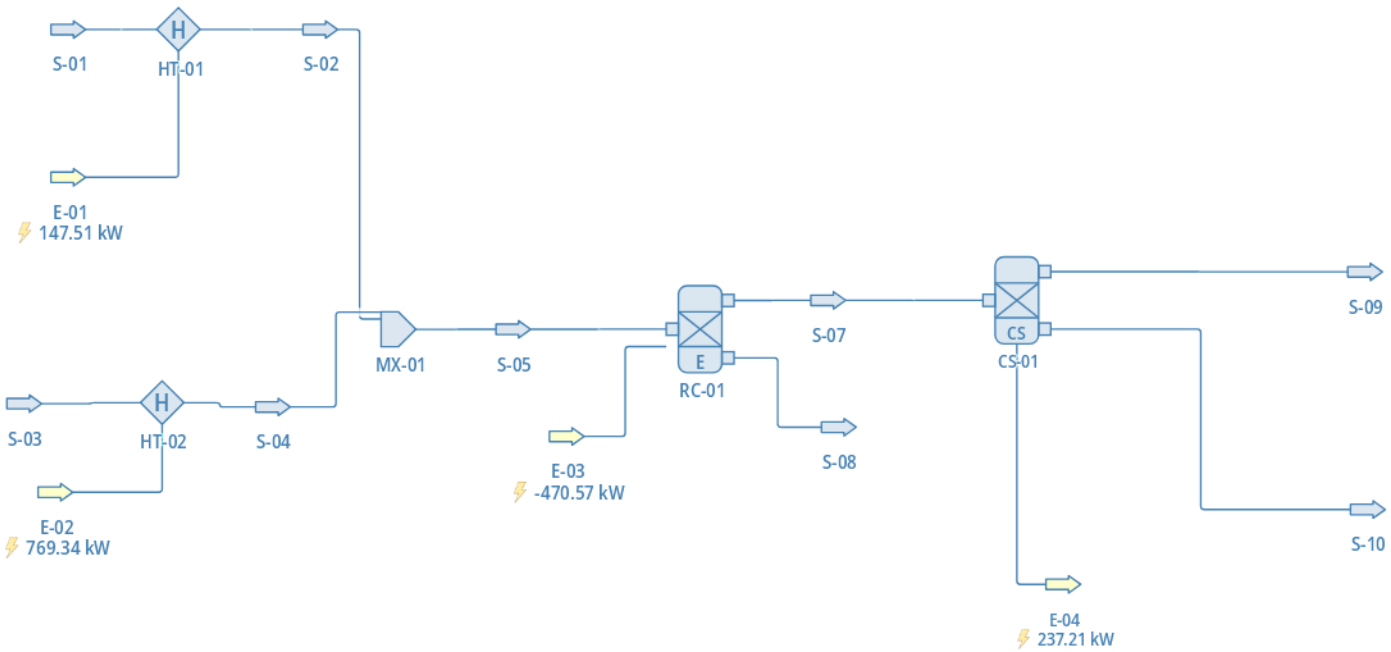
A. Background:

Ethanol is a key industrial chemical used in various applications, including as a solvent, a fuel additive, and a precursor to other organic compounds. The direct hydration of ethylene offers a synthetic route that is commercially viable, particularly when ethylene is readily available. This process involves a reversible, gas-phase reaction where ethylene (C2H4) and water (H2O) react over a solid acidic catalyst, at elevated temperatures and pressures to form ethanol (C2H5OH). The reaction is exothermic, and achieving optimal conditions is crucial for maximizing conversion and yield.

B. Description:

Two material streams containing Ethylene (C2H4) and Water (H20) are preheated separately before being mixed, which is then sent to an equilibrium reactor, where the catalytic hydration reaction takes place. The resulting mixture of ethanol, ethylene and water is sent to a compound separator, which separates out into: Product stream containing pure Ethanol (C2H5OH) and raffinate containing unreacted Ethylene (C2H4) and excess Water (H20).

C. Flowsheet:



D. Results and Conclusion:

Ethanol of required purity was produced by simulation of Ethanol production by direct hydration in DWSIM v9.0.4 and the results are tabulated below:

Master Property Table						
Object	**S-10**	**S-09**	**S-07**	**S-03**	**S-01**	
Temperature	80	80	80	25	-50	**C**
Pressure	1.01325	1.01325	1.01325	1.01325	20	**bar**
Mass Flow	371.645	1628.35	2000	1000	1000	**kg/h**
Molar Flow	20.3558	35.3464	55.7023	55.5084	35.6466	**kmol/h**
Molar Enthalpy (Mixture)	-40136.8	3630.03	2966.57	-45705.5	-14660.3	**kJ/kmol**
Molar Entropy (Mixture)	-106.213	11.3837	17.4624	-123.116	-82.2319	**kJ/[kmol.K]**
Molar Fraction (Mixture) / Ethylene	0.00952198	0	0.00347971	0	1	
Molar Fraction (Mixture) / Water	0.985253	0	0.360051	1	0	
Molar Fraction (Mixture) / Ethanol	0.00522495	1	0.636469	0	0	

Therefore, we conclude that synthesis of Ethanol by direct hydration of Ethylene remains a viable pathway for production, especially when ethylene is readily available, instead of production by fermentation organically.