

# Production of Ethanol by Direct Hydration of Ethylene

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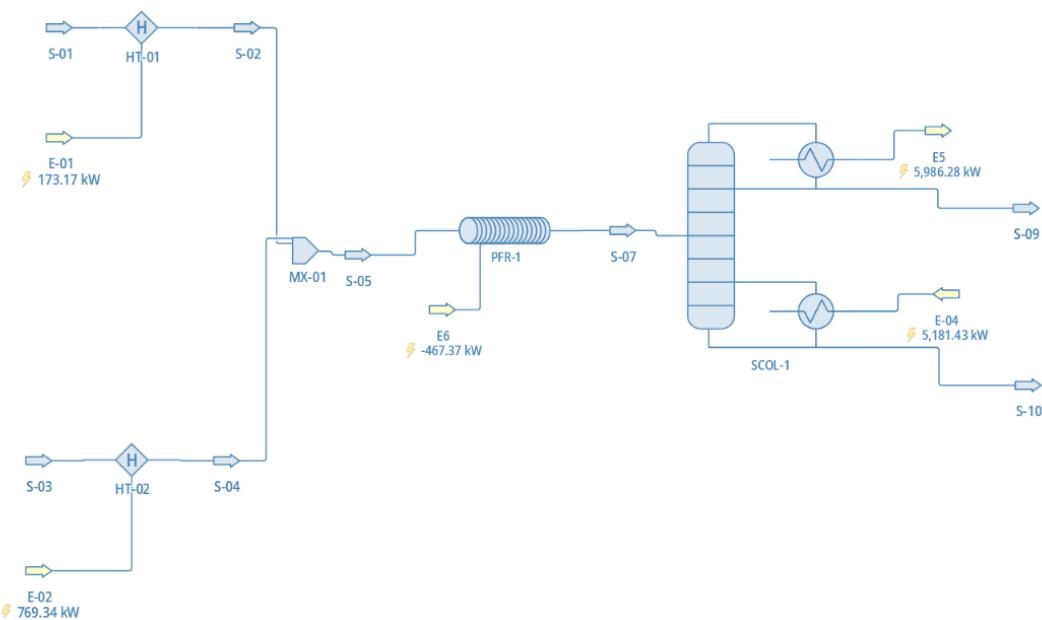
## A. Background:

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 ( $C_2H_4$ ) and water ( $H_2O$ ) react over a solid acidic catalyst, at elevated temperatures and pressures to form ethanol ( $C_2H_5OH$ ). The reaction is exothermic, and achieving optimal conditions is crucial for maximizing conversion and yield.

## B. Description:

Two material streams containing Ethylene ( $C_2H_4$ ) and Water ( $H_2O$ ) 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 distillation column, which separates out into: Product stream containing pure Ethanol ( $C_2H_5OH$ ) and raffinate containing unreacted Ethylene ( $C_2H_4$ ) and excess Water ( $H_2O$ ).

## 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	100.905	-156.668	98.1611	25	-50	C
Pressure	1.01325	1.01325	1.01325	1.01325	20	bar
Mass Flow	380.842	1619.29	2000	1000	1000	kg/h
Molar Flow	20.8187	35.7964	56.6121	55.5084	35.6466	kmol/h
Molar Enthalpy (Mixture)	-14165.6	-66345.1	4020.93	-45705.5	-14660.3	kJ/kmol
Molar Entropy (Mixture)	-36.7088	-244.296	20.9128	-123.116	-82.2319	kJ/[kmol.K]
Molar Fraction (Mixture) / Ethylene	1.11755E-90	0.0308339	0.019495	0	1	
Molar Fraction (Mixture) / Water	0.989859	0.01	0.370336	1	0	
Molar Fraction (Mixture) / Ethanol	0.01	0.959248	0.610169	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.