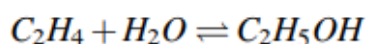


# Synthesis of ethyl alcohol from ethylene

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## Background & Description:

Ethyl alcohol is a volatile, flammable, colorless liquid with the structural formula  $\text{CH}_3\text{CH}_2\text{OH}$ . Ethanol that is produced by hydration of ethylene has a purity of about 95%, this method is followed by most of the modern industries, this is a catalytic gaseous reaction where phosphoric acid is used as a catalyst. Commonly phosphoric acid is adsorbed onto porous support such as silica gel or diatomaceous earth. This catalyst was first used for large-scale ethanol production by the Shell Oil Company in 1947. The reaction is carried out with an excess of high-pressure steam at 300 °C.



## Procedure:

Ethylene(S-01) and water(S-02) is used to produce ethanol through direct hydrolysis over phosphoric acid catalyst. Reactant mixture is taken to an operating condition of 300 C and 70 atm, mixture is then fed to plug flow reactor(RE-01) where a vapor phase reaction takes place. The unreacted ethylene, is separated and is fed back to the reactor as a recycled stream(S-12) to have better a conversion. Further stream containing water and ethanol is fed to distillation column, an ethanol-rich stream, containing approximately 85 mol% of ethanol is taken as a top product. Peng-Robinson thermodynamics model is used in this flowsheet. Side reactions are not considered in this flowsheet. Ethylene feed may be converted to acetaldehyde, which is at very low concentrations < 1 ppm hence tolerable in the final product.

## Flowsheet:

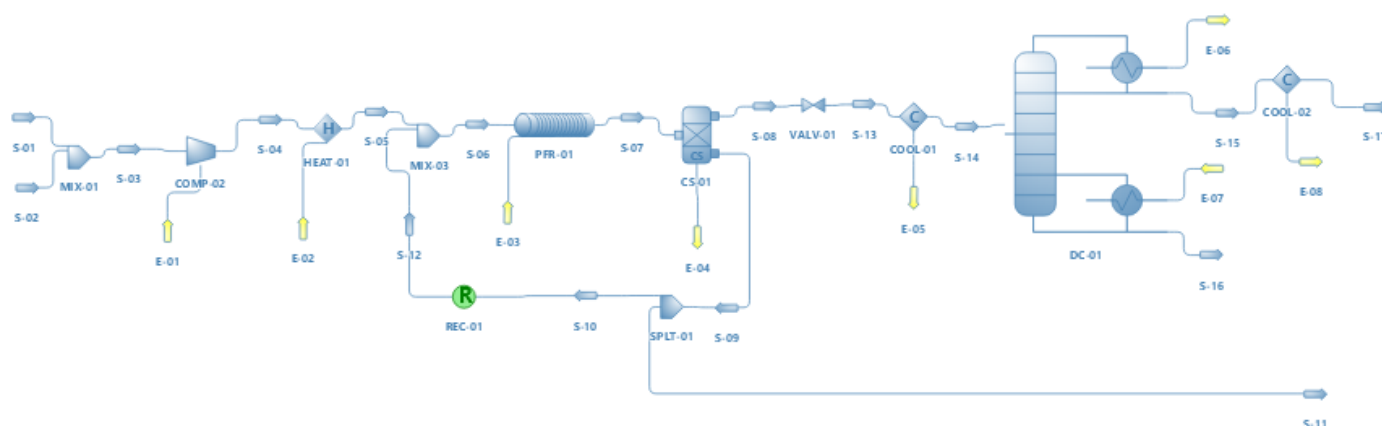


Fig 1. Flowsheet of synthesis of ethyl alcohol

## Results:

We get 94.27 wt% of Ethanol in stream 17 as a product.

Master Property Table							
Object	S-14	S-08	S-06	S-05	S-02	S-01	
Temperature	78	272.453	255.006	277.2	25	25	C
Pressure	2	60.7162	60.7314	69.9275	1	1	bar
Mass Flow	19334.3	19334.3	26204.2	20399.8	2384.52	18015.3	kg/h
Molar Flow	999.283	999.283	1293.36	1085	85	1000	kmol/h
Volumetric Flow	20.1818	587.281	757.895	532.619	2093.38	18.0817	m <sup>3</sup> /h
Molar Enthalpy (Mixture)	-39720.5	6055.4	5918.15	4649.79	-46.1261	-45705.5	kJ/kmol
Molar Entropy (Mixture)	-117.401	-14.9403	-12.4457	-17.8501	0.00839266	-123.116	kJ/[kmol.K]
Molar Fraction (Vapor)	0	1	0.983063	0.953342	1	0	
Phases	Liquid Only	Vapor Only	Mixed	Mixed	Vapor Only	Liquid Only	
Energy Flow	-11025.6	1680.85	2126.2	1401.4	-1.08909	-12696	kW

Master Property Table				
Object	S-17	S-16	S-11	
Temperature	25	99.6545	272.453	C
Pressure	1.01325	1.01325	60.7162	bar
Mass Flow	1853.14	17481.1	1030.49	kg/h
Molar Flow	43.8109	955.472	36.9902	kmol/h
Volumetric Flow	2.2884	18.3021	26.5576	m <sup>3</sup> /h
Molar Enthalpy (Mixture)	-42795.1	-38168.4	12530.7	kJ/kmol
Molar Entropy (Mixture)	-117.204	-101.354	-2.03168	kJ/[kmol.K]
Molar Fraction (Vapor)	0	0	1	
Phases	Liquid Only	Liquid Only	Vapor Only	
Energy Flow	-520.804	-10130.2	128.754	kW

## References:

“Ethanol production by vapour phase hydration of ethylene” by Attamah Chikaodilil