



Business Area
Biomass Chemicals

Ethylene from Ethanol

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The process for ethylene from ethanol has been proven in actual operation; has been modernized and updated based on actual plant data; uses a new and improved catalyst and is of considerable significance in the changing feedstock picture for ethylene production, particularly in petroleum poor, agriculturally rich economies.

The capacity ranges from 5,000 – 200,000 metric tons per year with a normal working time of about 8,000 hours per year.

The first plant was designed and built for Electro Cloro (a subsidiary of the Solvay group of Brazil). It was designed to produce 20 MT/day (about 6700 MTPY) of vinyl chloride monomer grade ethylene. From the start of operations in 1960 the plant operated at an average yield that was greater than design and equal to or greater than that reported in the literature for any operating plant. The plant has been expanded and the ethylene produced is also used as feed to a polyethylene plant.

The plants have been operated and shut down on and off over the years in response to changing economic conditions. They have demonstrated that they can be restarted quickly provided only that the usual maintenance procedures have been employed.

Because of the recent interest in the production of ethylene from ethanol in a number of countries, further studies have been made to improve the process and, in particular, a new catalyst has been developed with the following improved characteristics:

- a) Higher productivity. This permits a reduction of total reactor volume.
- b) Higher yield conversion and selectivity leading to better utilization of the ethanol feed and less by-products.
- c) Higher resistance to deactivation. This permits longer runs between catalyst regeneration.

Further, the improved catalyst enables significant improvements in the ethylene recovery and purification train. Process design studies have been conducted in light of the changed energy picture to optimize utilization of capital and energy.

Basic chemistry

Ethanol is catalytically dehydrated to produce ethylene according to the following chemical reaction.



The reaction is endothermic. Also the reaction is reversible with the equilibrium being favoured by higher temperatures and hindered by higher pressures and water vapour in the feed. As recovery of unconverted ethanol for recycle is energy and capital intensive, reaction conditions enabling 99% + conversion of ethanol are usually preferred. The SYNDOl catalyst makes it possible to consider a number of process schemes for supply of the heat the endothermic reaction requires.

A typical selectivity breakdown at 99% conversion is shown below:

Ethanol selectivity, %	
Ethylene	96.8
Ethane	0.5
Propylene	0.06
Butylenes	2.4
Acetaldehyde	0.2

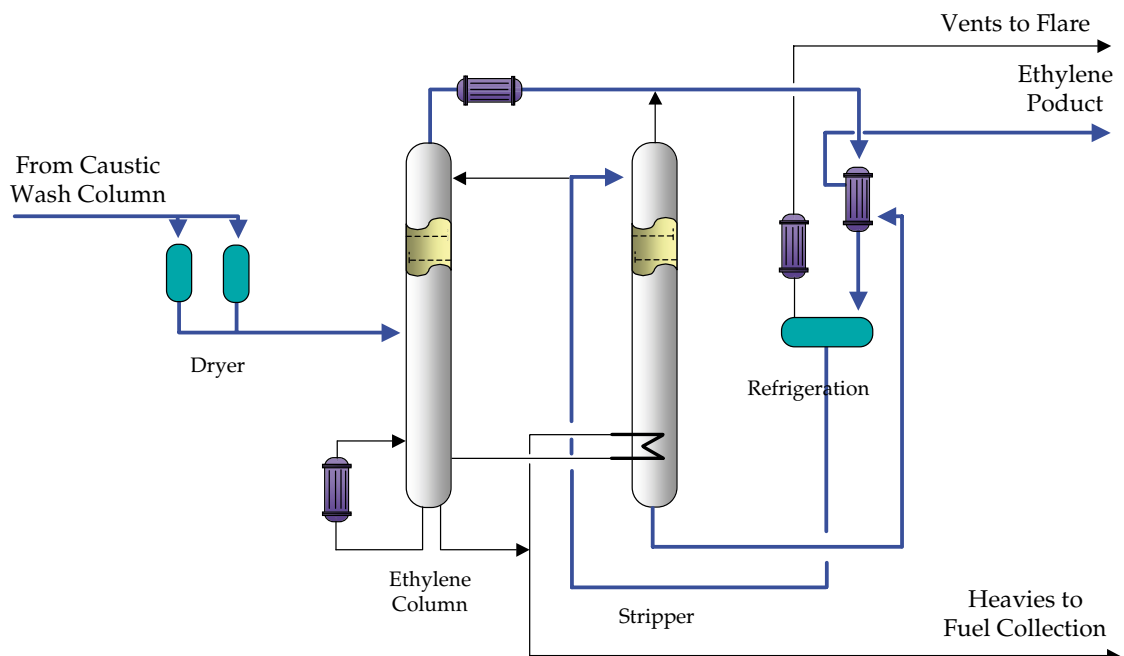
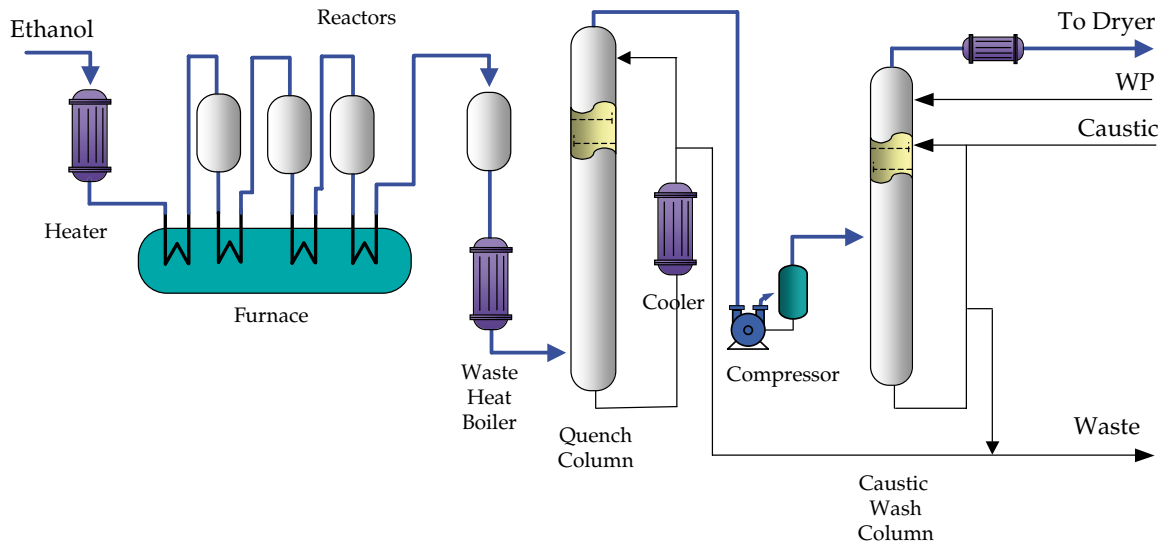
Minor amounts of methane, carbon monoxide and dioxide, ethyl ethers and hydrogen are also formed.

Products

The plants can be designed for crude, intermediate and polymer grade ethylene depending on the product application.

Flow sheets

The flow sheets show a typical polymer grade application. The process train for intermediate grade will be the same except that the caustic wash column and the stripper will be deleted. Crude grade ethylene is taken out after the quench column.



Raw material requirements and specifications

Raw material specifications

Ethanol (typical composition)

Ethanol	95% vol
Acetaldehyde	100 ppm wt
Fusel oil	100 mg/L
Acids	10 mg/L
Methanol	0.3 vol %
Sulphur compounds (as S)	0.5 ppm wt

Catalyst

- Catalyst Type: Syndol

Syndol is a very stable high yield ethanol dehydration catalyst. A start-of-run, selectivity to ethylene is typically 97% at 99% ethanol conversion.

Because of the expected long life, no regeneration facilities are included in the battery limits plant design.

