EtE EverGreen

Ethanol-to-Ethylene Technology

LUMMUS TECHNOLOGY

Overview

The EtE EverGreen™ ethanol-to-ethylene process technology, a Braskem based technology licensed exclusively by Lummus Technology, is an advanced solution to produce a polymer grade, green ethylene from ethanol. The process involves an efficient conversion of fuel-grade, plant-derived ethanol over a fixed bed catalyst reactor setup. Since the startup of the world's largest (200 KTA) commercial plant in 2010, process improvements have maximized reliability, performance and process safety. The technology is robust and reliable, resulting in excellent onstream time. It produces a polymerization-grade green ethylene which can be fed to different downstream polyethylene applications in seamless transitions with conventional ethylene.

Process complexity is moderate and comparable to a modern ethane cracker design. EtE EverGreen technology involves an environmental design to minimize emissions, effluents and solid wastes, and create the ultimate carbon footprint. Some efficiency approaches include using Lummus' heat transfer furnace designs to minimize CO_2 and other emissions footprint; minimizing hydrocarbon by-products formation; using renewable fuels to meet the energy demand of the plant; and maximizing heat integration. Due to the high turndown ratio, high rundown capacity and extensive use of automation systems and latest digital solutions, the plant operation is highly flexible in relation to the throughput.

Advantages

Process Features	Process Benefits
Feedstock flexibility	Operates with commercial fuel grade hydrous and anhydrous ethanol
Proven reliability with 10+ years of industrial scale production background	Allows for quick implementation to full production capacity
Consolidated solutions to prevent chronical problems (corrosion and fouling)	Offers reliable and continuous production at full capacity
Highly integrated for stand-alone operation	Produces wastewater as the only byproduct leaving the plant
High conversion and catalyst selectivity	Generates reliable high yield
Long-life and long-cycle catalyst	Provides reduced catalyst and regeneration cost and predictable operation
Optimized heat recovery	Reduces utility cost and CO_2 footprint
High-purity polymer-grade ethylene	Provides seamless transitions between bio-based and conventional ethylene while suitable for all downstream processes
High turn-down ratio	Delivers efficient operation at reduced capacity

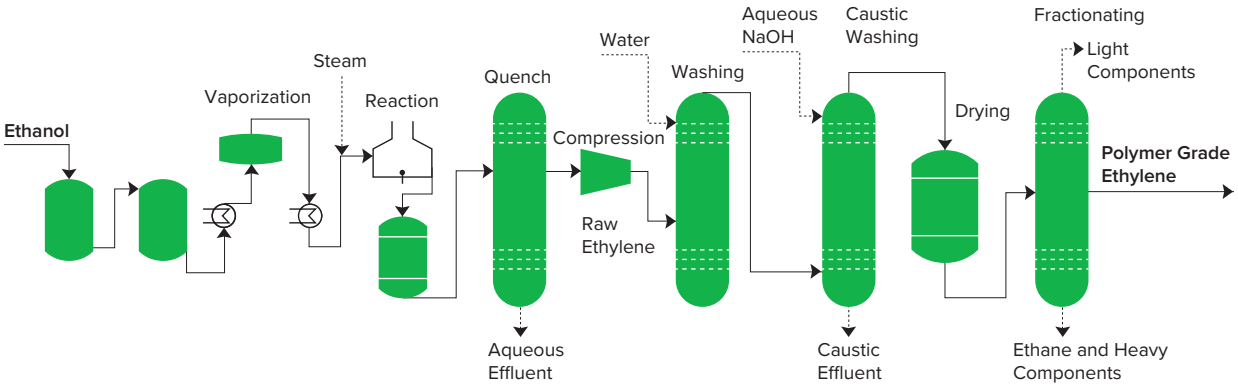
Performance Characteristics

Typical Feed and Product Specifications			
Hydrous Ethanol	Ethanol → ≥ 92.6 % weight	Ethylene (Mole Basis)	Ethylene → ≥ 99.9 %
	Water → ≤ 7.4 % weight		Ethane → ≤ 900 ppm
	Conductivity → ≤ 500 µS/m		Total alcohols → ≤ 5 ppm
	Colorless		Total ethers → ≤ 5 ppm
	Plant-derived		Aldehydes + ketones → ≤ 15 ppm

Performance Characteristics

Key performance indicators	
Conversion → ≥ 99 %	Selectivity → ≥ 98 %
Ethanol @ 93.8 % wt. → ≈1.85 $t/t_{ETHYLENE}$	

Block Flow Diagram

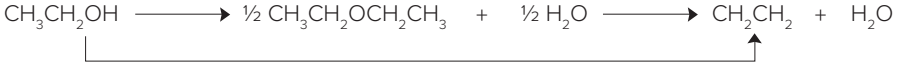


Process Description

EtE EverGreen ethylene is produced by the dehydration of bio-derived ethanol in fixed bed reactors. Ethanol is pumped to a pre-treatment and then it is vaporized and superheated. The superheated ethanol stream is distributed between the reactors to maintain as optimal reagent feed to each reactor. Lummus' heat transfer furnaces are responsible for heating the reaction mixture to the optimum temperature. The effluent from the reactors is a mixture that mainly contains ethylene formed in the reaction, water and some additional by-products used as fuel gas. The water is removed in a condensation tower. From this point onwards two streams are formed: (1) a stream in vapor phase called crude ethylene, and (2) an aqueous stream. The aqueous stream is treated to recover unreacted ethanol and to remove impurities so that the water can be reused or disposed of as an aqueous effluent. The gaseous phase, crude ethylene, is compressed and subjected to various purification processes to remove contaminants, ethane and other higher molecular weight hydrocarbons.

Process Chemistry

Dehydration



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