

# Ethylbenzene / Styrene Monomer



## Overview

Lummus Technology and UOP's *EBOne* ethylbenzene and "Classic" styrene monomer technologies have earned the reputation for being the most modern, efficient and reliable processes for the production of intermediate ethylbenzene (EB) and styrene monomer (SM), respectively.

The liquid-phase *EBOne* process uses a fixed-bed zeolite catalyst system and represents a major technological step change from older vapor phase EB technologies. The catalyst provides a run-length of three to five years, thus eliminating the need for regeneration equipment. The process has low investment requirements, provides high yields and is energy efficient. Xylene impurity formation is practically eliminated, resulting in an EB product of excellent quality. The process enables owners to maintain a safe, reliable, easy-to-operate plant. It has been commercially proven, exhibiting efficient, predictable and stable operation. Use of regenerated catalyst is also commercially proven,

exhibiting performance equal to or better than fresh catalyst.

The "Classic" SM process is well known in the industry for its deep vacuum/adiabatic EB dehydrogenation technology and demonstrated high mechanical integrity. The unique dehydrogenation reactor system is designed to operate at the most cost effective, minimal operating pressure for achieving the highest SM selectivities at high conversions. An off-line optimizer (SM GAIN™) can also be provided to allow personnel to closely monitor the important process variables and operate the plant at optimum conditions. Our ongoing program of catalyst and process development provides clients with technologies that have significant capital and operating cost advantages, as well as world-renowned operating reliability and mechanical integrity. More than 30 commercial plants are in operation worldwide.

## Advantages

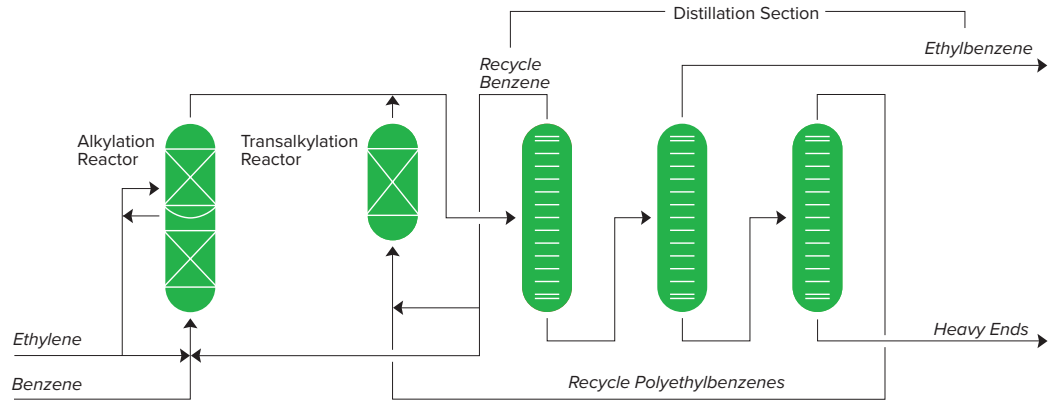
### ***EBOne* Ethylbenzene**

Process Features	Process Benefits
Long catalyst run-length with excellent stability	Minimizes plant downtime
Highly selective reaction	Insignificant amounts of xylenes are produced, providing highest product quality
High yield	Minimizes production cost
All carbon steel equipment	Reduces investment

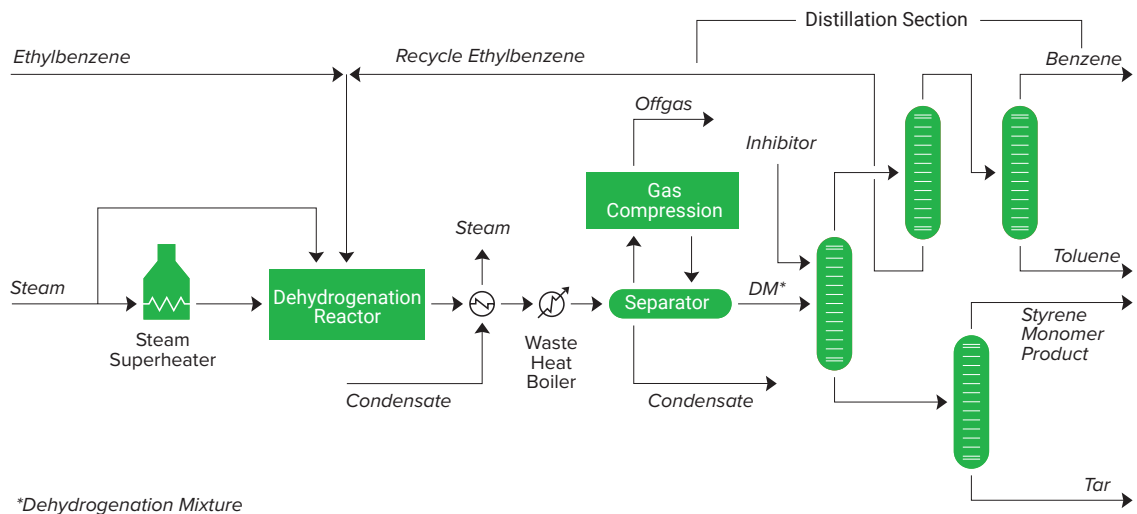
### **"Classic" Styrene Monomer**

Process Features	Process Benefits
Substantial recovery of low-level energy maximum	Increases energy savings
Unique reactor system achieving high conversion per-pass and high selectivities	Reduces investment Exceptional mechanical reliability
Long reactor run-lengths	Reduces downtime
Low steam/hydrocarbon ratio	Lower production cost

## Ethylbenzene Process Flow Diagram



## “Classic” SM Process Flow Diagram



## Process Description

The manufacture of EB involves the alkylation of benzene with ethylene to yield a mixture of alkylated benzenes and excess benzene. The mixture is distilled to recover the EB product. Unreacted benzene, and the higher ethylated benzenes produced by alkylation reactions, are separated and recycled to the reactors. These higher ethylated benzenes are transalkylated with benzene to form additional EB. The recycle benzene is sent back to the alkylator and transalkylator reactor vessels, and the EB product is sent to the dehydrogenation section of the styrene unit.

The major reactions in the manufacture of SM are the dehydrogenation of EB to SM and hydrogen.

Dehydrogenation side reactions produce benzene and toluene and some light compounds. The catalytic dehydrogenation reaction is endothermic, with reaction heat supplied by a superheater. The reactor effluent is cooled by generating steam. The offgas stream is compressed and used as fuel in the steam superheater. The dehydrogenated mixture is distilled to recover the SM product. Unreacted EB is recycled to the reactors. Benzene and toluene are produced as by-products. Proprietary treaters allow recycle of by-product benzene to the EB Unit.

Inhibitors are added to prevent styrene polymerization in the process equipment.