

Overview

The Lummus/UOP SMARTSM styrene monomer (SM) process represents a major technological advantage by offering unmatched revamp/expansion opportunities. Significant capacity expansion can now be achieved without the need of an additional train in an existing SM plant.

The technology offers the most advanced process for the manufacture of SM from ethylbenzene (EB). The process integrates UOP's innovative oxidative reheat step (StyroPlus) into the Lummus/UOP "Classic" deep vacuum/adiabatic EB dehydrogenation technology, which is well proven, reliable, and has demonstrated its mechanical integrity.

Advantages

Process Features	Process Benefits
Removal of hydrogen shifts the dehydrogenation reaction equilibrium to obtain 75-80% single-pass EB conversion	Lowers flow rate for a given capacity resulting in lower capital cost • Excellent for revamps
Oxidative exothermic heat of reaction provides reactor interstage heating	Allows 30-70% additional capacity through existing steam superheater system
Simple steam superheater system	Reduces investment
Competitive SM selectivities are obtained at high EB conversions	Reduces investment and production costs
Oxidation catalyst matches dehydrogenation catalyst life of 18-24 months	Reduces downtime
Substantial energy recovery without compression	Increases energy savings

Performance Characteristics

The SMART SM process uses a unique reaction system to ensure safe, trouble-free operation. The system, consisting of the steam superheater, superheated steam transfer piping, reactors, and reactor effluent exchanger, is designed as a mechanically and thermally integrated unit. This design is safe, compact, and reliable.

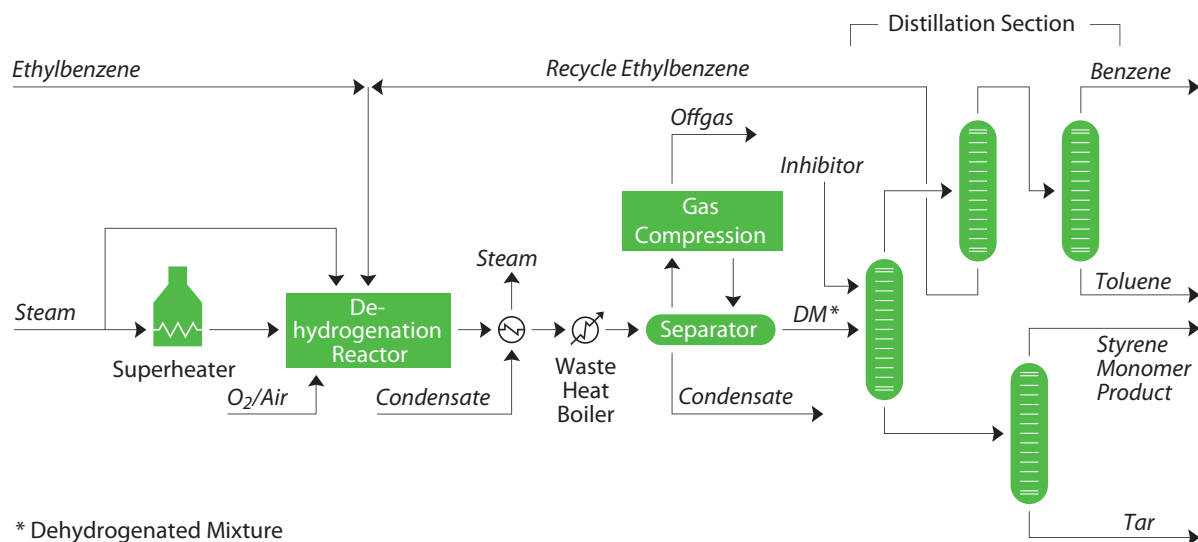
In conventional dehydrogenation units, selectivity and conversion are linked so that high conversion and high selectivity cannot be achieved simultaneously. Therefore, trade-offs must be made. To achieve high selectivity, conventional plants are limited to less than 70% conversion. In the SMART SM technology, however, the combination of

oxidative reheat with modern EB dehydrogenation technology results in high singlepass conversion and high selectivity being achieved simultaneously. High conversion obtained in the SMART process results in considerably less flow of feedstock through the plant for a given production of SM.

This technology is ideally suited for increasing plant capacity at the lowest capital investment. The combination of higher EB conversion and interstage reheat provided by the oxidative reheat step results in debottlenecking most of the constraining equipment, and provides 30 to 70% additional capacity.

SMARTSM Styrene Monomer Advanced Reheat Technology

Process Flow Diagram



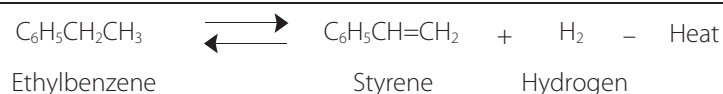
Process Description

The major reactions in the process are the dehydrogenation of ethylbenzene to styrene and the subsequent oxidation of the hydrogen produced in the first reaction. This hydrogen is reacted with oxygen over a highly selective catalyst. The removal of hydrogen from the process substantially increases single-pass EB conversions while maintaining high SM selectivity. The heat generated is used to reheat the reaction mixture, avoiding expensive interstage heat exchanger equipment.

Dehydrogenation side reactions also produce benzene and toluene, as well as some light compounds. A small steam superheater supplies part of the endothermic reaction heat for the dehydrogenation reaction. The reaction system contains two catalysts: a conventional EB dehydrogenation catalyst and an oxidation catalyst. The reactor effluent is cooled by generating steam. The dehydrogenated mixture is distilled to recover the styrene product, benzene and toluene by-products, and recycle ethylbenzene.

Process Chemistry

Dehydrogenation



Oxidation

