

petrochemical

Process Technology and Equipment

Lummus/UOP Classic SMTM Process

INTRODUCTION

The Lummus/UOP Classic SM process is well known in the industry for its deep vacuum/adiabatic ethylbenzene dehydrogenation technology, efficient heat integration, and demonstrated high mechanical integrity. The unique dehydrogenation reactor system is designed to operate at a very cost effective, minimal operating pressure for achieving the highest SM selectivities at high conversions. Our ongoing program of catalyst and process development provides clients with technologies that have significant capital and operating cost advantages with proven operating reliability.

The Lummus/UOP Classic SM process features:

- Styrene monomer purity of 99.85 wt-% minimum
- High per pass EB conversion (up to 69%) for lower operating costs due to less EB recycle
- Overall EB selectivity to styrene of more than 97 mol-% for lower EB feed consumption
- Low equipment pressure drop, which permits the reactor operation to operate at high vacuum, for higher product quality and lower EB feed consumption
- Minimum pressure drop radial bed reactors for lower operating pressure, resulting in lower EB feed consumption and reduced by-product formation
- Energy savings from patented heat recovery that does not require compression equipment

UOP also offers the Lummus/UOP EBOne[™] process, which features the EBZ-500[™] zeolitic catalyst. Combined with the Lummus/UOP Classic SM process, it provides an efficient and reliable process for the production of styrene monomer.



Lummus/UOP Classic SM Unit

DESCRIPTION

The feedstock, ethylbenzene, is catalytically dehydrogenated to styrene in the presence of steam in a fixedbed, radial flow reactor system. The dehydrogenation reaction is favored by low pressures and is generally conducted under deep vacuum. Toluene, benzene, and some light compounds are formed as by-products. The overall reaction is endothermic with heat supplied by steam in the adiabatic reactors. Reactor effluent waste heat is recovered through heat exchange with combined feed and by generating steam which is utilized in the process. The offgas stream is compressed, processed through the off gas recovery section, and used as fuel in the steam superheater. The condensates from the condenser and off gas recovery section flow into the separator where hydrocarbon and water phases separate. The dehydrogenated mixture is fractionated to recover the styrene monomer product and recycle ethylbenzene, as well as benzene and toluene by-products. Inhibitors are added to prevent styrene polymerization in the process equipment.

FEEDSTOCK AND PRODUCTS

Feedstock

Ethylbenzene Xylene Diethylbenzene 99.85 wt. % 50 ppm wt max. 8 ppm wt. max.

Styrene Product

Styrene Ethylbenzene Alpha-methylstyrene 99.85 wt. % min.0.03 wt. % max.0.03 wt. % max.

COMMERCIAL EXPERIENCE

Since its introduction in 1970, the technology has been selected for over 50 major projects throughout the world. Capacities range from 66,000 MTA to 715,000 MTA with 42 commercial plants in operation and 3 in design and construction.



FOR MORE INFORMATION

Lummus/UOP Classic SM technological services are available on request. For more information, contact your local UOP representative or contact our Des Plaines sales office:

e-mail: info@uop.com fax: +1-847-391-2253 phone: +1-847-391-2000

UOP LLC 25 East Algonquin Road Des Plaines, IL 60017-5017, U.S.A. www.uop.com



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Lummus/UOP Smart SMTM Process

INTRODUCTION

The Lummus/UOP Smart SM process combines oxidative reheat technology with adiabatic dehydrogenation technology to produce styrene monomer (SM) from ethylbenzene. It uses specially designed UOP reactors to achieve the oxidation and dehydrogenation reactions.

In the oxidative reheat section of the reactor, hydrogen is oxidized to supply the heat for the dehydrogenation reactions. This eliminates the costly interstage reheater and reduces superheated steam requirements. As hydrogen is consumed in the oxidation step, the dehydrogenation reaction equilibrium is shifted forward through the reduction in hydrogen partial pressure. This results in EB conversion of more than 80%. For existing SM producers, revamping to the Smart SM process is a cost-effective route to increased capacity.

The Lummus/UOP Smart SM process features:

- Styrene monomer purity of 99.85 wt-% minimum
- High per pass EB conversion (over 80%) for increased throughput
- Reduced superheated steam requirements
- No interstage heater

To provide the increased EB requirements of a revamped SM unit, UOP also offers the Lummus/UOP EBOne[™] process for AlCl3 ethylbenzene (EB) units. This commercially proven process uses the EBZ-500[™] zeolitic catalyst to provide significantly lower production cost. Revamping your complex using the Lummus/UOP Smart SM process combined with the Lummus/UOP EBOne process provides the most cost-effective option for increasing capacity and improving the profitability of your styrene complex.

Typical Smart SM Revamp



DESCRIPTION

The feedstock, ethylbenzene, is catalytically dehydrogenated to styrene in the presence of steam in a fixed-bed, radial flow reactor system. The dehydrogenation reaction is favored by low pressures and is generally conducted under deep vacuum. Endothermic heat of reaction in the Smart SM reactor is supplied by oxidative reheat through the combustion of hydrogen with a stream of oxygen. Toluene, benzene, and some light compounds are formed as by-products. Reactor effluent waste heat is recovered through heat exchange with combined feed, and by generating steam utilized in the process. The off gas stream is compressed, processed through the off gas recovery section, and used as fuel in the steam superheater. The condensates from the condenser and off gas recovery section flow into the separator, where hydrocarbon and water phases separate. The dehydrogenated mixture is fractionated to recover the styrene monomer product, recycle ethylbenzene, and benzene and toluene byproducts. Inhibitors are added to prevent styrene polymerization in the process equipment.

FEEDSTOCK AND PRODUCT

Feedstock

Ethylbenzene	99.85 wt-% n
Xylene	50 ppm wt-%
Diethylbenzene	8 ppm wt-%

Styrene Product

Styrene Ethylbenzene Alpha-methylstyrene nin max max

99.85 wt-% min 0.03 wt-% max 0.03 wt-% max

COMMERCIAL EXPERIENCE

Since the introduction of the Lummus/UOP Smart SM process in 1995, Lummus and UOP have been awarded 5 projects with styrene capacities ranging from 84,000 to 427,000 MTA. Five commercial plants are in operation worldwide having a total styrene capacity of more than 1,300,000 MTA.



FOR MORE INFORMATION

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e-mail: info@uop.com fax: +1-847-391-2253 phone: +1-847-391-2000

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UOP LLC 25 East Algonquin Road Des Plaines, IL 60017-5017, U.S.A. www.uop.com

OC-5[™] Catalyst

Catalyst Petrochemicals

Description

OC-5 catalyst is a solid, non-regenerable catalyst used for selective combustion of hydrogen. OC-5 catalyst consists of a spherical alumina support impregnated with platinum and promoters.

Applications

OC-5 catalyst is used in the Smart[™] SM process for production of styrene monomer (SM) from ethylbenzene (EB). The primary reaction is dehydrogenation of EB over an iron oxide catalyst to form SM and hydrogen. Because the dehydrogenation reaction is highly endothermic, conventional SM units employ two or more reaction stages with indirect steam reheat of the reaction mixture between stages. The Smart SM process employs an innovative oxidative reheat technology to selectively combust the hydrogen liberated by the dehydrogenation of EB. Selective oxidation of hydrogen with OC-5 catalyst provides direct and efficient reheat of the reaction mixture and shifts the reaction equilibrium toward production of SM. The Smart acronym stands for Styrene Monomer Advanced Reheat Technology.

OC-5 catalyst is the latest oxidation catalyst developed by UOP for the Smart SM process, replacing OC-4.2[™] catalyst.

Features and benefits

The Smart SM process is ideal for expanding the capacity of existing SM units by 30-50% with minimal capital investment.

- The spherical shape and improved formulation of OC-5 catalyst improves the diffusion characteristics of the catalyst and permits a more efficient distribution of platinum.
- OC-5 catalyst offers the same activity, selectivity and stability performance as OC-4.2 catalyst with half the platinum.

Experience

OC-5 catalyst was commercialized in 2003 and is currently operating in five Smart SM units.

Physical properties

Shape	Sphere
Nominal diameter, mm	3.8
ABD, kg/m³	750
Metals	Platinum

Packaging

- 55 U.S. gallon (210 liter) steel drums
- Net weight per drum of 140 kilograms

For more information

For more information, contact your local UOP representative or our Des Plaines sales office:

e-mail: info@uop.com fax: +1-847-391-2253 phone: +1-847-391-2000



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