

Styrene technology

As a leader in styrene technology for more than 55 years, the Badger name has become synonymous with energy efficiency, reliability and long on-stream times. Together with our operating partner TotalEnergies, we have developed a technology that operates at an ultra-low steam-to-oil ratio in the reactors with the longest operating runs between catalyst changes in the industry.

Styrene process

Low steam-to-oil, combined with our patented Multi-Effect Distillation and Catalyst Stabilization technologies, results in a low variable operating cost. Deep vacuum in the reactor section together with low distillation temperatures result in high raw material yields. Licensed units using our styrene technology represent approximately half of the styrene monomer produced via ethylbenzene dehydrogenation. Technip Energies Badger Process Technology's continued innovation in styrene unit design, such as Direct Heating Unit (DHU) technology, is second to none.

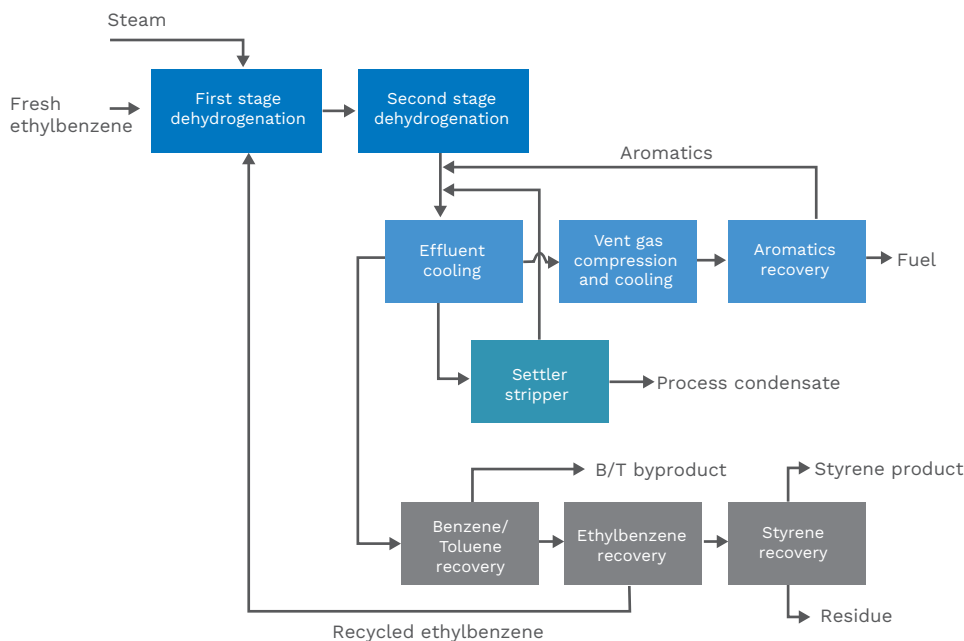
Reaction

A two-stage dehydrogenation reaction system converts ethylbenzene to styrene.

Purification

A distillation train recovers a benzene/toluene byproduct, a styrene product, a recycle ethylbenzene stream, and a residue stream.

Styrene process scheme



Styrene Technology Highlights

LOW VARIABLE OPERATING COST

- Low steam-to-oil reaction operation
- Low pressure results in high yields
- Catalyst stabilization extends run life

COMMERCIAL EXPERIENCE

- As of early 2022, Technip Energies Badger Process Technology has licensed plants representing almost half of the world's styrene manufactured by ethylbenzene dehydrogenation.
- Single train operating experience as high as 770 KTA
- Extensive feedback from operating plants

SUPERIOR TECHNOLOGY

- Demonstrated superior mechanical integrity
- External reactor reheat exchanger for easy access and maintenance
- Vertical feed/effluent exchanger provides constant pressure drop and compact design
- Low steam superheater outlet temperatures
- Low polymerization inhibitor consumption
- Equipment layout facilitates capacity expansion
- Multi-Effect Distillation (MED) significantly reduces the energy consumption

Direct Heating Unit technology

Direct Heating Unit (DHU) Technology is a groundbreaking improvement to the styrene industry.

Benefits of DHU technology:

- Combines the functions of a steam superheater cell and a reheat exchanger
- Fewer high temperature pipes
- Reduces steam consumption
- Less plot space
- Less pressure drop for both steam and the process
- Replaces a fired heater with a heat exchanger
 - Fewer interlocks
 - Less complex controls
 - Easier to operate
 - Inherently safer

Catalyst Stabilization technology

Licensed exclusively by Technip Energies Badger Process Technology, Catalyst Stabilization technology (CST) significantly extends the useful life of the dehydrogenation catalyst by replenishing the potassium promoter. Having been licensed to 30 styrene units, CST has proven to be a cost-effective solution by reducing the frequency that catalyst is replaced. CST is now licensed to 40% of the world's dehydrogenation capacity.

Benefits of CST include:

- Extended catalyst run times by 30-50%
- Fewer turnarounds, which means less lost production

Our Partner: TotalEnergies

TotalEnergies Refining & Chemicals' research facilities, together with the five operating units of TotalEnergies, are invaluable resources to the development and commercialization of styrene process improvements. Access to the operating plants also allows for demonstration of new or innovative concepts such as DHU.



PetroChina Dushanzi Petrochemical Company's
320 KTA EB/SM Plant



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