Technology Licensing
A Cost-Effective Process for Recovering Styrene
GT-Styrene®: A Cost-Effective Process for Recovering Styrene

In an effort to improve the production economics of naphtha cracking plants, operators must consider the recovery of valuable components from pyrolysis gasoline (pygas) over blending into the gasoline. Styrene is one such component that has far more value as a petrochemical product than as a motor fuel blendstock. GTC Technology’s GT-Styrene process uses extractive distillation to directly recover styrene from pygas at 99.9 percent purity, making it suitable for polymers production, and at a very attractive cost compared to conventional styrene production methods. The economics are attractive for reasonable-sized crackers using liquid feedstock, producing more than 600 KTA ethylene.

Process Overview (Conventional vs. GT-Styrene)

Conventional styrene production methods derive feedstock by steam cracking naphtha. Benzene is recovered from pygas through direct extraction. The C₈ fraction, which contains high levels of ethylbenzene (EB) content, may be routed to a hydrodealkylation (HDA) unit to produce benzene plus fuel gas. Benzene is then reacted with ethylene to produce EB, which is dehydrogenated to produce styrene. Attaining a product that already exists in the raw feedstock is complex. In addition, production of styrene by this route includes some drawbacks, such as:

- Fouling of the selective hydrogenation catalyst
- \( \text{H}_2 \) consumption
- Reduction of gasoline quality
- Large capital required to achieve economic rates

GT-Styrene technology, however, uses extractive distillation to enable the direct recovery of high-purity styrene from the pygas. Because styrene is the only unsaturated aromatic within a reasonably close boiling range, a solvent-based system can extract and purify styrene from a heartcut of the pygas. The highly selective co-solvent system alters the boiling point of the styrene, compared to the other species, allowing it to be separated in conventional distillation equipment. Thus, GT-Styrene replaces several operational steps, while producing the same end-product as conventional methods.

Advantages

The primary advantage of GT-Styrene comes from using a low-cost raw material. By recovering styrene, pygas producers can generate income from petrochemicals, instead of blending all components into motor fuel. Ethylene plants cracking liquids feedstock can achieve a favorable return on most world-scale units. The styrene produced by extractive distillation will always have the lowest feedstock cost, and therefore will have an advantage over traditional units feeding benzene plus ethylene.

The benefits of using GT-Styrene’s extractive distillation process as opposed to conventional methods of recovery include:

- Upgrade of the styrene component from fuel to petrochemical value
- Upgrade of xylenes from motor fuel to xylene isomer quality feedstock value
- Reduction in overall hydrogen consumption
- Reduction in catalyst fouling and operating costs in the selective hydrotreater unit
- Debottlenecking of the pygas hydrotreating area by diversion of part of the feed

The following factors can enhance the project’s value:

- Proximity to an existing styrene producing unit or styrene consumer to consolidate storage and reduce shipping costs
- Integration with xylenes processor to gain full value of EB-reduced xylenes
- Debottlenecking of pygas hydrogenation unit, if there is a constraint in this area
• Ability to reuse equipment in the pygas fractionation area
• Possibility of consolidating styrene fractions from nearby producers to gain economy of scale

Economic Analysis

<table>
<thead>
<tr>
<th>Basis</th>
<th>25 KTA Styrene Recovery</th>
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<tbody>
<tr>
<td>Erected cost</td>
<td>$21 MM</td>
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<tr>
<td>(ISBL, 2012 U.S. Gulf Coast Basis)</td>
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GT-Styrene

A heartcut C₈ stream from the raw pygas is selectively hydrotreated to remove phenyl acetylenes. This product is routed to an extraction section that uses GTC’s proprietary extractive distillation technology to separate styrene from the C₈ stream. The styrene is treated for trace impurity removal and then redistilled as final product.
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