Nexant

Technology and Costs

TECH 2018-7: Adipic Acid

Adipic Acid is one in a series of reports published as part of Nexant's 2018 Technoeconomics – Energy & Chemicals (TECH) program.

Overview

Adipic acid is a major chemical intermediate used in the production of polyamide 6,6, thermoplastic polyurethane (TPU), unsaturated polyester resin (UPR) and adipic acid esters. Although the technology for making adipic acid can be considered mature, researchers have continued to develop processes that either focus on direct oxidation routes, oxidations that use precursors other than KA oil, or bio-based routes. At the same time, the industry has also moved toward finding economical processes to remove or recover nitrogen oxides (NOx).

This TECH report provides an updated overview of the technological, economic, and market aspects of adipic acid. The following issues are addressed in this report:

- What are the major technologies for KA oil and subsequent adipic acid production? How do technologies differ? Which technologies are available for license?
- How do the process economics compare across processes and different geographic regions?
- What is the current market environment for adipic acid? How does growth compare in different regions? Which region will drive future growth?

Production Technologies

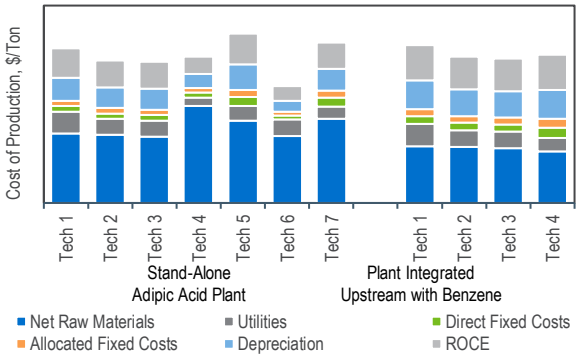
Commercial production processes for adipic acid depend on the production (or purchase) of KA oil. KA oil is a mixture of cyclohexanone and cyclohexanol; a ketone (K) and an alcohol (A). Benzene is the usual source of the precursors - cyclohexane, phenol, cyclohexene – which are used to produce KA oil. By far, the most common route to the KA oil needed for adipic acid production is the air oxidation of cyclohexane. Various routes involving air oxidation of cyclohexane to KA are reviewed in this TECH report such as the boric acid promoted route, the cobalt catalyst route (the oldest process still in use), and the so called high peroxide route. Production of KA from phenol is also covered, as well as the Asahi process for cyclohexanol production from benzene via cyclohexene. Subsequently, the KA oil is converted to adipic acid by oxidation using an excess of nitric acid.

In addition to the commercial routes cited above, developing technologies covered in the report include thee direct single stage oxidation of cyclohexane to adipic acid either by air, oxygen, ozone/UV, or hydrogen peroxide, butadiene-based routes to adipic acid through carbonylations and/or hydroformylation reactions, and a route based on the dimerization/hydrogenation of acrylonitrile or acrylic acid or its ester.

Process Economics

Detailed cost of production estimates for various technologies are presented for USGC, Western Europe, and coastal China locations. Estimates are developed for five commercial routes and two alternative routes to adipic acid. The economics of adipic acid plants integrated with feedstock production were also developed for four commercial routes.

U.S. Gulf Coast Summary of Adipic Acid Production Costs



Commercial Overview

Global adipic acid consumption was estimated at approximately 3.0 million tons in 2017, with polyamide 6,6 and TPU being the largest end-uses. Increased demand has been driven by investment in downstream derivatives in Asia Pacific (mainly China). Demand is expected to grow above 3 percent annually driven by the automotive and electronics sectors.

An overview of the supply, demand, and trade of adipic acid on a global and regional (North America, Western Europe, Asia Pacific, and Rest of the World) basis is provided in this TECH report.

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TECH's comprehensive studies include detailed technology analyses, process economics, as well as commercial overviews and industry trends. Reports typically cover:

- Trends in chemical technology
- Strategic/business overviews
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- Chemistry
- Process flow diagrams and descriptions of established/conventional, new and emerging processes
- Process economics – comparative costs of production estimates for different technologies across various geographic regions
- Overview of product applications and markets for new as well as established products
- Regional supply and demand balances for product, including capacity tables of plants in each region
- Regulatory and environmental issues where relevant

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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program (formerly known as PERP), the Biorenewable Insights program (BI), the Sector Technology Analysis, and the new Cost Curve Analysis. These programs provide comparative economics of different process routes and technologies in various geographic regions.

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