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Technology and Costs

TECH 2023S4: Ultra High Molecular Weight Polyethylene

Ultra High Molecular Weight Polyethylene (UHMWPE) is one in a series of reports published as part of NexantECA's 2023 Technoeconomics – Energy & Chemicals (TECH) program.

Overview

UHMWPE is a thermoplastic polyolefin with a molecular weight usually between 2 and 6 million g/mol. Its impact resistance, abrasion resistance, performance at low temperatures, weatherability, lubricity, and chemical resistance makes it suitable for a variety of applications from bearings in medical implant, battery separators and armor.

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

- How is UHMWPE produced? What technology is used in production?
- How do the process economics compare across processes and different geographic regions, for UHMWPE resin, rods and yarn?
- Who are the top producers of UHMWPE?
- What do patent filing trends reveal?
- What is the current market environment for UHMWPE? What applications will drive growth?

Commercial Technologies

The polymerization of UHMWPE was commercialized by Ruhrchemie AG (Ticona, and now Celanese Corporation), based in northern Germany, during the 1950s.

UHMWPE is synthesized by a slurry process using a heterogeneous Ziegler-Natta catalyst with a hydrocarbon as diluent. Since the active sites in such catalyst systems are relatively close together, the chains grow in close proximity to each other. As a result of the relatively high polymerization temperature, crystallization of the polymer chains is relatively slow and the resulting polymer has a very high degree of entanglements. Due to the high molecular weight and high degree of entanglements, the mobility of these chains is very limited and complete fusion of these polymer particles during processing is difficult to achieve. Thus, the structure created during synthesis of the polymer affects the final properties of the polymer.

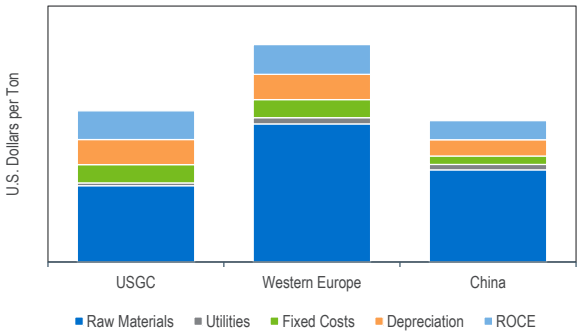
UHMWPE production technology are usually developed inhouse as licensing agreement is not common. In China, petrochemical companies collaborate with research institute to commercialize UHMWPE process technology.

Process Economics

The economic analysis provides an overview of production costs for UHMWPE resin, UHMWPE rods and UHMWPE yarns in the United States, Western Europe, and China in 3Q 2023. An overview of the carbon intensity of the UHMWPE resin production is also presented.

Cost of UHMWPE Production by Geography

Capacity – 40 ktpa, 2023-Q3



Commercial Overview

In 2023, global UHMWPE is estimated at about 475 000 tons while capacity at about 701 000 tons, implying an operating rate close to 68 percent. China has the largest capacity following rapid expansion from 2020 onwards.

By 2025, the global capacity is expected to reach over one million tons, with capacity expansions driven mainly by China.

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- Regional supply and demand balances for product, including capacity tables of plants in each region
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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program, the Biorenewable Insights program (BI), 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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