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Technology and Costs

TECH 2022S12: Emerging Technologies to Recycle Plastic Waste

Emerging Technologies to Recycle Plastic Waste is one in a series of reports published as part of NexantECA's 2022Technoeconomics – Energy & Chemicals (TECH) program.

Overview

Plastic producers are actively investing in technologies under the pressure of stricter government regulations (such as plastic bag bans) and end users' increased preference for sustainable materials.

Tertiary/advanced recycling, mainly solvent purification technologies, are generally less developed than other recycling methods, but are gaining increased attention because polymer bonds are not broken, the molecular structure of the polymers is the same as the input material, additives and colors are removed, and virgin-like polymer is produced.

This TECH report provides an updated overview of the technological, economic, and global outlook for recycled polyolefins, polystyrene, and polyethylene terephthalate produced from scrap. The following issues are addressed in this report:

- What are the main drivers for plastic recycling?
- Who are the main technology developers that offer solvent purification, decomposition, and enzymatic hydrolysis processes?
- How do the economics of producing pellets from plastic scrap compare across different geographic regions?
- Which recycled plastic pellets were profitable during the first quarter of 2022 in the U.S. Gulf Coast?
- What are the plastic markets that could be targeted by mechanical and/or emerging recycling technologies?

Recycling Technologies

Solvent-based purification/dissolution technologies can fill the gap between mechanical recycling and thermolysis. Solvents can selectively dissolve polymers from mixed plastics waste and multilayer packaging and separate them from additives, including colorants.

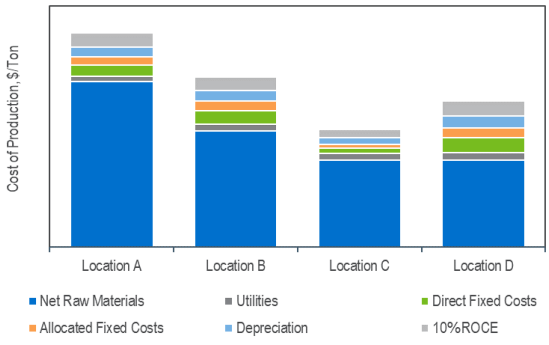
Depolymerization is generally limited to condensation polymers (e.g., polyester, polyurethane, nylon (polyamide), and polycarbonate), but not addition polymers (e.g., polyethylene, polypropylene, and PVC) except for polystyrene (using pyrolysis). However, some companies are attempting to decompose polyolefins into intermediate products, such as carboxylic acids and formic acid, which can be used to produce valuable products, although not the original polyolefins.

There are three main chemical recycling routes to depolymerize PET: glycolysis, methanolysis, and hydrolysis. Compared to other depolymerization methods, glycolysis is the best for PET recycling (i.e., more economically feasible). In recent years, the hydrolysis of PET waste using an enzyme has been investigated. The enzymatic hydrolysis of PET generates a mixture of terephthalic acid and monoethylene glycol.

Process Economics

Detailed cost estimates are presented to produce recycled flakes (where required) and corresponding pellets from scrap material, at China, Japan, USGC, and Western Europe locations. Estimates are developed for PP, PS, and PET on a first quarter 2022 price basis scenario. Sensitivity analyses on feed scrap pricing are also included.

Recycled PP Pellets Production Costs



Market Analysis

Approximately three quarters of the PET market could be targeted by emerging recycling technologies in 2022. In the case of polyolefins, the potential market for advanced recycling is close to 60 percent of the 2022 total polyolefins demand. At the same time, around 55 percent of the PS/EPS market can be potentially targeted by emerging recycling technologies based on the current combined demand.

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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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