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Technology and Costs

Biorenewable Insights: Bio-Super Absorbent Polymers (SAPs)

Bio-Super Absorbent Polymers (SAPs) is one in a series of reports published as part of NexantECA's 2018 Biorenewable Insights program.

Overview

Currently, the prospects for bio-based content in super absorbent polymers are good, though the base to grow from is very small—and the existing market very large. Super absorbent polymers (SAPs) are a unique group of materials that can absorb over a hundred times their weight in liquids (being particularly effective in deionized solutions), and do not easily release the absorbed fluids under pressure. Super absorbents were first developed by the United States Department of Agriculture (USDA) in the 1960s when working on materials that conserved water in soils.

Overall, there are primarily two types of SAPs: starch grafted and synthetic materials based on cross-linked polyacrylates. Although starch-graft polymers were the first developed, these polymers suffer from the disadvantage of salt instability. Polyacrylate polymers had difficulty achieving high absorption under load (AUL) characteristics at moderate pressures, as the materials would partially dissolve. However, this problem was solved by partly cross-linking the polyacrylate to provide a networked-structure.

Although other chemistries, such as polyacrylamide, poly(ethylene oxide), polyvinyl alcohol), polysuccinimides, and hydrolyzed polyacrylonitrile polymers have been explored, polymerization of sodium polyacrylate remains the commercially preferred route to produce SAPs.

Technologies

The following bio-based technologies are reviewed in this report for making SAPs from:

- Acrylic acid via:
  - 3-hydroxypropionic acid (3-HP)
  - Acrolein from glycerol
  - β-Propiolactone from ethylene oxide
  - Fumaric acid from glycerol
  - Bio-based lactic acid
  - Bio-based acetic acid and formaldehyde
- Itaconic Acid
- Starch
- Polyglutamic Acid

Process Economics

Cost of production models for USGC, Brazil, Western Europe and Japan are shown for:

- Glacial acrylic acid via two-step propylene oxidation
- Glacial acrylic acid via acrolein from glycerol
- Glacial acrylic acid via 3-hydroxypropionic acid from dextrose
- Glacial acrylic acid via biomass gasification
- Glacial acrylic acid via β-propiolactone from ethylene oxide (bio-based)
- Glacial acrylic acid via catalytic dehydration of lactic acid from glucose
- SAP via the solution process
- SAP via the suspension process

Capacity

NexantECA has catalogued existing and planned bio-SAP capacity and provides project profiles.

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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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