NexantECA

Technology and Costs

Biorenewable Insights: Bio-Surfactants

Bio-Surfactants is one in a series of reports published as part of NexantECA's 2022 Biorenewable Insights program.

Overview

"Net Zero by 2050" commitments have reached all corners of the energy and chemicals industry, are helping to drive innovation in all sectors. There are strong motivations for participants in the surfactants industry to lead the way in the chemicals industry in improving sustainability: products containing surfactants are used in everyday life and easily recognized by non-experts as "chemicals" and therefore, similarly to plastic packaging, consumer pressure can have a large impact. For example, consumer concerns about the uses of sulfates in shampoo or the toxicity of 1,4-dioxane have impacted formulators and surfactant producers.

Surfactants can be produced from both natural and synthetic feedstocks within industry. For example, plant oils are already commonly used and could be considered bio-based feedstocks. These are often further processed, and/or reacted with other bio-based or synthetic materials. However, "biosurfactants" as a topic of interest generally refers to surfactants produced from 100 percent plant-based feedstocks ("bio-based") or biologically-produced ("biosurfactants"):

- Bio-based surfactants include oleochemical-based surfactants using bio-ethylene oxide ("bio-EO") for ethoxylation and surfactants derived from glucose such as alkyl polyglycosides (APGs).
- Biologically-produced surfactants refer to materials that are biologically produced during the regular cellular lifespan of various species of yeasts and bacteria (such as sophorolipids and rhamnolipids).

Technologies

NexantECA has evaluated technologies to produce the following biosurfactants:

- Glycolipids (including sophorolipids, rhamnolipids and trehalose lipids)
- Lipopeptides/lipoproteins
- Polymeric biosurfactants
- Fully bio-based ethoxylates
- Biobased AOS/LAB/LAS

Biobased surfactant processes are generally based on well-established steps. For example, bio-based ethoxylates use ethylene oxide derived from bio-ethanol (typically from corn or sugar-cane) and alpha olefin sulfonates (AOS) can be produced from triglycerides using the Godrej-Lurgi process.

Several bio-based processes have already been commercialized. For example, Croda produces bio-based ethoxylated surfactants which are certified as 100 percent bio-based in its New Castle, Delaware plant in North America. BASF has Alkyl polyglucoside (APG) plants in the United States, Asia, and Europe, and Solvay, Dow, and Colonial also offer APGs at commercial scale.

Biologically produced surfactants require fermentation processes which can be challenging to scale-up and operate continuously. However, companies such as Evonik, Holiferm and Saraya are already selling biosurfactants into commercial markets.

Process Economics

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

- Sophorolipids
- Fully bio-based alcohol ethoxylates

A sensitivity analysis and discussion on the major cost elements is provided.

Commercial Impact

Besides the major driver of companies, governments and consumers wanting to improve the sustainability of surfactants, growth is supported by quality and supply-led considerations.

In the past two years there has been a spate of announcements by large surfactant producers regarding investment in biosurfactants. Larger companies such as Evonik, Dow, Stepan and Sasol have been investing in biosurfactant production and collaborating with smaller startups. This indicates the industry is maturing and moving beyond academic interest.

NexantECA has catalogued existing and planned bio-surfactant capacity and provides project profiles. Discussion on the main market drivers and constraints is provided.

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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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