



TECH 2023S5: Membrane Materials for Hydrogen

Membrane Materials for Hydrogen is one in a series of reports published as part of NexantECA's 2023 Technoeconomics – Energy & Chemicals (TECH) program.

Overview

Perfluorosulfonic acid (PFSA) membranes are referred to as proton exchange membranes (PEM) as they only allow positive ions (protons) to go through while blocking transfer of hydrogen, oxygen or water.

In addition, they have excellent proton conductivity, chemical stability, heat resistance and mechanical properties including durability and mechanical strength.

Those membranes can work in harsh conditions (such as strong acid, alkali and oxidant media) despite their relative thinness.

These are crucial to green hydrogen production (i.e., hydrogen made from renewable power via electrolysis).

This TECH report provides an overview of the technological and economic aspects of PFSA polymer and membrane production.

The following issues are addressed in this report:

- What are the major production technologies for PFSA membranes and how do they differ?
- Is the technology available and who are the key technology owners?
- Who are the top producers of PFSA polymer and membranes?
- What are the strategic and business considerations associated with entering this market?
- What are the key factors that impact overall economics for producing PFSA membranes across different geographic regions?
- What is the carbon intensity (scope 1 and 2) of PFSA membrane processes and how does it compare across different geographic regions?

Commercial Technologies

The current commercially available routes to produce PFSA polymers and membranes, using either long side chain (LSC) or short side chain (SSC) structure are reviewed in this report.

The side chain structure impacts the equivalent weight (EW) of the molecule and thus its properties.

The merits of extrusion casting versus solution casting and the typical composition type (i.e., homogeneous versus reinforced) are discussed in this report.

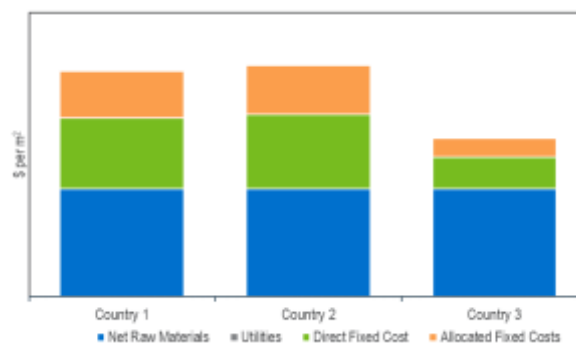
Developing Technologies

Different types of membranes are being investigated or under development for alternative non-PFSA PEM membranes (such as SPEEK or PBI membranes) or alternative electrolyzers types (such as acidic/alkaline amphoteric, anion exchange membranes, membrane-free, microbial or photoelectrochemical) for green hydrogen production.

Process Economics

Detailed cost of production estimates for homogeneous, reinforced and catalyst-coated membranes for the first quarter of 2023 are presented for USGC, Western Europe, and China, reflecting the location of existing capacities.

Reinforced Membrane Regional Cash Cost of Production



Commercial Overview

PFSA membranes are diverse applications outside PEM water electrolysis. They are also used for chlor-alkali electrolysis as well as in PEM fuel cells, and other specialty applications.

A complete global capacity list by producer and region is provided in this TECH report.



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- Trends in chemical technology
- Strategic/business overviews
- Process Technology:
- 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, 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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