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Technology and Costs

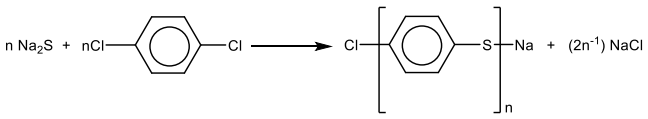
# TECH 2022S2: Polyphenylene Sulfide (PPS)

**Polyphenylene Sulfide (PPS) is one in a series of reports published as part of NexantECA's 2022Technoeconomics – Energy & Chemicals (TECH) program.**

## Overview

Polyphenylene sulfide (PPS) is one of a number of engineering thermoplastics (ETPs). This partly crystalline polymer is well-suited for automotive and electrical/electronic applications, as the polymer offers chemical resistance, high continuous-use temperatures, excellent electrical properties, outstanding dimensional stability, and good mechanical properties. PPS typically competes against other heat-resistant engineering thermoplastics such as high-temperature nylons, polyetherimide, polysulfones and liquid crystal polymers.

Polyphenylene sulfide, sometimes called poly-thiophenylene or polyarylene sulfide, was first observed by Friedel and Crafts in 1888 from the reaction of benzene and sulfur. However, PPS synthesized by this manner had low yields and many byproducts. A commercial process to produce PPS was eventually developed by Phillips Petroleum Company. The reaction involved the polymerization of *para*-dichlorobenzene and a sodium sulfide source in a polar organic compound at elevated temperature and pressure. The polymer produced had a simple, linear structure.




By itself, PPS can be rather brittle with low heat resistance. However, its physical properties are significantly improved when reinforced with glass fibers, carbon fibers or mineral fillers to improve its impact strength and other mechanical properties.

## Commercial Technologies

Presently, all commercial routes to PPS are fundamentally similar, and rely on the nucleophilic substitution of an aromatic compound with elimination of alkali chloride, as initially described in the Phillips basic patent. However, the initial PPS "flash" process produced a linear polymer with modest molecular weight and mechanical strength. While suitable as a coating resin, for injection molding applications the material has to be "cured" to extend the polymer chain and provide moderate cross-linking yet still retain thermoplastic characteristics. The polymer was initially cured by heating below the melting temperature with oxygen, although other approaches have since been developed.

## Process Economics

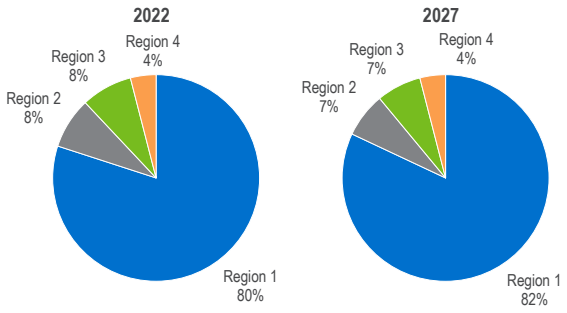
The economics for PPS as produced by the three common production processes for second quarter 2022 have been developed. A standard grade with minimal additives is modelled. The evaluation provides:

- Investment and cost of production (COP) estimates for grassroots facilities
- Estimates were made for plants located in the USGC, Japan, and China Coast

## Commercial Overview

Polyphenylene sulfide enjoys strong growth as a result of a number of factors, the most important of which is a continuing trend towards higher continuous use temperatures, particularly in the transportation and electrical/electronic sectors. In automotive, higher end-use temperatures are a result of the need for longer warranty periods and operating lifetimes, use of LED lighting which can release heat in a localized area, and the size reduction of the engine compartment due to more compact designs. In electrical/electronics, the trend towards miniaturization of printed circuit boards leads to even smaller surface-mount devices with thinner wall thicknesses; LED lighting is also a growth driver in this segment.

A forecast of PPS demand for 2022 versus 2027 is provided, as is a regional breakdown and estimate of demand by major end-market.




A global capacity table for PPS base resin is also provided.

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