## **Developments in SBR Technology (92S5)**

Styrene butadiene rubber (SBR) was the first major synthetic rubber to be produced commercially. Early grades produced in Germany by Buna S and in the United States by Standard Oil Company/The Rubber Reserve Company during the Second World War were based on the emulsion polymerization technology developed by I.G. Farbenindustrie AG of Germany.

SBR technology developments have continued even though the business is mature. Developments are being prompted by tire producers that are looking for elastomers with improved performance characteristics. The flexibility of solution processes has enabled producers to develop "tailored" SBR grades, which improve the combination of mechanical properties (e.g. traction - grip; handling - ride, cornering performance, performance at speed; and rolling resistance) and processing characteristics.

More recently, producers have focused on the capability to use additives to vary the stereochemistry of the diene polymerization and to control polymer micro and macro structure to produce solution SBR grades with optimum properties.

This report reviews current commercial technologies and economics for producing solid random SBR grades using emulsion and solution processes. Recent process developments are also reviewed. The commercial analysis includes an evaluation of current SBR supply and demand in the United States, Western Europe, and Japan.

- 2 -

Property optimization has been achieved, to some extent, by conventional solution SBR technology. By modifying the way in which monomers are added, the polymerization conditions, the use of cocatalysts and randomizing agents, the proportion of *cis* and vinyl isomers, and the chain structure of the resulting "tailored" polymer can be altered. Nevertheless, the overall properties of "tailored" solution SBR fall short of expected tire industry requirements (e.g. better rolling, wear, blow out, chipping/chunking resistance,

road traction under a variety of weather conditions, handling, noise).

Required property improvements are being achieved partly by reformulating compounds. However, there a number of in-reactor and novel compounding developments.

SBR is generally compounded with a vulcanization system, reinforcing filler (usually carbon black), processing/extending oil, and an antioxidant/stabilizer package prior to molding/fabrication. Tire compounds frequently use a combination of elastomers in order to achieve optimum properties in the final application. There are several recent developments that influence SBR compounding.

The SBR market is dominated by the tire industry, which accounts for 75 percent of total demand in major economies. Six percent of demand is accounted for by other automotive applications. Consequently, factors affecting the tire and automotive sectors have a major influence on SBR demand growth.

There is growing competition between emulsion SBR and solution SBR grades. Solution SBR has superior physical properties (particularly wear resistance) and blendability with other rubbers. However, they have been failing to make significant inroads, owing to processing difficulties and higher price. The SBR industry is undergoing rationalization due to continued overcapacity and low profitability. There has been no investment in emulsion SBR in recent years and no new plants are planned, reflecting the negligible growth prospects for emulsion SBR. New investments have been confined to flexible solution plants with the capability to produce BR and styrenic-based thermoplastic elastomers, depending on market requirements.