## OVERVIEW OF SYNTHETIC RUBBER

The importance of the rubber industry ever since it first appeared and the decisive role that it has played in the development of modern civilization prompted much interest in discovering its chemical composition in order to synthesize this product. Through these research projects, the tire industry saw the possibility of breaking away from the grip of the world's natural rubber plantations.

The drop in natural rubber production coincided with World War I and II, triggering the need for lower-cost products with steadier supplies in order to manufacture tires. This was how GR-S, Buna S, Hycar OS and SBR appeared, which are styrene and butadiene copolymers. The launch-pad for the massive development of the synthetic rubber industry, this product could be vulcanized easily, and became the flagship of the world rubber industry, although its properties did not correspond to all the qualities of natural rubber. But its costs and main characteristics made it into an unbeatable competitor. Although synthetic rubber had been known since 1875, its production had been expensive and almost negligible.

During World War II, a crucial historical episode altered the scenario for this market. On December 7, 1941, the USA entered the War. Three months after the attack on Pearl Harbor, the Japanese invaded Malaysia and the Dutch East Indies, desperate to take over natural rubber production from the allies. This gave the Axis control over 95% world rubber supplies, plunging the USA into a crisis.

Each Sherman tank contained twenty tons of steel and half a ton of rubber. Each warship contained 20,000 rubber parts. Rubber was used to coat every centimeter of wire used in every factory, home, office and military facilities throughout the USA. There was no synthetic alternative. Looking at all the possible sources, at normal consumption levels, the nation had stocks for around one year. And these reserves also had to supply the largest and most critical industry in the history of the world during a time of rapid expansion: the arms segment.

The response of Washington was rapid and dramatic. Four days after Pearl Harbor, the use of rubber in any product that was not essential to the war drive was banned. The speed limit on US highways fell to 35 miles an hour, in order to reduce wear and tear on tires countrywide. Rubber chips were sold a penny or more per pound weight at over 400,000 depots all over the country. Even President Franklin Roosevelt's pet dog, Fala, saw his rubber toys melted. This was the largest recycling campaign ever recorded in history, ensuring the success of the Allies through to 1942.

Under these circumstances, an order was sent to all chemists and engineers to develop a synthetic rubber industry. In 1941, the total output of synthetic rubber barely topped 8,000 tons, consisting largely of products not suitable for tires.

The nation's survival depended on its capacity to manufacture over 800,000 tons of products that had barely begun to be developed. There were few detailed instructions on how the factories should organize themselves to produce this vast amount. No facilities had been built, nor were there any way of producing enough raw materials to produce rubber.

The US industrial sector had never been called upon to shoulder such a massive task, achieving so much so quickly. The engineers were given just two years to reach this target. If the synthetic rubber program failed, the capacity of the USA to fight the war would be blunted. This US drive was to help spread synthetic rubber throughout the world's market, even in Brazil as it strove to consolidate its industrial park during the post-War years.
A wide variety of synthetic rubbers have been developed since this product was first discovered. As massive investments were required to develop these different varieties, the production technology was heavily concentrated in long-established global enterprises such as DuPont, Bayer, Shell, BASF, Goodyear, Firestone, Michelin, EniChem, Dow, and Exxon.

The use of rubber is widespread, as the characteristics and properties of these elastomers make them useful in almost all economic sectors: automobiles, footwear, civil construction, plastics, hospital/medical materials and others that are of crucial importance in the daily life of society. As they are most widely used to produce tires, the SBR and BR varieties are the most widely consumed type of synthetic rubber.

**Table 1 Main Types and Applications for Synthetic Rubbers**

| Name | Type of Rubber | Asphalt Modifications | Footwear | Adhesives | Technical Goods |
|---|---|---|---|---|---|
| E-SBR | Styrene-Butadiene in emulsion | - | X | X | X |
| S-SBR | Styrene-Butadiene in solution | X | X | X | X |
| BR | Polybutadiene | - | X | - | X |
| NBR | Nitrile | - | X | - | X |
| EPDM | Ethylene-propylene | X | - | - | X |
| IIR | Butyl | - | - | X | X |
| CR | Polychloroprene | X | X | X | X |
| TPR | Thermoplastic | X | X | X | - |
| Latex | Various types of latex | X | X | - | X |

| Name | Type of Rubber | Tires | Treads | Plastics Modifications |
|---|---|---|---|---|
| E-SBR | Styrene-Butadiene in emulsion | X | X | - |
| S-SBR | Styrene-Butadiene in solution | X | X | - |
| BR | Polybutadiene | X | X | X |
| NBR | Nitrile | - | - | X |
| EPDM | Ethylene-propylene | X | - | X |
| IIR | Butyl | X | - | - |
| CR | Polychloroprene | - | - | - |
| TPR | Thermoplastic | - | - | X |
| Latex | Various types of latex | - | X | - |