Uses of Rubber and Rubber Mixtures

Lubricants are processing additives that are used to improve compound flow and release. In the early days of rubber processing it was recognized that stearic acid, zinc stearate, and wool grease were effective in improving the flowability of rubber compounds. Barium, calcium, and lead stearate were used but were withdrawn some time ago for environmental reasons.

The essential raw materials for this class of products are fatty acids, fatty acid salts, fatty acid esters, fatty acid amides, and fatty alcohols. In addition, hydrocarbons such as paraffin wax are of importance. More recently, low molecular weight polyethylene and polypropylene have been used because of their waxlike character.

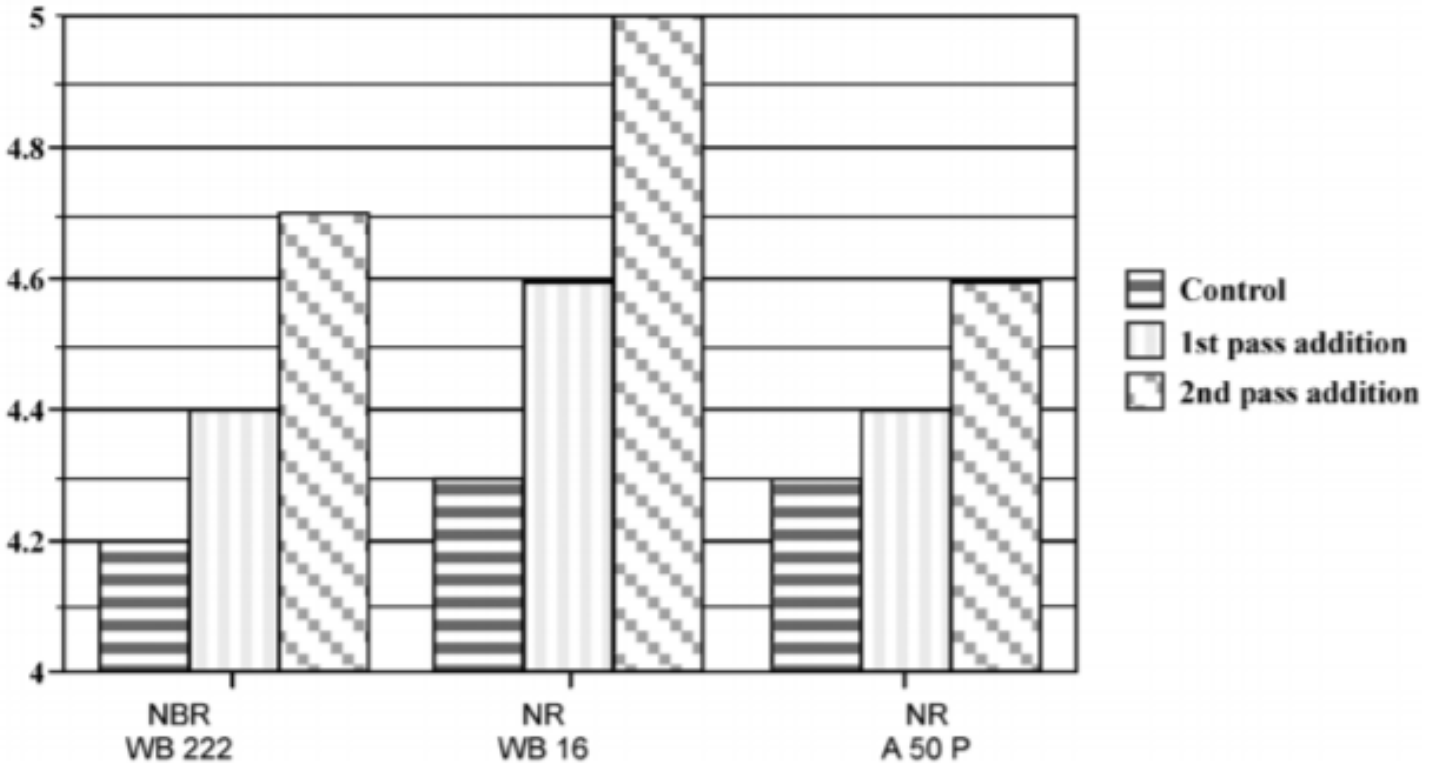


Figure 9 Spiral mold cavity fill with lubricant-added in first or final stage. Struktol WB 222 is an ester of saturated fatty acids. It is a lubricant and release agent predominantly used for polar elastomers. STRUKTOL® WB 16 is a mixture of calcium soaps and amides used as a lubricant for nonpolar polymers. STRUKTOL® A 50 P is a zinc soap of unsaturated fatty acids. It is used as a physical peptizer in NR compounds. (Courtesy of Schill + Seilacher.)

REF: General Compounding Harry G. Moneypenny Moneypenny Tire & Rubber Consultants, Den Haag, The Netherlands Karl-Hans Menting Schill + Seilacher ‘‘Struktol’’ Aktiengesellschaft, Hamburg, Germany F. Michael Gragg ExxonMobil Lubricants & Petroleum Specialties Company, Fairfax, Virginia, U.S.A.

Table 6 Important Raw Materials for Fatty Acids

Castor oil	Cotton oil
Coconut oil	Groundnut oil
Herring oil	Linseed oil
Olive oil	Palm oil
Palm kernel oil	Rapeseed oil
Soybean oil	Sunflower oil
Tallow	

Source: Schill + Seilacher, Hamburg, Germany.

Fatty acid esters are produced through reaction of fatty acids with various alcohols

Table 7 Important Fatty Acids

Fatty acid	Chain length[a]	Double bonds
Palmitic	16	0
Stearic	18	0
Oleic	18	1
Erucic	22	1
Ricinoleic[b]	18	1
Linoleic	18	2
Linolenic	18	3

[a] Number of C atoms.
[b] 12-Hydroxyoleic acid.
Source: Schill + Seilacher, Hamburg, Germany.

The most well known soap, zinc stearate, is also used as a dusting agent for uncured slabs based on nonpolar rubbers.

Mixtures of zinc salts based on aliphatic and aromatic carboxylic acids are cure activators, strongly delaying the reversion of NR compounds.

HOMOGENIZING AGENTS

The homogenizing resins are themselves complex blends and contain parts that are compatible with aliphatic and aromatic structures in a blend. Potential raw materials for use as homogenizing resins can be divided into three groups:

1. Hydrocarbon resins including coumarone-indene resins, petroleum resins, terpene resins, bitumens, tar, and copolymers, e.g., high styrene reinforcement polymers
2. Rosins and their salts, esters, and other derivatives
3. Phenolic resins of various kinds, such as alkylphenol-formaldehyde resins, alkylphenol and acetylene condensation products, and lignin and modifications thereof

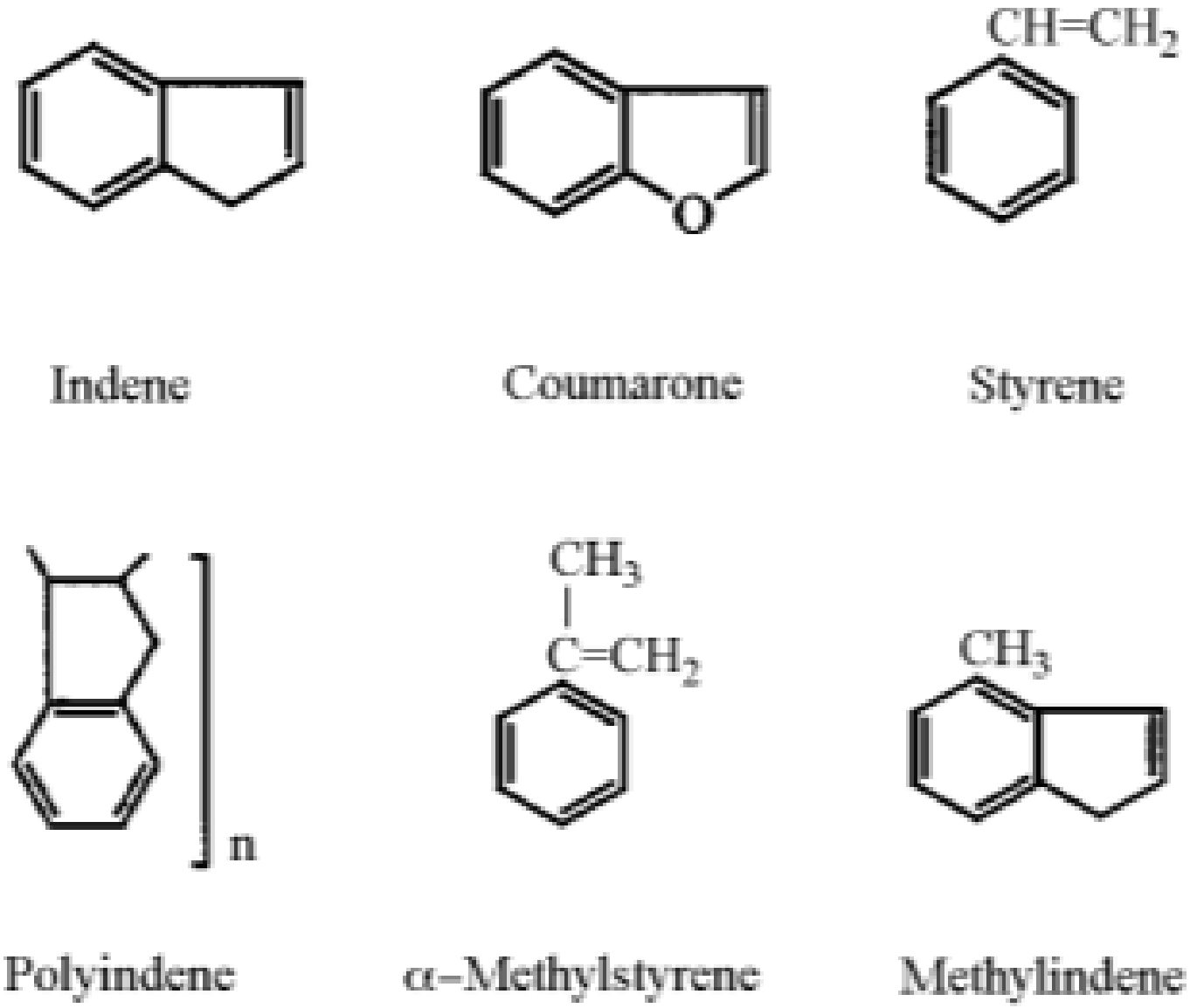


Figure 10 Coumarone resins—structural members. (Courtesy of Schill + Seilacher.)

DISPERSING AGENTS

Additives allowing compounding of all necessary powder or liquid ingredients to the rubbers, very often marked as auxiliary processing additives

Dispersing agents are usually added together with the fillers. Their product form and low melting point facilitate easy incorporation. When fillers are added in two steps, the dispersing agents should be added at the beginning

Dispersing agents have distinct wetting properties. They are often less polar fatty acid esters. Because often a combination of dispersing properties and good lubrication is desirable, the dispersing agents available on the market are occasionally mixtures of higher molecular weight fatty acids and metal soaps.

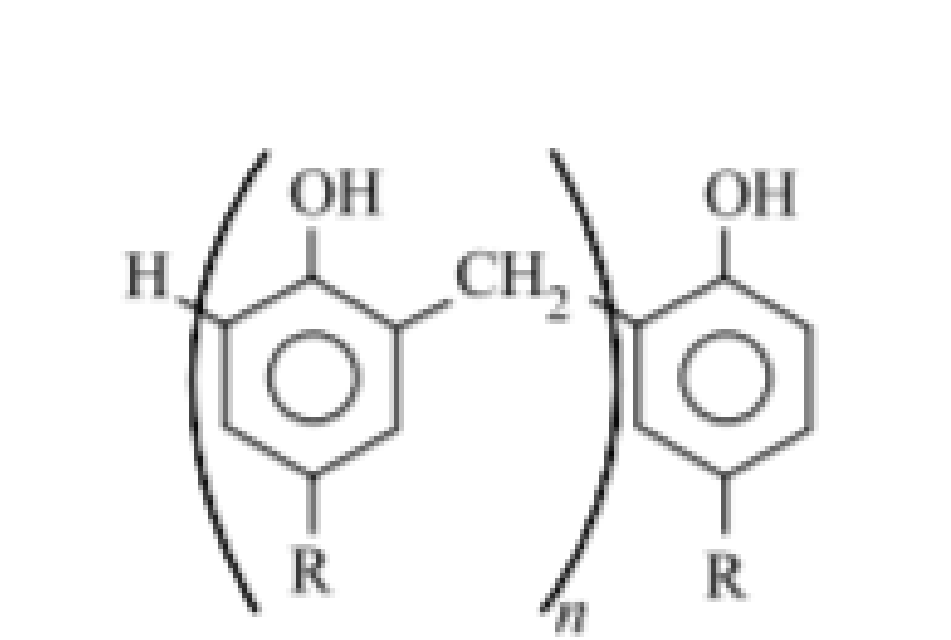
Most products on the market are offered as ‘‘dispersing agents and lubricants’’ and are not listed separately in the product ranges. Their mode of action has already been described in the section on lubricants.

Chemicals are frequently dusty powders that are difficult to handle and to disperse. They can become electrostatically charged, and as a result incorporation into a product is made more difficult. Also, dusty powders are undesirable for environmental reasons, and this has led to the use of binders and dispersing agents to improve materials handling and weighing. Generally preparations are coated, nondusting powders, granules, and masterbatches.

Tackifiers

Resins that have a high melting point should be added early in the mixing cycle in order to guarantee melting and sufficient dispersion. Soft resins can be added together with fillers to make use of their wetting and dispersing properties.

The most extensively used tackifying resins are of the phenol-formaldehyde (PF) type, generally ‘‘novolaks’’



General structure of phenol–formaldehyde novolak resin.

The best retention of tack values was found with a novolak based on p-tert butylphenol. It was noted that to remain effective as a tackifier a resin had to display limited compatibility, and because increasing the length of the alkyl groups increases compatibility the novolak based upon p-tert-butylphenol was

Two other tackifying resins are in use:

1. KoresinR (BASF AG, Ludwigshafen, Germany), a polymeric addition product from p-tert-butylphenol and acetylene. Its effectiveness is only marginally influenced by heat, humidity, and atmospheric oxygen.
2. Xylene-formaldehyde resins are highly effective tackifiers with good plasticizing properties that improve knitting, on injection molding. Their tack improvement properties have been known for a long time but the reaction of tackifying agents in rubber mixes may be mainly to prevent tack degradation upon aging. Schlademan (23) proposed that the phenolic resin tackifiers act as antioxidants to prevent surface cross-linking and showed that if aging is carried out in nitrogen instead of air even formulations with no tackifier will exhibit no tack loss with aging.

Hamed (10) noted that the reaction of tackifying agents with high viscosity rubber stocks may be mainly to prevent tack degradation upon aging.

REF: General Compounding Harry G. Moneypenny Moneypenny Tire & Rubber Consultants, Den Haag, Tobil Lubricants & Petroleum Specialties Company, Fairfax, Virginia, U.S.A.-19. and 23. ref