The world of elastomers tends to split into tyre and non-tyre arenas. The manufacture of tyres has little in common with that of hoses, belts, sealing strips and so on. Tyres are made mainly from natural and styrene-butadiene rubbers (SBR), whereas a variety of speciality elastomers are employed to make technical rubber goods.

Ethylene-propylene elastomer has, in the 40 years since its commercialisation, displaced older elastomers such as polychloroprene, natural rubber or SBR for many articles – EPDM compounds have an excellent price-performance ratio, and good ozone and UV resistance. They can also be used at temperatures from -40 to 150°C and crucially, they accept large quantities of filler and oil while maintaining good physical properties and even improving the processibility of the compounds.

More than one million tonnes of EPDM are made annually, most of which is used in crosslinked form, some is added to thermoplastics (polypropylene, polyamide) to improve impact resistance, or mixed with motor oils as a viscosity modifier. Crosslinked applications include extruded profiles for building and vehicle seals, hoses and tubes, sheets for waterproofing roofs and ponds, and moulded goods such as pipe seals.

Global EPDM usage and production has generally grown at the rate of GDP, however, there are applications that offer faster growth rates – for example, in vehicles where cleaner engines that leak less oil enable manufacturers to replace belts made from oil-resistant elastomers such as polychloroprene, and in the weatherstrips that seal vehicle doors and windows. Here, crosslinked EPDM is used because it retains its elasticity over the life of the vehicle, resisting compression set in summer heat and winter cold.

**Hard grind**

Products are available where rubbers are ground and then kept in a powder form with a portioning agent. However, the grinding of rubber is not easy and processors have been unwilling to accept the higher cost. The granular products from the gas phase process that are used to make Dow’s NORDEL MG hydrocarbon rubber offer an alternative.

In a gas-phase polymerisation process, more commonly used to make hard semi-crystalline polymers such as polyethylene and polypropylene, the monomers are blown into a fluidised bed consisting of polymer particles that are about one millimetre in diameter. The process operates without solvents or water. The particles are drawn out of the fluid bed, cooled and bagged.
In order to prevent the EPDM agglomerating during the process or subsequently, around 20% weight carbon black is added to the reactor gases. The particles grow from the inside out, as the catalyst molecules are situated at the centre, surrounded by a coating of carbon black. Polymerisation occurs at relatively low temperatures, and the low heat input, which is necessary to avoid agglomeration, inhibits the formation of gel.

The gas-phase process gives a unique combination of advantages that come together in a holistic way. The molecular weight of a polymer made in this way is unlimited. A high molecular weight is better because these polymers form a network that is close to perfect when crosslinked and have improved mechanical properties, which in practice means that they can be extended with more filler and plasticiser (paraffinic oils in the case of EPDM) to reduce cost and still meet manufacturers’ specifications.

**Strip search**

Modern rubber recipes for automotive weatherstrips are based on high molecular weight EPDM and extended to 600 parts, of which 100 are the rubber and the rest carbon black, paraffinic oils, and clay or calcium carbonate. The mechanical properties of the compound decrease as the amount of rubber is reduced, but good performance is maintained up to high filler levels (see graph). The extrusion properties improve as the extension level increases, the extruder power uptake and die swell decrease, and volume throughput rises. The graph shows the effect of extension level on viscosity.

Gels from the rubber are one of the biggest causes of surface defects in applications such as automotive weatherstrips. Higher molecular weight products are more susceptible to gel formation, because a network of only a few prematurely crosslinked chains can cause the defect. The gas-phase process introduces a low input of heat energy into the polymer during polymerisation and finishing so that the gel level is low.

In an industry with a continuous history of development since the discovery of sulphur vulcanisation in the 1830s, major innovations are rare. NORDEL MG gives compounders the opportunity to make a step change in formulation and mixing costs.

These lines show the dynamic viscosity of compounds versus frequency in dynamic mechanical testing at 100°C. At 100 radians/second, the compound based on higher molecular weight polymer has a viscosity 30% higher than the standard polymer. If the loading of fillers and oil is increased, the viscosity again becomes comparable to that of the original compound, and extruder output is maintained.

**Author’s details**

Tim Clayfield is Senior Development Specialist at Dow Europe GmbH in Horgen, Switzerland. E-mail: tclayfield@dow.com.