19.12 Processing Elastomers

Recall from Section 7.9 that, in terms of its processing characteristics, an *elastomer* is a polymer; in terms of its function and performance, it is a *rubber*. The raw material to be processed into various shapes is basically a compound of rubber and various additives and fillers. The additives include carbon black, an important element that enhances such properties as tensile and fatigue strength, abrasion and tear resistance, ultraviolet protection, and resistance to chemicals.

These materials are then mixed to break them down and to lower their viscosity; the mixture is subsequently *vulcanized*, using sulfur as the vulcanizing agent. This compound is then ready for further processing, such as calendering, extrusion, and molding, which may also include placing reinforcements, in such forms as fibers and fabric. During processing, the part becomes cross-linked, imparting the desirable properties that are associated with rubber products, ranging from rubber boots to pneumatic tires.

Elastomers can be shaped by a variety of processes that also are used for shaping thermoplastics. Thermoplastic elastomers are commonly shaped by extrusion or injection molding, the former being the more economical and faster process; they also can be formed by blow molding or thermoforming. Thermoplastic polyurethane, for example, can be shaped by any of the conventional methods. It also can be blended with thermoplastic rubbers, polyvinyl chloride compounds, ABS, and nylon to obtain specific properties.

The temperatures for elastomer extrusion are typically in the range from 170°to 230°C, and for molding are up to 60°C. Dryness of the materials is important for product integrity. Reinforcements are used in conjunction with extrusion, to impart greater strength. Examples of extruded elastomer products are tubing, hoses, moldings, and inner tubes. Injection-molded elastomer products cover a broad range of applications, such as components for automobiles and appliances.

Rubber and some thermoplastic sheets are formed by the **calendering** process (Fig. 19.21), wherein a warm mass of the compound is fed into a series of rolls, and **masticated** (compressed and kneaded into a pulp). The thickness produced is typically 0.3 to 1 mm, but can be made less by stretching the material. It then is stripped off, at speeds on the order of 2 m/s to form a sheet, which may be as wide as 3 m. The calendered rubber then may be molded into various products, such as tires and belts for machinery. The rubber or thermoplastics also may be formed over both surfaces of a tape, paper, fabric, or plastics, thus making them permanently *laminated*. Roll surfaces may also be textured to produce a rubber sheet with various patterns and designs.

Discrete rubber products, such as gloves, balloons, swim caps, etc., are made by *dipping* or **dip molding** a solid metal form, such as in the shape of a hand for making gloves, repeatedly into a liquid compound that adheres to the form. A typical compound is *latex*, a milk-like sap obtained from the inner bark of a tropical tree. The compound is then vulcanized (cross-linked), usually in steam, and stripped from the form, thus becoming a discrete product.

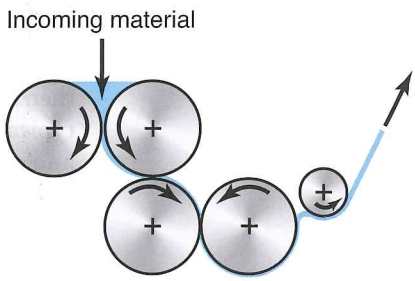

FIGURE 19.21 Schematic illustration of calendering; sheets produced by this process subsequently are used in thermoforming; this process also is used in the production of various elastomer and rubber products.