Lecture 15. Production of rubber

- **Production of rubber goods can be divided into two principal steps:**
- Production of the rubber
- Processing of the rubber into finished good

Processing of rubber into finished good

- The process sequence includes the following principal operations:
- Compounding
- Mixing
- Shaping
- Vulcanizing

Compounding

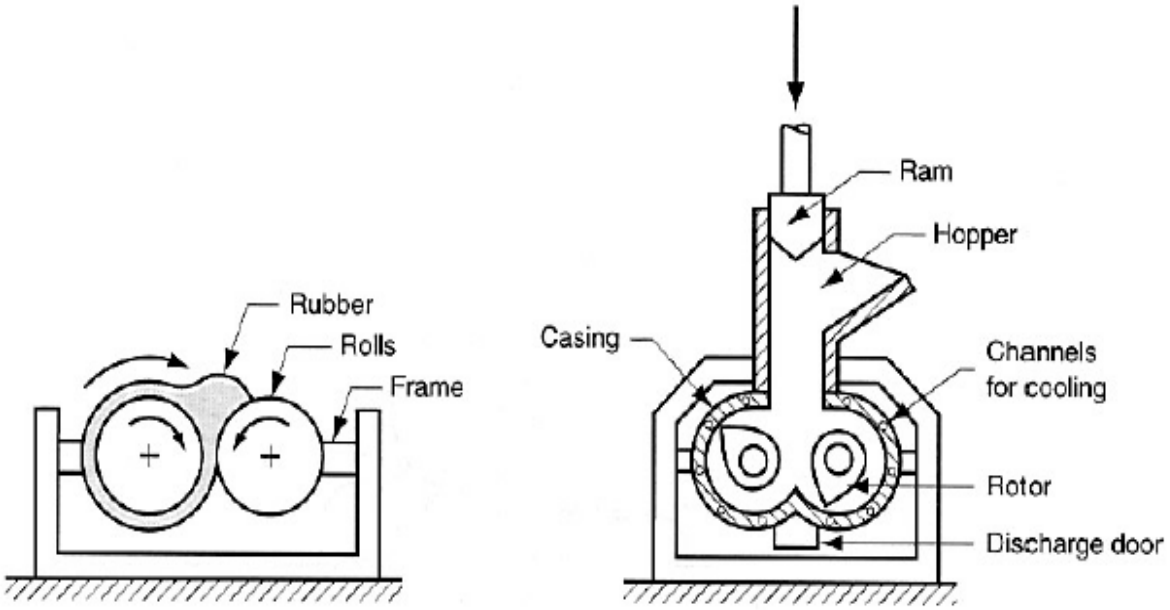
The purpose of *compounding* is to add chemicals (*sulphur*) for *vulcanization* to the rubber. Other additives are filling materials to enhance the mechanical properties (carbon black), antioxidants, ozoneprotective chemicals, coloring pigments, et al. Additives are mixed with the base material during the next step, *mixing*.

Mixing

The process of mixing is accomplished in two phases to avoid premature vulcanization:

- Mixing all non-vulcanizing additives
- Mixing sulphur additive

The figure illustrates the equipment used for mixing:



Mixers used in rubber processing: (a) two-roll mill, and (b) internal mixer

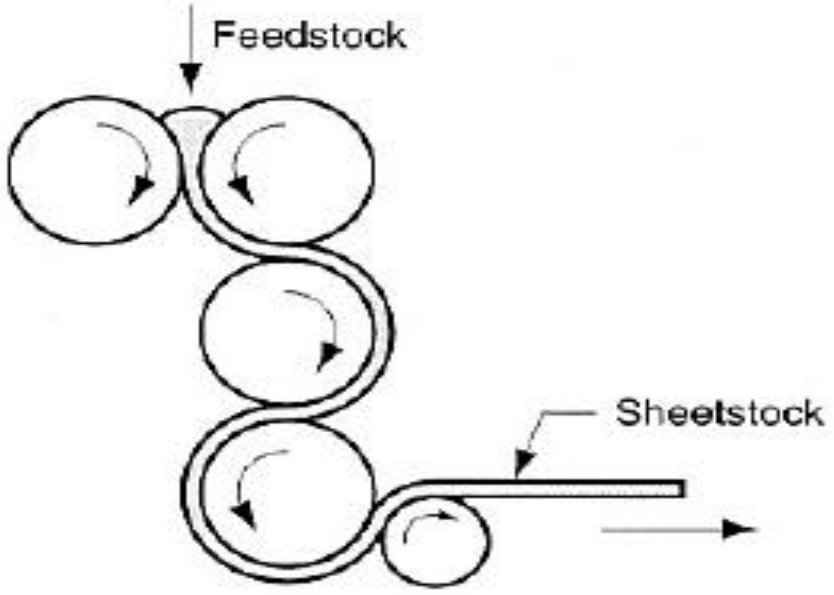
Shaping processes

Extrusion

The extrusion process for rubber is the same as for polymers.

Calendering

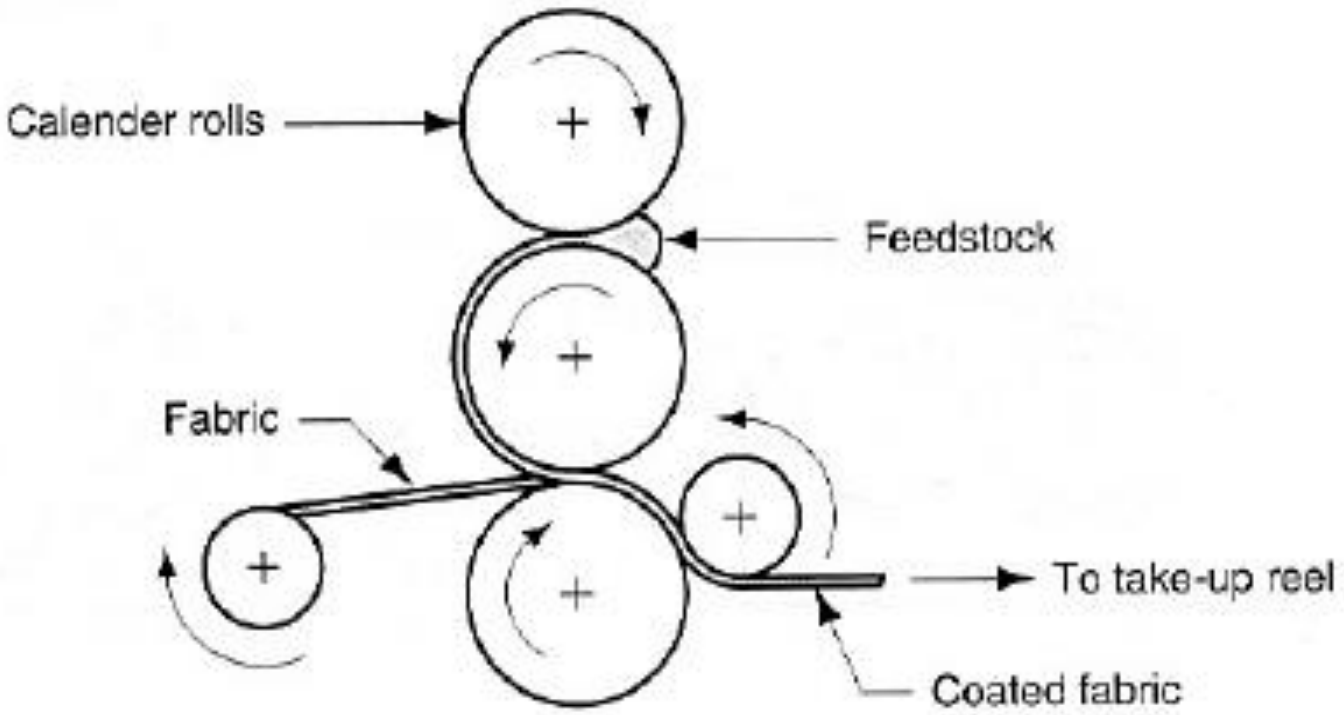
Calendering is a process for producing sheet and film stocks out of rubber or thermoplastics. Extrusion and calendering can be combined in the roller die process.



A typical roll configuration in calendering

Coating

This process involves coating of rubber onto substrate fabrics:



Coating of fabric with rubber using a calendering process

Molding and casting

The process setup is the same as for the other materials. A special process for rubber is so-called *dipcasting*, in which a mold is submersed in a liquid polymer for certain duration. Dipping may be repeated to form the desired thickness. Coating is then stripped from the form and cured.

Vulcanization is a treatment for rubber to become stiffer and stronger. The process involves the use of sulphur at a temperature of 140o C for about 5 hr.; time enough to accomplish cross-linking of elastomers molecules.

The production of Styrene Butadiene Rubber (SBR)

Polymer Chemistry: The production of Styrene Butadiene Rubber (SBR) follows addition polymerization. Its glass transition temperature is approximately -55oC, but may vary with the Styrene content. It can be used extensively within the temperature range of -40 to 100 °C. It may be blended with natural rubber or can be used by itself. It has good abrasion resistance properties and the addition of additives may endow it with aging stability.

Technology

SBR is produced by the copolymerization of Butadiene and Styrene by emulsion polymerization in 3 : 1 weight ratio. The fresh and recycle monomers are purified by 20 % aqueous caustic purification. Then the stream is continuously passed through 6 to 12 glass – lined or stainless steel reactors. The residence time in these reactors ranges from 5 to 15 hours. Steam heating, water cooling and refrigeration are carried out in these reactors. These reactors are equipped for producing both cold and hot SBR. Cold SBR is produced at 5oC and 1 atm gage by refrigeration techniques ; whereas hot SBR is manufactured at 50 oC , and 3-4 atm gage. The polymerization product is then stripped with chemical inhibitors and the latex resulting from the reactors are collected in blow down tanks. The latex is then sent to a falling film stripper to remove the butadiene ; and the bottoms are fed to a perforated plate column where styrene is stripped out.

The monomer – free emulsion is then added with certain compounding ingredients in blend tanks. The latex is coagulated to rubber. The crumbs of rubber float onto shaker screens where the catalyst , emulsifiers and other solubles are removed by the action with wash water. The crumbs are dried in continuous belt dryers with hot air and are subsequently pressed into bales.

Technological scheme