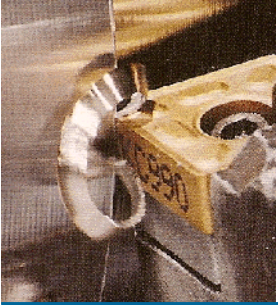


TIIAME RUBBER PROCESSING TECHNOLOGY

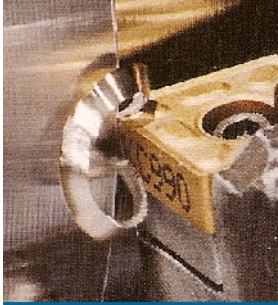


TPE-6mm
Store No. 1159397
183*61cm



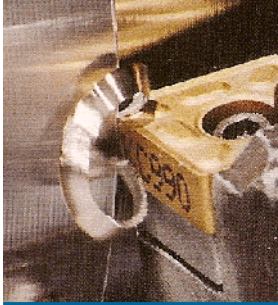
RUBBER PROCESSING TECHNOLOGY

1. Rubber Processing and Shaping
2. Manufacture of Tires and Other Rubber Products
3. Product Design Considerations



Overview of Rubber Processing

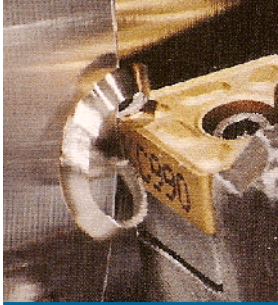
- Many of the production methods used for plastics are also applicable to rubbers
- However, rubber processing technology is different in certain respects, and the rubber industry is largely separate from the plastics industry
- The rubber industry and goods made of rubber are dominated by one product: tires
- Tires are used in large numbers on automobiles, trucks, aircraft, and bicycles



Two Basic Steps in Rubber Goods Production

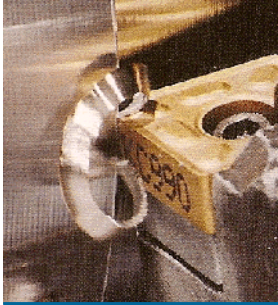
1. Production of the rubber itself
 - Natural rubber (NR) is an agricultural crop
 - Synthetic rubbers is based on petroleum
2. Processing into finished goods:
 - Compounding
 - Mixing
 - Shaping
 - Vulcanizing





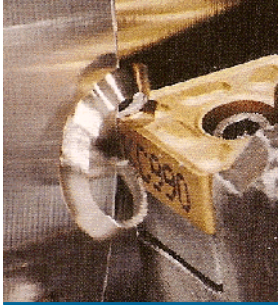
The Rubber Industries

- Production of raw NR is an agricultural industry because *latex*, the starting ingredient, is grown on plantations in tropical climates
- By contrast, synthetic rubbers are produced by the petrochemical industry
- Finally, processing into tires and other products occurs at processor (fabricator) plants, commonly known as the rubber industry



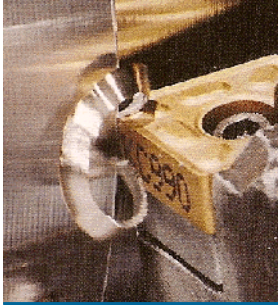
Production of Natural Rubber

- Natural rubber is tapped from rubber trees (*Hevea brasiliensis*) as latex
 - In Southeast Asia and other parts of the world
- Latex is a colloidal dispersion of solid particles of the polymer *polyisoprene* in water
 - Polyisoprene $(C_5H_8)_n$ is the chemical substance that comprises NR, and its content in the emulsion is about 30%



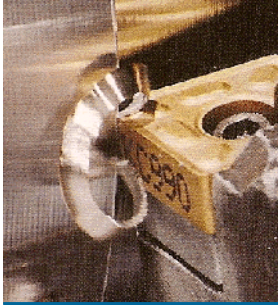
Recovering the Rubber

- Preferred method to recover rubber from latex involves coagulation - adding an acid such as formic acid (HCOOH)
 - Coagulation takes about 12 hours
- The coagulum, now soft solid slabs, is then squeezed through rolls which drive out most of the water and reduce thickness to about 3 mm (1/8 in)
- The sheets are then draped over wooden frames and dried in smokehouses for several days



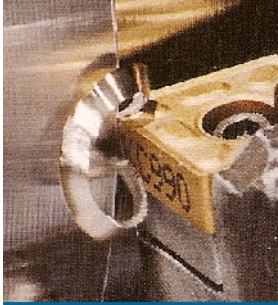
Grades of Natural Rubber

- The resulting rubber, now in a form called *ribbed smoked sheet*, is folded into large bales for shipment to the processor
- In some cases, the sheets are dried in hot air rather than smokehouses, and the term *air-dried sheet* is used
 - This is considered a better grade of rubber
- A still better grade, called *pale crepe rubber*, involves two coagulation steps, followed by warm air drying



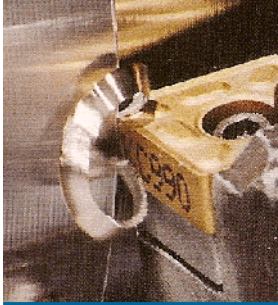
Synthetic Rubber

- Most synthetic rubbers are produced from petroleum by the same polymerization techniques used to synthesize other polymers
- Unlike thermoplastic and thermosetting polymers, which are normally supplied to the fabricator as pellets or liquid resins, synthetic rubbers are supplied to rubber processors in the form of large bales
 - The rubber industry has a long tradition of handling NR in these unit loads



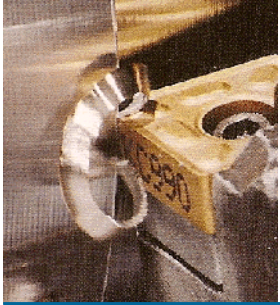
Carbon Black in Rubber

- The single most important reinforcing filler in rubber is *carbon black*, a colloidal form of carbon obtained by thermal decomposition of hydrocarbons (soot)
 - It increases tensile strength and resistance to abrasion and tearing of the final rubber product
 - Carbon black also provides protection from ultraviolet radiation
 - Most rubber parts are black in color because of their carbon black content



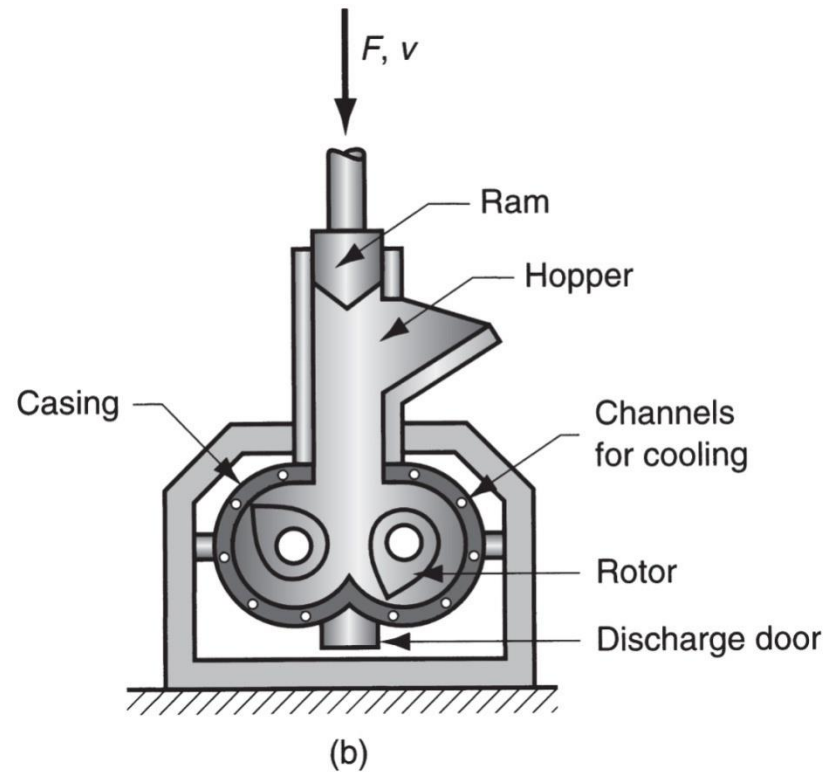
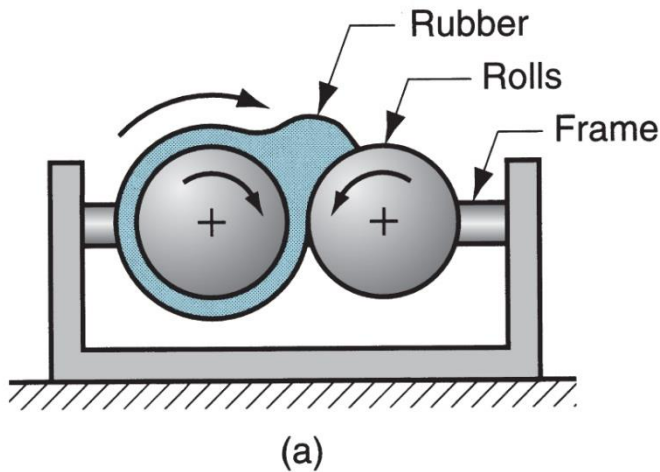
Mixing

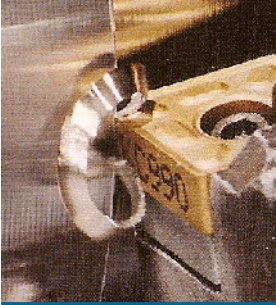
- The additives must be thoroughly mixed with the base rubber to achieve uniform dispersion of ingredients
- Uncured rubbers have high viscosity so mechanical working of the rubber can increase its temperature up to 150°C (300°F)
- If vulcanizing agents were present from the start of mixing, premature vulcanization would result - the “rubber processor's nightmare”



Mixers in Rubber Processing

- (a) Two-roll mill and (b) Banbury-type internal mixer

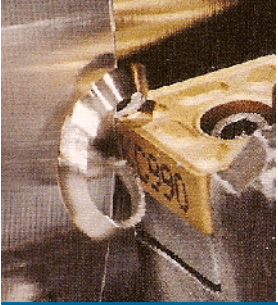




What is Vulcanization?

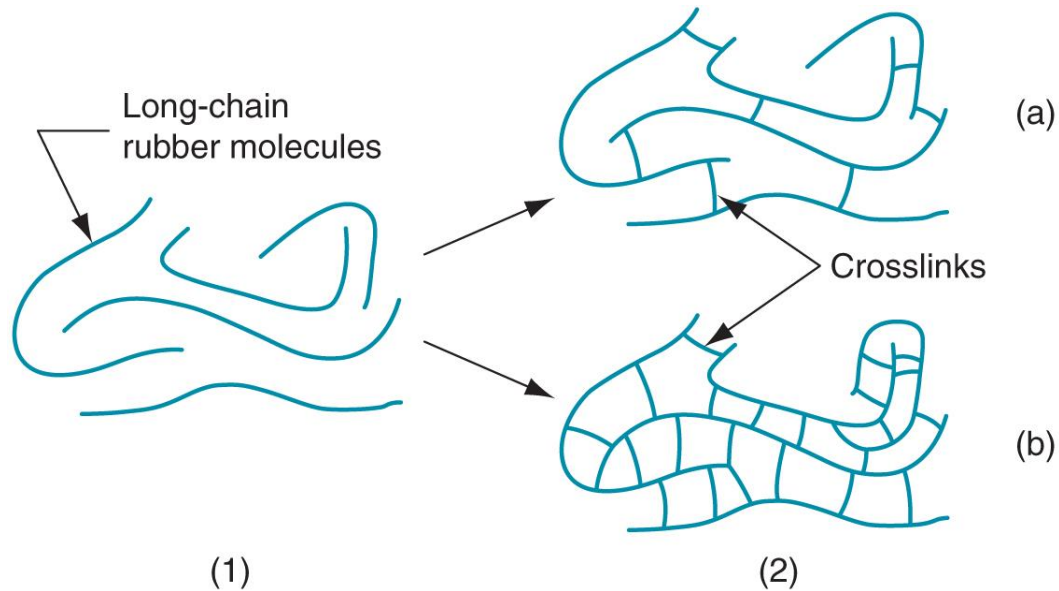
The treatment that accomplishes cross-linking of elastomer molecules

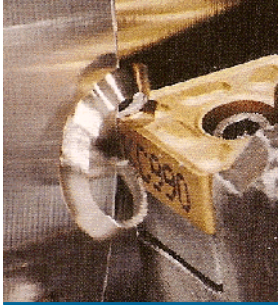
- Makes the rubber stiffer and stronger but retain extensibility
- The long-chain molecules become joined at certain tie points, which is reduces the ability to flow
 - Soft rubber has 1 or 2 cross-links per 1000 mers
 - As the number of cross-links increases, the polymer becomes stiffer (e.g., hard rubber)



Effect of Vulcanization on Rubber Molecules

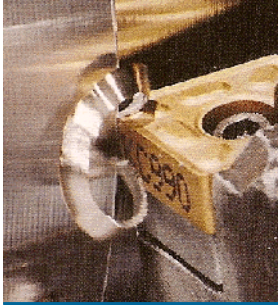
(1) raw rubber, and (2) vulcanized (cross-linked) rubber:
(a) soft rubber and (b) hard rubber





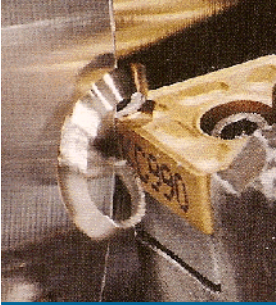
Vulcanization Chemicals and Times

- When first invented by Goodyear in 1839, vulcanization used sulfur (about 8 parts by weight of S mixed with 100 parts of NR) at 140°C (280°F) for about 5 hours
 - Vulcanization with sulfur alone is no longer used, due to long curing times
- Various other chemicals (e.g., zinc oxide, stearic acid) are combined with smaller doses of sulfur to accelerate and strengthen the treatment
 - Resulting cure time is 15-20 minutes



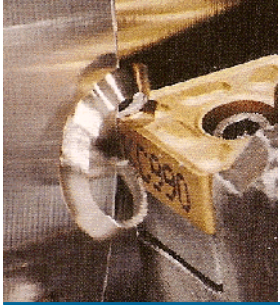
Tires and Other Rubber Products

- Tires are about 75% of total rubber tonnage
- Other important products:
 - Footwear
 - Seals
 - Shock-absorbing parts
 - Conveyor belts
 - Hose
 - Foamed rubber products
 - Sports equipment



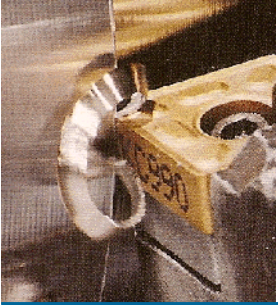
Pneumatic Tires

- Functions of pneumatic tires on vehicle :
 - Support the weight of the vehicle, passengers, and cargo
 - Transmit the motor torque to propel the vehicle
 - Absorb road vibrations and shock to provide a comfortable ride
- Tires are used on automobiles, trucks, buses, farm tractors, earth moving equipment, military vehicles, bicycles, motorcycles, and aircraft

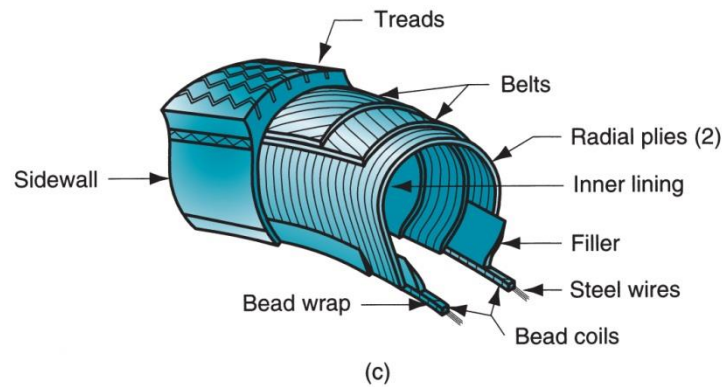
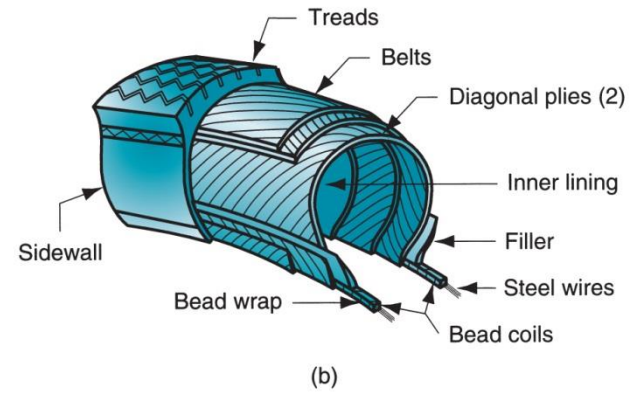
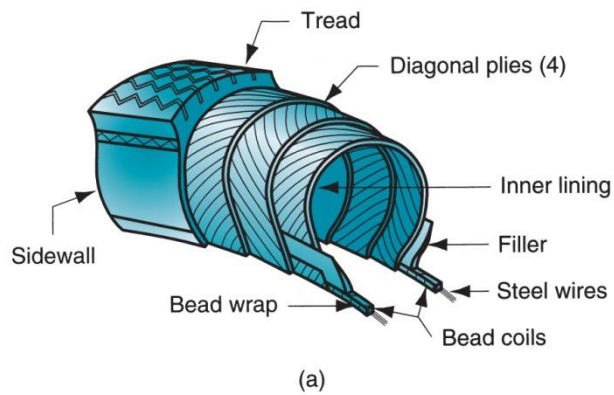


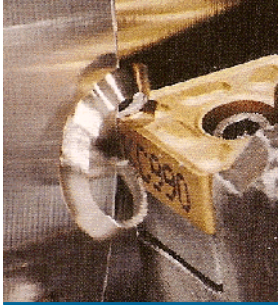
Tire Construction

- A tire is an assembly of many components
 - About 50 for a passenger car tire
 - Large earthmover tire has as many as 175
- The internal structure of the tire, known as the *carcass*, consists of multiple layers of rubber-coated cords, called *plies*
 - The cords are strands of nylon, polyester, fiber glass, or steel, which provide inextensibility to reinforce the rubber in the carcass



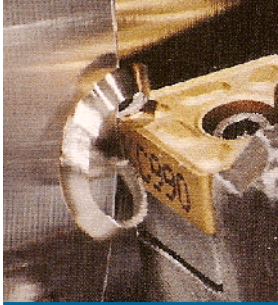
Three Tire constructions: (a) diagonal ply, (b) belted bias, and (c) radial ply





Other Rubber Products: Rubber Belts

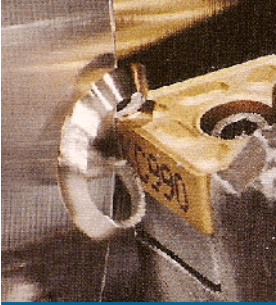
- Widely used in conveyors and pulley systems
- Rubber is ideal for these products due to its flexibility, but the belt must have little or no extensibility
 - Accordingly, it is reinforced with fibers, commonly polyester or nylon
- Fabrics of these polymers are usually coated by calendering, assembled together to obtain required number of plies and thickness, and subsequently vulcanized by continuous or batch heating processes



Other Rubber Products: Footwear

- Rubber components in footwear: soles, heels, rubber overshoes, and certain upper parts
- Molded parts are produced by injection molding, compression molding, and certain special molding techniques developed by the shoe industry
- The rubbers include both solid and foamed
- For low volume production, manual methods are sometimes used to cut rubber from flat stock

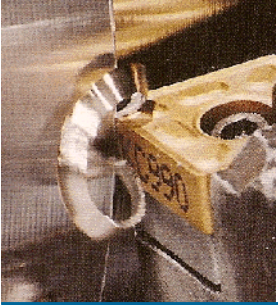




Processing of Thermoplastic Elastomers

A thermoplastic elastomer (TPE) is a thermoplastic polymer that possesses the properties of a rubber

- TPEs are processed like thermoplastics, but their applications are those of an elastomer
- Most common shaping processes are injection molding and extrusion
 - Generally more economical and faster than the traditional processes for rubbers that must be vulcanized



Thanks for
attention