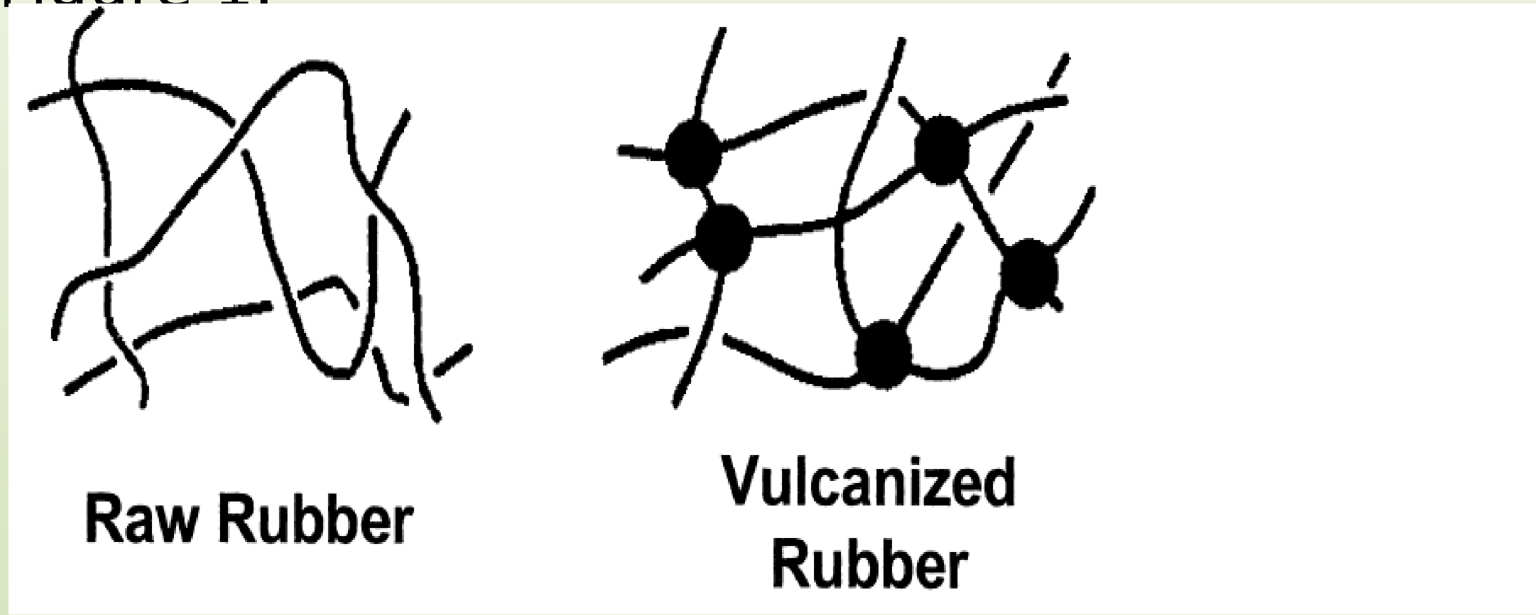
Rubber Structure and Properties:
VULCANİZATION

Natural rubber is often vulcanized a process by which the rubber is heated and sulfur, peroxide or bisphenol are added to improve resistance and elasticity

Vulcanization is the process of treating an elastomer with a chemical to decrease its plasticity, tackiness, and sensitivity to heat and cold and to give it useful properties such as elasticity, strength, and stability.

This process converts a viscous entanglement of long chain molecules into a three dimensional elastic network by chemically joining (cross-linking) these molecules at various points along the chain.

The process of vulcanization is depicted graphically in Figure 1.



In vulcanization the randomly oriented chains of raw rubber become cross-linked as indicated

As a result, vulcanization removes the undesired properties of rubber

Not Croslinked	Crosslinked
Soft	Hard
Sticky	Not sticky
Low strength	High strength
High permanent deformation	Low permanent deformation
Soluble	Not or less solubl
very sensitive to heat	Less sensitive t heat
thermoplastic	Elastomer or thermosetting

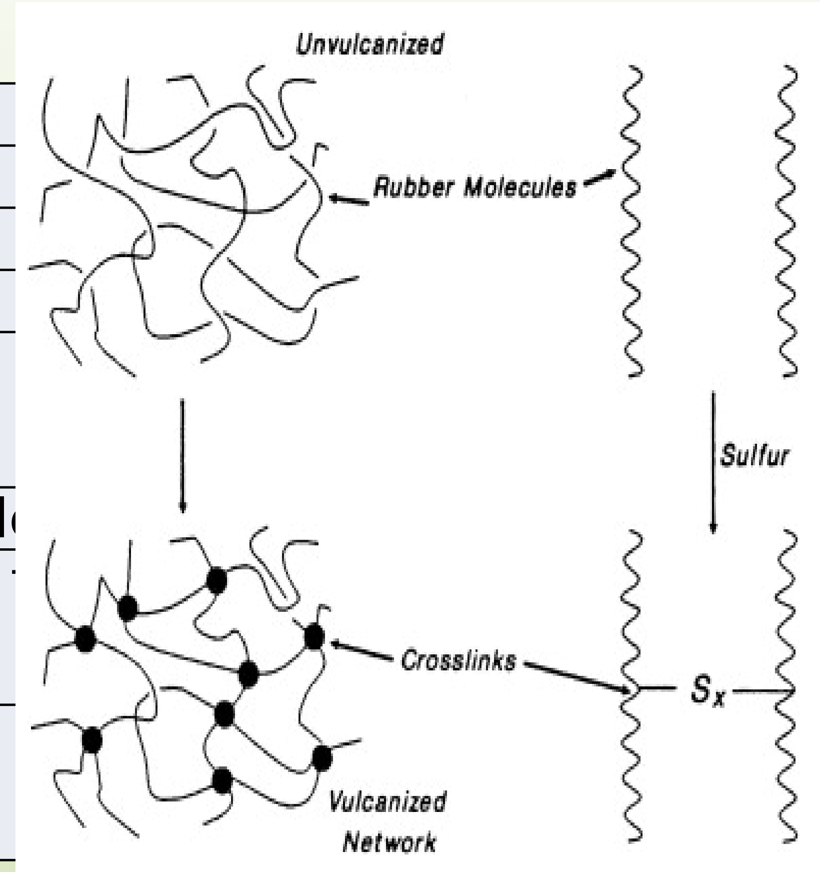


Figure shows sulfur linkages

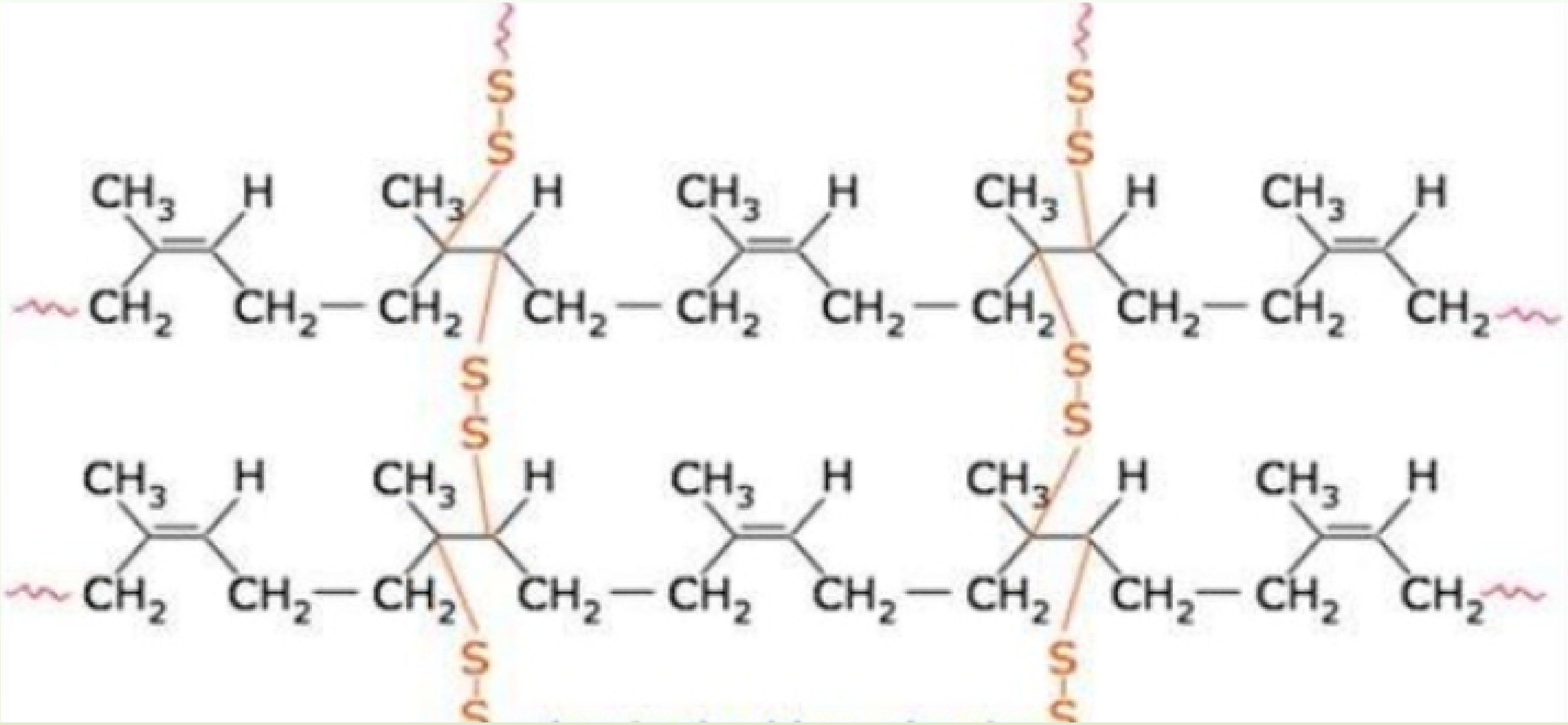
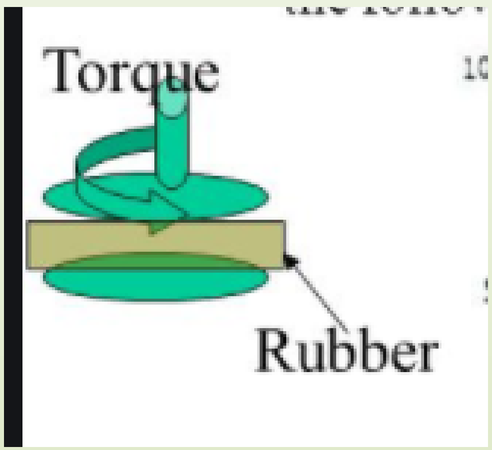
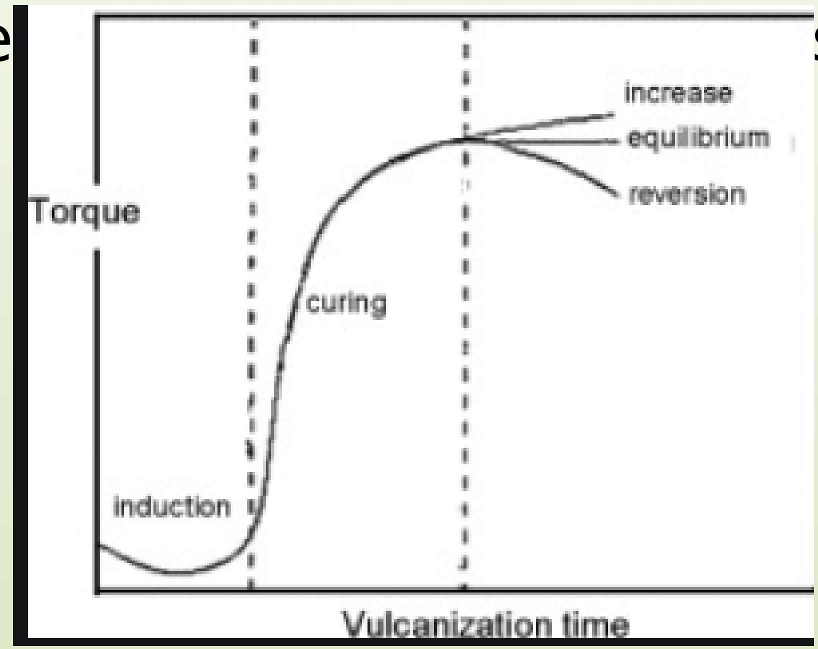


Figure indicates vulcanized rubber, showing disulfide cross-links three-dimensional network rendering the compound elastic. The compound is thus no longer plastic or deformable and cannot be shaped or further processed. After the point of scorch, the chemical cross-linking continues providing more cross-links and thus greater elasticity or stiffness (modulus).

Scorch safety is the length of time for which the compound can be maintained at an elevated temperature and still remain plastic. This time marks the point at which the plastic material begins the chemical conversion to the elastic network. Thus if the compound scorches before it is formed into the desirable shape or composite structure it can no longer

Time to scorch is thus important because it indicates the amount of time (heat history) the compound may be exposed to heat during shaping and forming operations before it be ss.





Rate of cure or cure rate describes the rate at which cross-links form. The rate of cure determines how long a compound must be cured in order to reach ‘‘optimum’’ properties.

State of cure refers to the degree of cross-linking (or cross-link density) of the compound. State of cure is commonly expressed as a percentage of the maximum attainable cure (or cross-link density) for a given cure system.

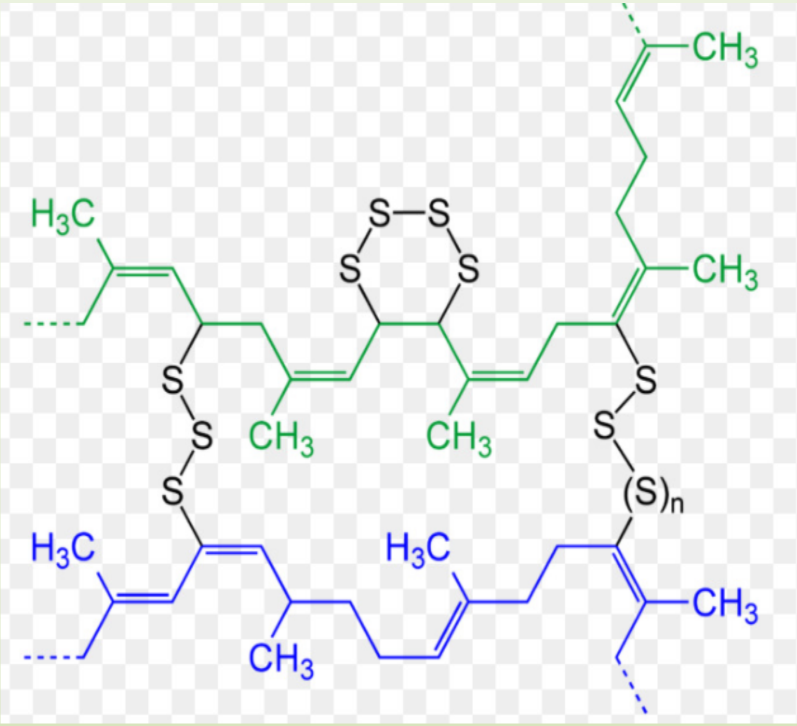
The elastic force of retraction, elasticity, is directly proportional to the cross-link density or number of cross-links formed in the network.

Vulcanizing agents

They are chemicals that will react with active sites in the polymer to form connections or cross-links between chains.

Sulfur is the oldest and most widely used vulcanizing or cross-linking agent. The majority of cure systems in use today involve the generation of sulfur containing cross-links, usually with elemental sulfur in combination with an organic accelerator.

Sulfur vulcanizates provide an outstanding balance of cost and performance, exhibiting excellent strength and durability for very low cost. No other cure system has, on its own, successfully competed with sulfur as a general purpose vulcanizing



The use of sulfur donors have increased to give great improvements in the thermal and oxidative stability of the vulcanizate.

One limitation imposed upon the use of sulfur as a vulcanizing agent is that the elastomer must contain some chemical unsaturation. In saturated elastomers, other chemicals, particularly organic peroxides, have been found quite useful.

Other vulcanization systems that do not use sulfur or sulfur donors are less commonly used and include various resins such as resorcinolformaldehyde resins, urethanes, or peroxides. Metal oxides or sulfur-activated metal oxides can be used for halogenated elastomers.