KELSEAL Rubber

Introduction to Rubber

June 2025

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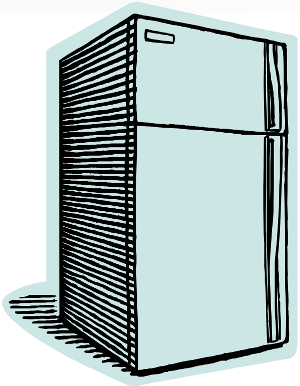
Outline

- 1. Uses of rubber
- 2. Definitions
- 3. Components of rubber compound
- 4. History
- 5. Classification and types of material
- 6. Summary
- 7. Questions?

Uses of Rubber – Air tight

- Used for tires, inner tubes, strip around refrigerator door.



Uses of Rubber – Absorbs vibration

- Imagine shocks, rattles, and noise if we did not have rubber cushions and shock absorbers.

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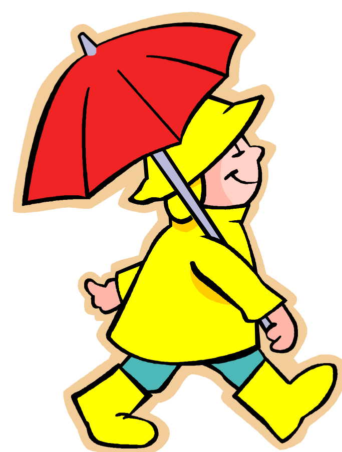
Uses of Rubber - Waterproof

- It has been used for raincoats, boots, and weather stripping around car's windshield.



Uses of Rubber - Adhesive

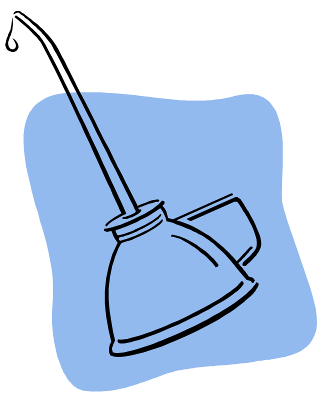
- Rubber has been used to coat medical and athletic tape.

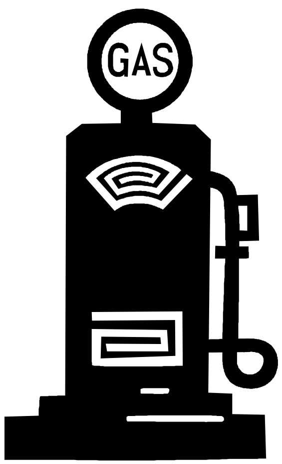
Uses of Rubber – Electrical Insulation

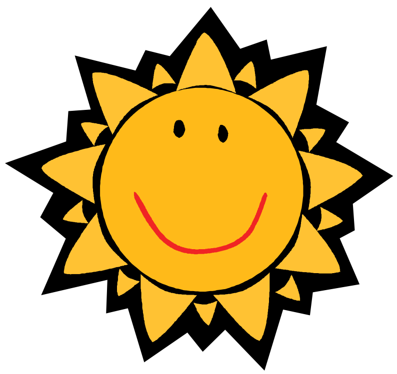
- At one time, all wiring was coated with rubber. Plastic is mainly used now.

Uses of Rubber - Gasketing

- Rubber is resistant to oil, gas, light, and even acids.

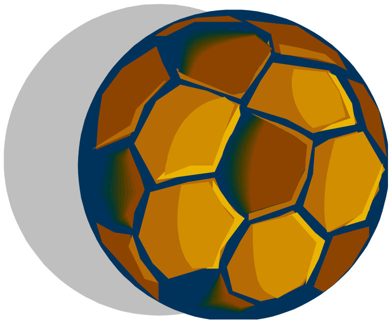






Uses of Rubber - Toys

- Of course, the most fun use is toys. It is used to make basketballs, super balls, and dog toys.



Definitions

- Rubber is a polymer, which is a word that is derived from the Greek meaning “many parts”.

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Definitions - Monomer

- Monomers are very small molecules such as water.

Water = H2O H-O-H

Definitions – Polymer

- Polymers are huge molecules. They are still too small to be seen by a microscope, but are many, many times larger than water molecules.

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                H       H H  H
Example:   -(C-C=C-C-C)20,000 -
                H H      H  H
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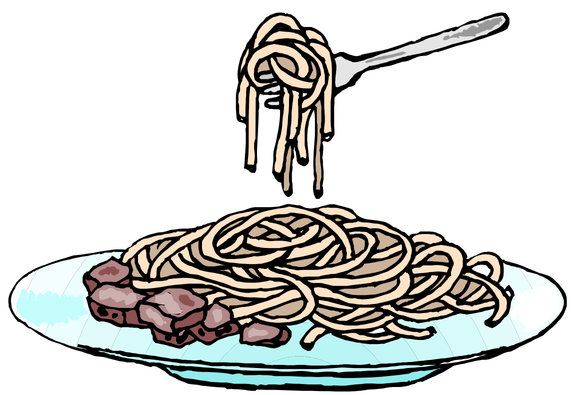
Definitions – Polymer (cont.)

- Some polymers are found in nature, such as cellulose in wood. Natural rubber is a naturally occurring polymer obtained from the latex of rubber trees. If you could see a bunch of polymers, they would look like a bowl of spaghetti.



Definitions - Elastomer

- An elastomer is a cross-linked or vulcanized polymer. Cross-linking is a chemical way of linking the long polymer chains. A way to think of this would be to take the bowl of spaghetti and tie them together with a piece of thread where ever the pieces of spaghetti touch each other.

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Components of a rubber compound

- In their natural, original form, most rubbers have limited usefulness. The early uses of natural rubber were limited by the fact that it was sticky when hot and brittle when cold. To develop the toughness and strength that we normally associate with rubber parts, we must crosslink or vulcanize the rubber molecules.

Components of a rubber compound

- There are several ways to crosslink rubber, but the most common is through the use of sulfur. Sulfur, with the addition of heat and pressure, will crosslink rubber. They connect up the long individual polymer chains into what is literally a single unit.
- Charles Goodyear was the person who discovered that sulfur will cure rubber. He accidentally dropped sulfur into a pot of rubber that he was heating on the stove.

Components of a rubber compound

- Cross-linking decreases the tackiness or stickiness of raw rubber, increases its strength, and decreases its solubility in solvents. Uncured rubber is soft and tends to flow like very thick molasses with time. Vulcanization decreases this “cold flow”, increases elasticity, and makes rubber less sensitive to changes in temperature.

Components of a rubber compound

- Using sulfur alone to crosslink sulfur is very slow. It can take as long as 8 hours to cure natural rubber with just sulfur. After Goodyear discovered that sulfur would cure rubber, the search was on for additional materials to enhance the properties of the cross-linked material and to speed up the times required to cure rubber.

Components of a rubber compound

- Accelerators and Activators were soon developed to speed up the curing process. The combination of sulfur, accelerators, and activators allows us to optimize compound properties with minimum cure time.
- There are other items that have also been added to increase strength, improve processability, and improve resistance to oxidation, ozonation, and aging.

Components of a rubber compound

1. Rubber or polymer.
2. Fillers – these are carbon black, clay, or calcium carbonate. They are used to improve rubber product properties and reduce formulation costs. They can increase tensile strength, hardness, and resistance to tear and abrasion.

Components of a rubber compound

3. Process Aids – as the name implies, these aid in the process of rubber, both in the molding process and mixing process.
4. Activator – these form chemical complexes with the accelerators, which further activate the curing process.
5. Antidegradents – these are added to protect rubber from oxidation, ozonation, and aging.

Components of a rubber compound

6. Accelerator – These accelerate the vulcanization of curing by increasing the cure rate.
7. Cure agent – Usually sulfur, but peroxide can also be used.

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History

- Rubber trees have been cultivated in Southeast Asia, primarily in Malaysia, Indonesia, and Thailand. Rubber trees grow to a height of about 60 feet tall, in hot damp climates.

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History

- Natural rubber is found in the latex that comes from the rubber trees. It is collected in a cup mounted on each tree, by slashing the bark to reach the latex vessels, which are like blood veins of the tree. The liquid is 30-40% rubber. The latex is dried and we have rubber.

History

- During WWII, we were cut off from rubber in Southeast Asia, because Singapore came under Japanese control. Because an immense amount of rubber was needed for the war, the US Government sponsored a huge program to accelerate research, development, and mass production of synthetic rubber.

History

- The first synthetic rubber to come from this research was SBR, which comes from Styrene and Butadiene. Within 2 years, a multi-million dollar industry had been developed – a project that ordinarily would have taken 20 years. Most of the synthetic elastomers that are used today, such as neoprene, nitrile, and butyl, were mass produced and became commercially successful between 1942 and 1945.

History

- After WWII, many more synthetic elastomers were developed to meet the demands of modern technology. Today, much more synthetic rubber is used than natural rubber.

Classification and types of material

- General Purpose
- Solvent Resistant
- Heat Resistant

Classification and types of material

- General Purpose

1. Natural – low cost material with excellent physical properties.
2. Polyisoprene – man made natural rubber – this is cleaner than true natural rubber.

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Classification and types of material

- General Purpose

3. SBR – very similar to natural rubber. It is usually the lowest cost and highest volume of any rubber made. It has slightly poorer physical properties than natural rubber, but is tougher and slightly more resistant to heat and flex cracking.

Classification and types of material

- General Purpose

4. Butadiene – similar to natural and SBR. It is very difficult to process, so it is usually blended with other polymers

Classification and types of material

- General Purpose

5. Butyl – This is chemically unlike the others we have talked about. It is very resistant to ozone and some corrosive chemicals. It is impermeable to gases, so it is used in tires. It is also very energy absorbing.

Classification and types of material

- General Purpose

6. EPDM – This has excellent resistance to heat, ozone, and sunlight. It has a very unique combination of physical properties. Other than applications requiring resistance to oil, there is scarcely an application in which EPDM is totally unsuitable. It also processes very well.

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Classification and types of material

- Solvent resistant

1. Neoprene – polychloroprene – excellent all purpose elastomer with a nearly ideal balance of properties and few practical limitations. It is used for wet suits.

Classification and types of material

- Solvent resistant

2. Nitrile – nitrile and neoprene are the highest volume oil-resistant elastomers. Nitrile is superior to neoprene in resistance to oil and gasoline. However, it does not perform as well as neoprene in applications requiring exposure to weather, ozone, and sunlight.

Classification and types of material

- Solvent resistant – nitrile (cont.)

  Properties of nitrile vary considerably depending on the ratio of acrylonitrile and butadiene. As the acrylonitrile level increases, oil and solvent resistance and abrasion resistance improve. As the acrylonitrile level decreases, these properties decrease, but low temp., flexibility and resilience improve.

Classification and types of material

- Solvent resistant – nitrile (cont.)

  When nitrile is modified with PVC, its resistance to weather, ozone, and sunlight improves considerably without significant sacrifice in oil-resisting properties.

3. NBR/ PVC – resistant to gasoline & ozone
4. Carboxylated nitrile – this is tougher and more resistant to tear and abrasion, but is less resilient and flexible at low temps.

Classification and types of material

- Solvent resistant

5. Hypalon – this is a close match to neoprene, except is superior in resistance to acids, solvents, ozone, and oxidation. It is used on a lot of roofs.
6. Epichlorohydrin – Excellent resistant to gasoline. It appears to have a combination of desirable properties of nitrile and neoprene, but it's superior impermeability to gases often causes processing problems and produces processing problems due to air entrapment.

Classification and types of material

- Heat resistant

1. Silicone – outstanding ability to retain rubbery properties through extremes in temperatures. It is the most heat resistant elastomer on the market. Service temps from -150 to 500F. Silicone does not have very high tensile strength, but most of it can be retained at very high temps.

Classification and types of material

- Heat resistant

2. Flouroelastomer (Viton, Flourel) – very expensive with outstanding resistance to a wide variety of oils, fuels, acids, and solvents at elevated temperatures. Because of it's price, it is used only in applications requiring excellent stability under extremely severe operating conditions.

Summary

- The bottom line is that we use a certain material based on the 3 P's: Processability, Properties, and Price
- Questions? Call us at (02) 9600 6342