A STUDY AND ANALYSIS OF MANIFACTURING PROCESS OF THIOKOL RUBBER

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Abstract:

Thiokol owes its origins to two chemists, Joseph C.
Patrick and Nathan Mnookin, who were trying to invent an inexpensiveantifreeze. In 1926, in the course of an experiment involving ethylene dichloride and sodium polysulfide, they created a gum whose outstanding characteristic was a terrible odor. The substance clogged a sink in the laboratory, and none of the solvents used to remove it were successful. Then the frustrated chemist's realized that the resistance of the material to any kind of solvent was a useful property. They had invented synthetic rubber, which they christened "Thiokol," from the Greek words for sulfur (theion) andglue (kolla). Thiokol Chemical Corporation was subsequently founded on December 5, 1929. Thiokol is a trademark used for any of various polysulfide polymers in the form of liquids, water dispersions, and rubbers used in seals and sealants

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Keywords:

Introduction:

Thiokol (polymer) ... The company **Thiokol** was founded in 1929 to produce these polymers. **Thiokol** polymers are used as an elastomeric in seals and sealants. **Thiokol** polymer is used as binder in solid rocket fuel, a first production plant started in 1948 in Elkton, Maryland.

Thiokol rubber is a type of artificial elastomeric, which is invariably a polymer. An elastomeric is a material with the mechanical property that it can undergo more elastic deformation under stress as compared to most materials and then return to its previous size without permanent deformation. Thiokol rubber acts as a substitute for natural rubber in many cases. Now-a-days Thiokol rubber is used as a great deal in printing textile. In most cases, titanium dioxide is used with copolymerization and volatile matter in producing rubber for textile use.

Comparison of Natural and Synthetic Rubber

Natural rubber obtained from latex is polymerized isoprene having a small percentage of impurities in it. There are limitations on the proportions of cis and trans double bonds which result from methods of polymerizing natural latex. This also limits the range of properties of natural rubber, rather addition of sulfur and vulcanization are used to improve the properties.

Thiokol rubber is made from the polymerization of a variety of monomers which includes isoprene, 1,3-butadiene, chloroprene, and isobutylene with a small percentage of isoprene for cross-linking. Monomers can be mixed in different desirable proportions to be copolymerized for a wide range of physical, mechanical, and chemical properties. The monomers are produced pure and the addition of impurities is controlled by design to give optimal properties. Polymerization of pure monomers can be better controlled for giving a desired proportion of cis and trans double bonds.

Thiokol rubber is a polymer of ethylene polysulphide. Thiokol rubber can be prepared by the condensation of 1, 2-dichloroethane with sodium polysulphide.

Properties

Thiokol rubber is resistant to the action of oxygen, ozone and also to the action of petrol, lubricants and solvents.

Uses

- It is used in hoses and tank linings for the handling and storage of oils and solvents.
- It is used in lining of vessels used in the manufacture of chemicals.
- It can be applied to engine gaskets and other such products that come into contact with oil.
- Thiokol mixed with oxidizing agents can be used as a fuel in rocket engines.

If you are in search of top leading rubber manufacturing company in India then I would suggest you Deesawala Rubber industries for best products which you are looking. Deesawala has specialized on moulded components such as tyres, Bellows, diaphragms, vibration pads and PVC water stoppers in various industries such as mining, automobile, pharmaceutical industries. with almost 20 years of experience in the rubber industry , it has created multiple rubber products our professionals always try to give specific design and functionality for the products according to the client specific requirements with a proper design. it provides variety of rubber products in India with exclusive design and functionality.

Some important products produced by Deesawala rubber industry highlighted below:

1. Pipeline Rubber Gaskets

2. PVC encapsulated Footsteps rungs

3. DAM Gate

4. Silicon Rubber product sheet

5. PVC water stopper

In this post, we have highlighted detailed explanation for PVC water stoppers, before using this product you should consider these below points.

1. PVC water Stopper is one of the largest products manufactured by Deesawala rubber industry in a variety of specific designs and as it helps in providing insulation between the pipe joints it helps in

joining the breakage between the pipe joints. It is mainly used for water structures mainly in basements and waterproof structures

PVC water stopper mainly used in water pipes, basements and in construction purposes.

Benefits of using PVC water stopper in construction purpose:

1. It acts as a sealant in RCC masonry concrete joints

2. It acts as a waterproof barrier in water pipes and helps to wound the breakage of the pipes.

Some important factors should be check before choosing appropriate PVC water stopper

1. Ribbled type: It should be multipurpose design where settlement of concrete gap is desired

2. Dumbbell type: Greater variation in temperature helps to increase expansion and contraction features of joints

3. Kicker surface: These are used externally where embedded structures should be avoided due to reinforcement

Some important applications areas of PVC water stoppers

1. Public Utilities: Water tanks, tunnels and swimming pools

2. Building: It is used in construction of basements, water structures

3. Industries: It is used in thermal, chemical plants and hydro plants.

- The gray sealing gasket when you open the door of your washing machine is an EPDM rubber product. washing machine door gasket

- The dust bellows in the joint area when you open your car door is an EPDM rubber product which also has rubber or plastics or rubber+plastic compound coated electric wires inside.

- The seals on your house and car windows are either rubber or rubber+plastic compound. window seal

Synthesis of Thiokol rubber

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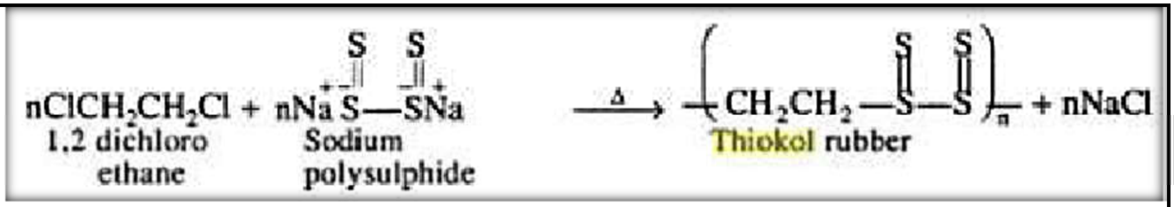
Preparation of Thiokol Rubber

Idea:

Thiokol rubber is obtained by the of 1,2-dichloroethane with sodium polysulphide.



$$nClCH_2CH_2Cl + nN\overset{+}{a}\,\overset{-}{\overset{\overset{S}{\|}}{S}}-\overset{\overset{S}{\|}}{S}N\overset{+}{a} \xrightarrow{\Delta} \left(CH_2CH_2-\overset{\overset{S}{\|}}{S}-\overset{\overset{S}{\|}}{S}\right)_n + nNaCl$$

Procedure:

- In a beaker containing 100 ml. of dist. Water dissolve 5 g. of sodium hydroxide and heat to boiling.
- Add 7 to 10 g. of sulfur flowers, stirring until all of the sulfur has dissolved. A deepred solution is obtained due to the formation of sodium polysulphide. If some sulfur remains undisclosed the solution is filtered.
- Allow the solution to cool to below 83°C, the boiling point of 1, 2-dichloroethane, and add 20 ml. of 1, 2-dichloroethane with stirring.
- Continue to stir for a few minutes (15-20 min.) while a rubber polymer separates out as a lump.
- Decant the supernatant liquid and wash the product several times with water and leave in the fume cupboard for a few minutes to allow excess 1, 2-dichloroethane to evaporate.

Properties:

The properties of the polymers depend on the length of the aliphatic groups and the number of sulphur atoms present in it. The polymer behaves like elastomer when four sulphur atoms, or greater, are present per monomer; lower amounts of sulfur give ahard, brittle resin. Some of the important properties are:(i) Thiokol is resistant to the action of oxygen and ozone.(ii) It is also resistant to the action of petrol lubricants and organic solvents.(iii) Thiokols outstanding resistance to swelling by organic solvents but benzene and its derivatives cause some swelling.(iv) Thiokol films are impermeable to gases to a large extent.

This preparation of Thiokol rubber is a two-step process. The first step is the preparation of sodium polysulfide by the reaction of sulfur, S8, with a strong base, sodium hydroxide, NaOH.

$$S_8 + 2\ NaOH \rightarrow Na_2S_8$$

At room conditions, sulfur is normally in the form of S8 rings and chains. The reaction with sodium hydroxide produces a mixture of mostly Na2S8 with other chain lengths of sulfur present. That mixture is called sodium polysulfide.The second step of this preparation is the reaction of sodium polysulfide with ethylene dichloride.

$$Cl\text{-}CH_2\text{-}CH_2\text{-}Cl + Na_2S_x \rightarrow [\text{-}CH_2\text{-}CH_2\text{-}S_8\text{-}]_n + 2n\ NaCl$$

Materials Needed : Sodium hydroxide solution, 1M Sulfur 1,2-dichloroethane Distilled or deionizer water Copper wire, approximately 6 inches long (15 cm) 2 10-mL vials with Teflon cap liners 2 400-mL beakers 10 mL graduated cylinder Glass pipette (dropper) Hot plate Chemical resistant gloves

Synthetic Thiokol rubbers Some fundamental of synthetic rubbers production Synthetic rubbers, similarly to other polymers, are the most often produced by means of polyreactions of the chain or gradual character. Great part of them is achieved by the chain polyreactions, namely: • radical • ionic or ©Matador Rubber s.r.o. 2007 11 • coordination polymerization and copolymerization, which are the most often used in: • emulsion • solution or • suspension Chain polyreactions run in more following actions, running in parallel Primary act of the whole process is creation of the reactive particle that is able to start the monomer molecules addition process on it. Reactive particle may be radical, ion or ionic pair.

According to this the whole process can run by radical or ionic (anionic, cationic, coordination) mechanism. In free radical polymerization and copolymerization systems used during synthesis of rubbers, the primary radical is the most often generated by decomposition of suitable initiator. At temperatures around 50°C those are mostly peroxides (dibenzoyl peroxide, potassium per sulfate, ammonium per sulfate) and azocompounds (azo-bis-isobutyronitrile), at temperatures around 5°C oxidation reductive systems consisting of hydroperoxide (p-menthane hydroperoxide, pinane hydroperoxide) and metal salt of transition valence (Fe^{2+}), eventually activator (sodium salts of suitable acids). Macromolecules of polymers prepared by radical polymerization or copolymerization have polydispersion character.

It is mainly because of the fact that growing polymer radical terminated not only in consequence of termination reactions with other polymers radical, but also in consequence of transfer reaction to other reaction system components (polymer, monomer, initiator, and solvent). Chain transfer reactions are used also for targeted regulation of molecular weights of rubbers. Chain transfer agents (e.g. mercaptanes, halogenides, disulfides) are added into reaction systems in these cases. Rubbers based on vinyl and diene monomers are the most often prepared by means of radical polymerization and copolymerization. Diene monomers keeps its reactive function groups also in form of structural unit mutually connected into polymer, eventually copolymer chain (α-methylene hydrogens and double bonds), thus there may take place under their presence also transfer reaction of growing polymer radical to polymer and also to its addition to double bonds.

These reaction leads to branching and cross-linking of created rubber. In consequence of their rate increasing with elevated temperature, the rubbers prepared under higher temperature are more branched and they have also higher content of gel. To reduce these unwanted reactions, the polymerization and copolymerization of diene monomers is normally finished at about 60 % conversion. Polymers with randomly distributed structural units (cis-, trans, 1.4, 1.2, eventually 3.4) are created during radical polymerization of diene monomers. Rubbers with such microstructure have worse elastic properties than their stereo-regulated equivalents. Primary radical from both co-monomers are created during copolymerization. They also react with both monomers in elementary propagation act, so the copolymer molecule is combined from structural elements of both monomers.

Their structure and arrangement in macromolecules depend mainly on mutual reactivity of growing copolymer radicals against individual monomers (it is characterized by the ©Matador Rubber s.r.o. 2007 12 monomer reactivity ratios) and from their content in monomer feeds. In such case when copolymerization monomers create azeotropic mixtures, the composition of copolymers is equal to the composition of monomers mixtures. References

In the ionic polymerization systems there are created reactive particles that are able to initiate growth of polymer chain by means of the charge transfer from initiator ion to monomer, in cationic polymerizations those are cations and in anionic anions. During cationic polymerization four elementary reactions run in similar way as in free radical reaction – initiation, propagation, termination and transfer. The most frequently acids used for initiation are Brönsted´s or Lewis's acids (H2SO4, HClO4, HCl, BF3, AlCl3, SnCl4) itself or in combination with small amount of co-catalyst (water, alcohols, ethers and others). During propagation the monomer molecules enter between polycation and opposite anion of initiator.

Termination of the polycation is the most often achieved by its monomolecule fragmentation or reaction with anion fragment of the initiator. In cationic polymerization systems similarly to radical system there can transfer of growing polycation onto some of the polymerization system compounds (monomer, polymer, solvent, or impurities) take places; consequently created various length macromolecules and they can be branched. Cationic polymerizations are performed under very low temperatures (around – 50 to – 100 °C). In this condition activation energy of transfer reaction is higher than the activation energy of initiation and propagation, accordingly polymers with narrower distribution and lower branching than in radical polymerization are formed. Cationic polymerizations are performed the most often in polar solvents. Typical example of rubber produced by means of cationic polymerization is IIR rubber.

Anionic polymerization and copolymerization can be performed in non-polar as well as polar solvents. In non-polar medium (aromatic and aliphatic hydrocarbons) alkyl metals (butyl lithium) are the most often used for initiation, but they only partially dissociate to ions. In polar solvents of the electron-donor character (tetrahydrofurane, naphthalene, benzophenone) total dissociation of initiator (phenyl lithium, sodium, potassium) onto ions take places, and at the same time also solvent becomes a part of stabilizing cation. Reactive anions that are able to initiate the growth of polymeric chain may be created by addition of initiator’s anion to monomer, by means of the electron transmission from initiator onto monomer or through amphions that generate reactive monomer anion by means of reaction with monomer.

During propagation the present monomer is added to created anion and if no impurities are present in the system (e.g. water, oxygen, carbon oxide) the polyanion grows until all monomer is consumed (living anionic polymerization). Termination takes places only after addition of terminating agent (substances that are able to accept electrons - water, carbon oxide, alcohols, ethylene oxide and others). Living anionic polymerization can be used also for preparation of „pure“ block copolymers (thermoplastic styrene-butadiene rubbers). In this case the second monomer is added into system already after finished reaction of the first one; from this reason neither random connecting of its structural units into the first monomer block cannot take place. Final structure of copolymer depends on type of used termination agent. If termination agents with more functional groups are used, thus star-shaped copolymers may start-up. Polymers with very narrow distribution are created in anionic polymerization systems and their molecular weights depend only on concentration ratio between initiator and monomer. Blocks length in the block copolymers depends on amount of monomer that was added into system.

Specialty of the coordination polymerization is in creation of sterically regular polymers. The most frequently used initiators in these systems are Ziegler-Natta´s catalysts. These are created by transition metal salts of Group IV to VIII elements, and organometallic alkyl- or acyl-compounds of Group I to III elements of Periodic Table. As transition metal salts the most often used are halides or others compounds of titan, cobalt, nickel, vanadium and similar metals, the second part is mostly created by diethylaluminum chloride or triethylaluminum. One should expect that effective initiator is created by means of alkylation of transition metal in salt. Its initiation activity is based on the fact that transition valence metal in lower valence is able to create not only covalent bonds (alkyl – metal), but also the coordination bonds with unpaired π-electrons of double bonds and to change them mutually.

If molecule of olefin or diene occurs in catalyst's coordination field, than coordination bond is created between them, during which time the bond between alkyl carbonmetal is destabilized, monomer molecule is inserted between atoms of carbon and metal and at the same time condition for creating the new coordination bond is established. To allow the polymer chain to be created in this way, the monomer molecules must enter spatially oriented into the propagation step. From this reason stereo regular polymers are created by means of coordination polymerization. Depending on catalyst composition polymers with high content of same structural units may be prepared by this way.

References:

- Slater, Alan, Making Thiokol Rubber, Stratford Central Secondary School, Stratford, Ontario, Canada, 1995 Russo,
- Tom and Mark Meszaros, Thiokol Rubber,
- Vail Organic II, Flinn scientific, Inc., Batavia, IL, 2001 Katz, David A., Rubber, Chemistry in the Toy Store, 1985.
- http://laroverket.com.
- www.google.com