Advantages of Manufacturing and Using Natural Rubber Gloves[1]

By courtesy of PRI, Malaysia

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It is easier to manufacture rubber gloves using natural rubber (NR) latex than synthetic latexes due to certain unique properties of NR latex which are not found in synthetic latexes. These include lower surfactant content, longer shelf life, much better wet gel strength and film formation properties than synthetic latexes. In addition, NR latex can be fully vulcanised in latex state, making it less susceptible to temperature fluctuation in the curing oven. Most rubber glove users like the performance properties of NR gloves because they are generally softer, more elastic than the synthetic gloves, which provide good comfort, low hand fatigue and good tactile sensitivity to the user. They are also more durable, have good resistance against polar solvents such as alcohol. The tear resistance of NR gloves is the highest among the common rubber glove materials. In addition, NR gloves also have the ability to reseal a small hole when punctured by a sharp object. NR gloves are generally cheaper than most synthetic gloves and are of low carbon foot-print products, and are biodegradable. Therefore, the use of NR gloves helps to reduce the impact of global climax change.

Keywords: Natural rubber, gloves, advantages, manufacturer, user

Introduction

Materials for rubber glove applications must be able to form thin and flexible barrier films to provide the users with good comfort and protection. Currently, the major rubber materials are NR, carboxylated acrylonitrile butadiene copolymer (nitrile rubber), polychloroprene (chloroprene rubber), polyvinyl chloride (vinyl), and polyethylene. Other rubber materials such as synthetic polyisoprene, styrene-isoprene block copolymer, polyurethane, butyl rubber, and other copolymers are also being used to manufacture rubber gloves. Despite the strong competitions from the synthetic rubbers, NR is still being widely used in the manufacturing of rubber gloves. This paper reviews some of the advantages of manufacturing and using NR gloves.

Discussion

Manufacturing NR Gloves

Long Shelf life of Latex Concentrate

When a NR latex concentrate is well preserved with sufficient stabilisers such as ammonia, the mechanical stability of the latex improves during storage even after a year. This is partly due to the hydrolysis of phospholipids to form phosphate and fatty acids. Phosphate is known to precipitate the magnesium ion in the latex to form magnesium phosphate. Magnesium ion is one of the ions that is known to reduce the latex stability.[1] The free fatty acids released from the phospholipids could form fatty acid soap with ammonium ion which imparts stability to the latex.[2] However, during the long term storage of the latex, it must be regularly agitated to prevent the latex from creaming due to the lower density of the latex particles. The shelf life of synthetic latexes, on the other hand, is normally shorter, typically no more than six months.

Fully Prevulcanised Latex

NR latex concentrate can be fully prevulcanised in latex state. After prevulcanisation, the latex can be used to produce NR gloves without further vulcanisation. In commercial prevulcanised latex, the excess vulcanising agent is removed after prevulcanisation by low speed centrifugation. This gives the latex a longer shelf life and pot life because the latex will not undergo significant vulcanisation during storage or production of latex products. Continual vulcanisation during production of latex products would eventually render the latex over-vulcanised or over-cured with poor mechanical properties. As the prevulcanised latex is optimally vulcanised, the mechanical properties are less susceptible to the fluctuation of drying oven temperature, leading to more consistent product quality. Therefore, it is possible to dry prevulcanised latex film with one oven temperature setting. Synthetic latexes, on the other hand, cannot be fully prevulcanised, have a shorter pot life, normally require multiple oven ozones for gradual drying and curing to prevent cracks.

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Good Wet Gel Strength

NR latex is known to have much better wet gel strength than synthetic latexes.[3] Wet-gel strength is the strength of a wet latex film after coagulant but before drying. Good wet gel strength is needed to prevent the latex wet film from tearing or cracking during processing such as wet gel leaching, beading and drying. A good wet gel strength property allows the latex film to be dried at a high speed without cracking issue. Rubber gloves with poor wet gel strength properties may crack during leaching or drying especially when the speed of production line or temperature is high. It may also tear easily during beading.

Low Surfactant

NR latex contains native stabilising surfactants such as proteins and phospholipids. Therefore, additional surfactant required to stabilise the latex system is much lower than that of synthetic latexes. The low surfactant makes it easier to leach the latex film and helps in inter-particles integration. This also results in lower chemical oxygen demand (COD) value of the effluent. The general observation that leaching could significantly improve the tensile properties of latex film indicates the advantage of NR latex having low surfactant content as shown by its good wet gel strength and high tensile properties with just moderate leaching process.

Low shrinkage

Due to the broad particle size distribution the particles in NR latex film could be closely packed resulting in a lower shrinkage during drying compared to synthetic latex films. This is because the smaller particles could occupy the space in between the large particles. A high shrinkage glove is expected to pose a higher risk in cracks formation during drying. In addition, the low surfactant level of natural rubber latex also leads to a lower shrinkage. This is because when the surfactant is removed out during leaching, it is replaced by water or latex particles via reorientation. All this leads to the film shrinkage. The higher surfactant therefore is expected to cause higher shrinkage in the dry film. A low shrinkage will have a lower risk of film cracks.

Simple Procedure

NR latex has been used to produce latex products for a long time. As such, the formulation, machine design, processing conditions are simple and have been well studied and published. On the other hand, the information on synthetic rubber gloves manufacturing is less readily available in the literature as synthetic rubber gloves, particularly the thin products were only started to manufacture 20-30 years ago, which is relatively short compared to NR gloves.

Using NR Gloves

Soft Products

Except for synthetic polyisoprene gloves, NR gloves are much softer than most of the synthetic rubber gloves, due to the low glass transition temperature. This is reflected in the low stress value at 300% or 500% elongation and the high elongation at break value which is generally above 800%. The highly stretchable property of NR gloves will result in lower hand fatigue, better fit and good comfort when the products are used for a long time. Because of these, most glove users prefer to use NR gloves in the healthcare settings.[4]

High tensile and Tear Strength

The tensile strength of NR gloves is normally higher than the synthetic gloves due to the ability of the rubber to undergo stretch-induced crystallisation. Because of this, the ASTM tensile requirements for NR examination and surgical gloves are significantly higher than those of synthetic rubber gloves. The tear strength of NR gloves is also better than most of the synthetic rubber gloves.[5,6] It is worth noting that synthetic polyisoprene gloves, although having the similar chemical structure as NR, have poorer tensile and tear strengths than NR gloves.[7] Glove tearing is one of the most common quality issue faced by the thin glove users. A glove having good tensile and tear strength such as NR gloves, will give a better protection to the glove users.

Excellent Barrier Protection

Due to the good wet gel strength and film formation properties, NR gloves generally have a lower defect rate than synthetic gloves. In addition, NR gloves have also been found to have the unique ability to reseal when punctured by needles. This provides additional barrier protection against transmission of infectious pathogens. This is well-demonstrated by studies showing that unlike synthetic gloves such as vinyl, chloroprene and nitrile gloves which showed significant viral and bacterial leaks when punctured with an injection needle, NR gloves, on the other hand, could "self-reseal" resulting in significantly less viral and bacterial penetrations as observed during the laboratory tests.[6,8]

Alcohol Resistance

NR is a non-polar material. As such, the alcohol resistance of NR gloves is much better than some polar rubber gloves such as nitrile gloves. Alcohol resistance is an important properties of medical gloves because the

use of alcohol in medical settings is very common. CDC guidance recommends the disinfection of gloved hands by multiple applications of alcohol-based hand rub (ABHR) following the care of a patient with Ebola before glove doffing.[9] It is therefore important for medical gloves to remain intact in the presence of alcohol. Any degradation of glove during the disinfection by alcohol may expose glove user to pathogen in the healthcare settings.

Sustainable Material and Low Carbon Foot Print

NR gloves are made from NR latex which is produced by the Hevea brasiliensis tree. As such, NR latex a sustainable material and the carbon foot print of NR gloves is much lower than that of synthetic rubber gloves.

Conclusion

NR gloves have been used for protection against biological and chemical contaminants for many years. They have been reported to possess many superior properties that synthetic latex manufacturers are trying to replicate. Although synthetic polyisoprene can provide the similar fit and feel, the material cost is very much higher than that of NR, making the polyisoprene gloves unaffordable to many users. Moreover, the tear resistance of synthetic polyisoprene gloves is still very much inferior to that of NR gloves.[7] As more users consider sustainability of material as an important factor when choosing a product, NR gloves which are made of a plant based material, will remain relevant in the glove industry for many years to come.

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