Rubber Goods Manufactured from Natural Rubber Latex*

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Introduction:

Natural rubber latex is the main crop harvested from rubber plantations. This is an important industrial raw material. A number of rubber industries use latex as their principal raw material. The primary processing in rubber latex goods manufacture is preservation. Most popular preservative used is Ammonia. Latex is required in concentrated form in many types of products manufacture. This is done by using a centrifuge machine or by creaming process. Latex can also be concentrated by evaporation or by electro-decantation. Concentration by centrifuging is most popular among plantations in India. Creaming process is also used by some of the processing units. Themost important raw material of latex based industry is ammonia preserved concentrated natural rubber latex. In India total production of ammonia preserved concentrated latex was 25000 tonnes in 1987-88. There are 27 producers of centrifugally concentrated latex in the country. Creamed latex is produced in five units. But the quantity produced is below 1000 tonnes per year.

Types of concentrated natural lattices available and their specifications:

Types of ammonia preserved concentrated lattices and their specifications under IS.5430 of the Bureau of Indian Standards are given in ANNEXURE-1. Concentrated latex is marketed with ISI mark under licence from the Bureau of Indian Standards by 12 units in the country. List of producers of certified quality preserved natural rubber latex is given in Annexure-II. Concentrated rubber latex is a costly item today. Its price in the Indian market is around Rs. 30/per kg. as against around Rs. 38/- in the international market. Price of latex has gone up very high in the international market in recent years mainly because of the expanded market for disposable gloves in different countries. This industry expanded so quickly because of the fear for the dreaded disease "AIDS" in developed countries. In many countries in the west millions of pairs of disposable gloves are needed every day by different public utility services. Since latex is a costly material, it will be in the interest of the consumers to procure and use centrified quality lattices. This will help them to escape from marketing malparctices of traders and consequent losses.

Important latex based rubber industries:

Important products manufactured from latex are:

a) Foam rubber
b) Dipped rubber products.
c) Cast rubber products
d) Extruded rubber threads and tubes
e) Other latex products

A short account of the principles involved in manufacture of the products is given below.

a) Foam rubber from Latex:

The process of manufacture of foam rubber from latex consists of expansion of a suitably compounded latex to a desired volume, setting the rubber particles and then vulcanising it. Expanded and sponge rubber normally denote cellular products made from dry rubber. Sponge cells are open and inter-connected while expandeg rubber cells are closed and non-inter communicating. Foam rubber cells are open and innter-connecting. Most of the latex concentrates is used in foam rubber manufacture. There are two main processes for the manufacture of foam rubbber, namely, the Dunlop process and (2) the Talalay process. In India practically all the manufactures are using the Dunlop process in foam rubber production. The steps involved in this process are:

1) Componding of latex.
2) Maturation of the compound.
3) Foaming of the compound to required level of expansion.

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4) Gellation ad consolidation of shape.
5) Vulcanisation.
6) Washing, squeezing and drying.
7) Testing, grading and packing.

properties of the foam produced. Over maturing should be avoided. Period of maturation is standardised by each factory according to the environmental conditions prevailing at the location of the factory.

A typical formulation for manufacture of foam products is given below:

Ingredients	Wet weight
Natural rubber latex	167.00
Post: oleate 20%	7.50
Precipitated calcium carbonate dispersion 50%	40.00
Sulphur dispersion 50%	5.00
Zinc oxide dispersion 40%	8.00
Zinc diethyl dithio-carbamate dispersion 50%	1.6
Zinc mercapto benzthiazole dispersion 50%	0.8
Diphenyl gnanidine dispersion 50%	1.2
Anti: oxidant dispersion 50%	3.0
Sodium Silico fluoride slurry 20%	10.0

Order of addition of ingredients is important in foam rubber production. Primary and secondary gelling agents are held back till expansion of latex is completed. These are then added and gellation allowed to take place.

Compounding;-

If high ammonia latex is used, it should be de-ammoniated before mixing other compounding ingredients. Ammonia level should perferably be brought down to around 0.2% on volume of latex. A small amount is some times added to avoid risk of coagulation while de ammoniating. De-ammoniation might take 8 to 24 hrs. Sulphur, accelerator, antioxidant and fillers (in the form of dispersions or emulsions) are then added to the deamm- niated latex taken in mixing tank fitted with a slow speed stirring for a period of over 12 hrs. Maturation of latex is found to improve the

Foaming is done by the batch process in most factories in this country. A planetary mixer is used for this purpose. Required quantity of latex is taken in the bowl of the mixer and soap solution is added at the required level. By mechanical agitation latex is expanded. This is effected in 15- 20 minutes. Volume increase is generally from 4 to 6 times for cushions and upto 10 times for soft products.

After the desired volume increase has taken place zinc oxide, with secondary gelling agent, is added followed by sodium silico fluoride. The speed of beating is reduced at this stage to refine the foam or to reduce the size of rubbles. This is continued to ensure uniform distribution of the chemicals. Usually the time of stirring after addition of gelling agents will be below three minutes The formed compound is then transfered to moulds and closed with lid. The mould is then transferred to autoclave for bringing about vulcanisation.

After vulcanisation the foam produced is stripped from the mould and washed in water to remove the water soluables like soap etc. The product is then dried in an oven at 60°-80°C.

The product is now ready for packing and marketing. There is an IS specification for foam rubber (IS 1741). Many manufactcures arc marketing foam rubber with BIS licence. Necessary guidance on this will be available to interested manufaturers from the nearest office of BIS or from the Rubber Board, Kottayam 686 009.

b) Dipped Rubber Products:

Products like baloons, rubber bands, gloves, condoms, nipples etc. are produced by dipping formers is compounded latex. Thin walled products are produced by straight dipping. Coagulant dipping is employed when thicker articles are to be produced. Heat sensitised dipping procedure is also used for the production of some thicker products.

In coagulant dipping process, it is advisable to immerse the former first in latex before it is immersed in coagulant. This will ensure formation of a more uniform film deposit on the former. Formers may be given a dwell time while they are immersed in latex. This will help in obtaining desired thickness with minimum number of dips. Dwell times of the order I to 5 minutes are common for the production of some latex goods.

The formers used for dipping should be absolutely clear. The speed of immersion should be sufficiently slow to

prevent air being drawn to the bath with the former. Immersion speed of the order of 3 to 6 ft. per minute is usually found to be acceptable. Withdrawal speed recommended in coagulant dipping process is of the order of the 1 to 2 feet per minute. Leaching is an important step in dipped goods production. This is done to remove water soluable serum ingredients, residual coagulant and surface active agents. Warm water or hot water is recommended for leaching. If water soluble accelerators are used for leaching, this step may be avoided. Dusting is done on unvulcanised films to prevent sticking of surfaces.

Most important dipped product of this decade is rubber latex gloves like surgeons gloves, disposable gloves and household gloves. It is estimated that 2 billion pieces of disposable gloves will be used in developed countries annually by the turn of this centuary. India is also slowly entering the gloves export market. Around ten plants with facilities for automatic dipping are coming up in the export promotion zones to Madras and Cochin together for disposable gloves manufacture.

c) Cast rubber products

In cast toy manufacture the important processing step is production of moulds for casting. Plaster of Paris is used for mould making in most small industrial units. Light alloys of metals are also used in mould making. When latex is poured to plaster of Paris mould the following changes are believed to occur.

1) Plaster is porous and so it absorbs water. 2) The calcium iones of plaster destabilise latex and hasten film formation. In casting conditions of rotations of moulds, temperature of moulds during casting etc. are important When heat sensitised latex is used for casting, the excess latex poured out of moulds may be cooled. The number of useful mouldings that can be taken from a plaster mould depends on several factors like hardness of plaster from which it is obtained and degree of sharpness required in the product. It is reported that an average number of 25 to 30 castings can be taken from one plaster mould.

Prevulcanised latex is specially suitable for producing cast rubber product as it avoids need for a curing operation. The level of filler addition determines the hardness and flexibility of the product. Generally two levels of filler loading are used, those with upto 30 phr filler and those upto 250 phr filler. The former is the level used in flexible products such as toys, while the latter is used in hard products.

Slush moulding:

In slush moulding metal moulds are used for casting. Aluminium alloys are mostly used. The alloy used should be free from harmful metallic impurities like copper, Mn, or cobalt. The moulding process is simple. The moulds are cleaned well and lubricated, eg: with a solution of paraffin wax and stearic acid in organic solvent. The mould pieces are brought together and heated to the desired temperature. The mould cavity is then filled with latex compound and allowed to stand for production of a film of the required thickness. The mould is then opened and the film vulcanised.

Latex thread:

Latex thread is produced by allowing a latex compound to flow through capillary tubes into an acid bath followed by washing and drying of the resultant coagulam. The process is known as extrusion. The important steps involved in production of latex thread are:

a) Compound design
b) Thread extrusion
c) Vulcanisation
d) Testing
e) Packing and marketing

Latex thread can be produced either from creamed or centrifugally concentrated latex. For production of high count threads, centrifugally concentrated latex is found to give better results. A typical formulation for producing rubber latex thread is given below:

	Wet weight
1. 60% Latex	167
2. 10% Potassium Hydroxide solution	3
3. 20% Potassium laurate solution	2.5
4. 50% Sulphur dispersion	3.5
5. 50% ZMBT	2.0
6. 50% ZDC	1.0
7. 50% Antioxidant dispersion	3.0
8. 50% Titanium dioxide dispersion	4.10
9. 50% Zinc Oxide dispersion	0.6

The compound has to be matured 3 to 5 days before production starts under stirring in a closed tank. Air bubbles should be removed by applying mild suction for 6 to 10 hrs., if facilities are available. In small units this is achieved by keeping the compound undistrubed for overnight followed by removal of the froath by kneading. Latex is then seived through 80 mesh seive or through voil cloth. Latex properties like total solids,

viscosity, degree of maturation, and mechanical stability are then determined. The compound may be brought to 50+2 T.S. for good quality thread extrusion.

Extrusion:

The Latex compound standardised as described above is stored in a header tank. From the header tank the latex passes to a manifold extruding head which distributes the mix to the capillaries through flexible tubes. In a small scale unit the extrusion head usually contains 20–60 capillaries. The level of the head in the manifold must be kept constant to ensure constant rate of extrusion and size of the thread. The nozzle is immersed in the coagulant. The depth of nozzle immersion has an influence on the diameter of the thread produced. In common practice the rate of extrusion is 30 to 40 ft. per minute. The orifice of the nozzle is round and size varies from 0.5 to 1 mm. The length of coagulation bath is around 10 ft. and the width varies depending on number of threads extruded. Strength of acid used also depends on factors like speed of extrusion, number of threads extruded, diameter of threads etc. Weak solutions are used for larger diameter threads. The threads are washed in bath of 6 to 10 ft. long. Cold or warm water can be used for this purpose. At this stage all residual acid will be removed. The thread is then dried in an oven at 85 to 90° C. The thread moves over a conveyor through the drying chamber. When it leaves the dryer, moisture content will be below 5 percent. It is then coated with talc and spooled over mandrels. Some degree of stretching is given to the thread between the extruding nozzles and winding. This wll improve modules of the thread and reduce its permanent set.

Vulcanisation of threads is completed by heating the talced thread in water at 80° to 85°C for 4 to 6 hrs.

e) Other Latex products

Other latex products are coated fabrics, adhesives, latex backed carpets, fibre foam etc.

Latex spreading:

Latex compounds prepared in suitable formulations can be spread over textiles using doctor blade or spreading bar. These devices help in applying uniform coating of latex compound over textiles. Proofed fabrics can be produced using this procedure. The latex compound used for this purpose should have the desired viscosity. Only when the viscosity of the compound is in the desired range penetration of the compound to textiles will be proper. Two textile coated fabrics can be pressed together at the coated surface to obtain doubled fabric.

Latex carpet backing:

The most popular method for latex application in carpets is by lickroll method. Here also a doctor blade is used to control the thickness of the coating. Latex carpet backing is also produced by spreading and in some factories spraying procedure is used.

Latex based adhesives:

Apart from latex a latex adhesive may contain adhesion modifiers, tackifiers, plasticisers curatives, fillers, thickeners and other special additives. For bonding non-polar substances to those which are polar, a second component of mixed polarity is added as an adhesion modifier. Thus in the bonding of rubber to textiles as in the cord, resins are used to promote adhesion. Tackifiers are used to increase tack properties and to confer what is popularly called quick grab' to the adhesive, that is the ability of the adhesive to develop rapidly an amount of initial strength, sufficient to hold the adherents in place while the main bond strength develops. Tackifiers promote wetting and adhesion and contributes flexibility. The substances used as tackifiers are resinuous in nature. Cooked starch is used extensively in paper adhesives. Uncooked starch is used in heat sensitive latex adhesive. Plasticisers are used in adhesives when bond flexibility is a desirable property. Curatives improve the ageing properties of the bond. A typical adhesive formulation is given below:

NR latex	167.00
Sodium silicate 25% dispersion	20.00
Casein 10% solution	20.00
Carbon tetrachloride 50% emulsion	10.00
Zinc oxide 50 % dispersion	1.00
Sulphur 50% dispersion	2.00
ZDC 50% dispersion	1.00

Rubberised fibre Products:

Latex bonded fibres are different from latex bonded non-woven fabrics. In fibre coated rubber, usually the rubber content will be around 30 to 40 percent. These products have good resilience and this property is derived mostly from the fibre quality. Latex is used here only as a bonding agent. Most popular product under this category is fibre foam. In India coir fibre is used for the production of this product. Certain animal hairs are also used for this application in some countries. Suitably compounded latex is applied on well arranged fibre pads using a spray gum. The product is then dried, cured, laminated, shaped and marketed.

ANNEXURE-1

Concentrated Latex Specifications as per IS 5430

1.1 Description

Concentrated latex is produced mainly by centrifuging field latex. During centrifuging a low proportion of rubber particles of smaller dimensions, a major portion of the non-rubber materials and a part of water are removed from field latex.

1.2 Grades

Three grades of ammonia preserved concentrated lattices are available.

1.2.1. High-Ammonia (HA) Type

Centrifuged natural rubber latex preserved with ammonia only or by formaldehyde followed by ammonia with an alkalinity of atleast 0.6%

1.2.2. Medium-Ammonia (MA) Type

Centrifuged natural rubber latex preserved with ammonia and other preservatives as agreed to between the purchaser and the supplier with an alkalinity level between 0.3% and 0.6%.

1.2.3. Low-Ammonia (LA) Type

Centrifuged natural rubber latex preserved with ammonia and other preservatives as agreed to between the purchaser and the supplier with an alkalinity level less than 0.3%.

1.3. Specifications for for concentrated latex

	HA-type	MA-type	LA-type
1.3.1. Colour	All the three types of lattices shall not have pronounced blue or grey colour.		
1.3.2. Odour	All the three types of lattices shall not have any pronounced odour of putrefaction after neutralisation with boric acid.		
1.3.3. Dry Rubber Content, percent by mass (Min)	60.0	60.0	60.0
1.3.5 Non-rubber solids, percent by mass (Max)	2.0	2.0	2.0
1.3.5 Coagulum content, percent by mass (Max)	0.05	0.05	005
1.3.6. Sludge content, percent by mass (Max)	0.10	0.10	0.10
1.3.7 Alkalinity as ammonia, percent by mass of latex (Min)	0.60	Above 0.3 but below 0.6	0.3 (max)
1.3.8. KOH number (Max)	1.0	1.0	1.0
1.3.9. Mechanical stability, Sec. (Min)*	475	475	475
1.3.10 Volatile Fatty Acid Number (Max)	0.15	0.15	0.15
1.3.11. Copper content, ppm of total solids (Max)	8	8	8
1.3.12. Manganese content, ppm of total solids	8	8	8

1.4. Packing

Latex shall be packed in drums so that each drum contains 200+5 litres. The inside surface of the drums shall be painted with ammonia resistant paint. The drums shall have the following marking.

1 Name of the producer or trade mark, if any

2 Type of latex

3 Net and gross weight in kg. and volume in litres

4 Dry rubber content

5 Date of packing

* Test for mechanical stability shall be carried out at least after 20 days of the packing of rubber latex.

ANNEXURE-II

List of Latex Centrifuging Units With ISI Licence

1 M/s. Cochin Malabar Estates & Industries, Chemoni Estate, Palippally P.O., Via. Alagappa Nagar, Trichur, Kerala

2 M/s. Cochin Malabar Estates & Industries, Kinalur Estate, Balusseri P.O., Calicut 673 612, Kerala.

3 M/s. Rajagiri Rubber & Produce Co. Ltd., Shalicarry Estate, Shalicarry P. O., Punalur, Quilon Dist., Kerala.

4 M/s. Thiruambadi Rubber Co. Ltd., Thiruambadi Estate, Mukom P. O. Calicut Dist , Kerala.

5 M/s. Pullengode Rubber & Produce Co. Ltd., Pullengode Estate, Pullengode P.O., Via, Kalikavu, Malappuram, Kerala.

6 M/s. Plantation Corporation of Kerala Ltd., (Chanadanapally Estate), Kottayam Dist., Pin-686 004, Kerala.

7 M/s. Travancore Rubber & Tea Co. Ltd., Kuppakayam Estate, TC No.12/114, Pattom Palace P.O., Trivandrum-695 004, Kerala.

8 M/s. Vaikundam Rubber Co. 7/55 Fathima Compound, Pattom Palace P.O., Trivandrum, Pin: 695 004, Kerala.

9 Karnataka Forest Plantation Corporation Ltd., Medinaduka Factory, Sullia Division, Sullia, D. K. Karnataka State.

10 M/s. Rehabilitation Plantations Ltd., Thalicode, Punalur-691 33, Kerala.

11 M/s. Padinjarakara Agencies (Pvt) Ltd., Kodimatha, Kottayam, Kerala.

12 Glenview Rubber Co. Ltd , Pangh P O., Kolathoor Via, Malappuram Dist., Kerala. □

Hottest decade

The world is passing through the hottest decade of the century.
According to British and U.S. experts, the 1980s' has so far been the warmest decade in the past 127 years with 1987 as the hottest on record.

The unusual warmth of the 1980s' is most evident in the southern hemisphere where seven of the eight warmest years recorded so far have occurred during this decade, reports American journal.' 'Scientific American.'

Latest investigations show that the average global temperature has increased by about 0.5 degree Celsius since the earliest reliable records, which date back to 1861.

The persistent warming of the present period could indicate the consequences of increased concentration of carbon dioxide (CO_2) and other radiatively active gases in the atmosphere, the experts feel. These gases absorb thermal radiation emitted by the earth and prevent its escape into space, thereby warming the lower atmosphere.

The concentration of atmospheric carbon dioxide is now 23 percent higher than it was before the industrial revolution and is increasing at a rate of 0.4 percent per year, the monthly says.

According to atmospheric scientists, the continuing increase in the amount of carbon dioxide and other gases like methane and nitrous oxide in the atmosphere is likely to cause a detectable global warming over the next few years.