Advisory Circular No.2016/13

Manufacture of Rubberized Coir Mattresses

Rubber Research Institute
of Sri Lanka

Manufacture of Rubberized Coir Mattresses

Rubberized-coir comprises of coir fibers in the form of a random web, the fibres being bonded together at their points of contact by rubber. The rubber merely serves to anchor the fibres to one another and to ensure the permanence of structure. Rubberized-coir is used as a cushioning material for beds, furniture, and vehicles. There are several advantages in the production of rubberized-coir in a country like Sri Lanka, since both major raw materials (*i.e.* natural rubber latex and coconut fibre), are locally available.

Some important features of rubberized-coir are less weight, no change in dimensions under high compressions and low permanent set properties.

Raw materials required

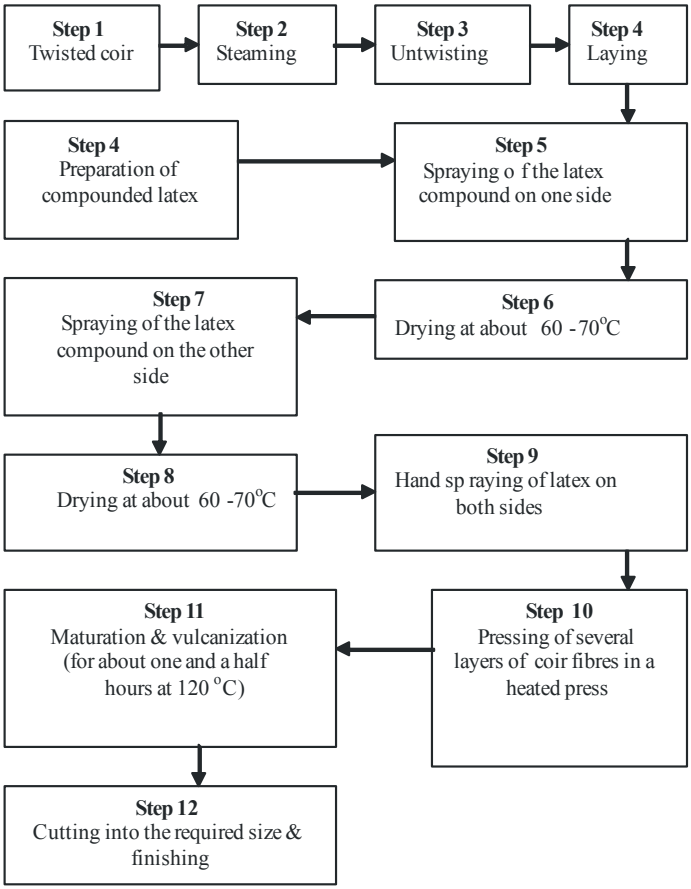
- 60% Concentrated natural rubber latex
- Specially processed coconut fibre
- Potassium hydroxide (KOH)
- Vulcastab LW (or any other suitable surfactant)
- Sulphur
- Zinc oxide (ZnO)
- Zinc diethyldithio carbamate (ZDC)
- Zinc mercapto benzothiazole (ZMBT)
- Antioxidant, *e.g.* Permanex TQ
- China clay or whiting

Machinery & equipment required

- Fibre processing machinery
- Fibre laying machine
- Ball-mill, pebble mill or colloid mill
- Mechanical stirrers
- Spraying device
- Drying oven
- Hand spraying equipment
- Hot press (hydraulic or a manually operated press)
- Vulcanising chamber
- Automatic cutting machine or a bandsaw
- Finishing equipment (*e.g.* sewing machines)

Process flow chart

The principal stages in the manufacturing process of rubberized-coir are given in the flow chart.



Twisting of coir (Step 1) and steaming (Step 2)

The coconut fibre are spun into a rope with a double twist in a coir spinning factory (mill). This gives the fibre a tight curl. Subsequently, the ropes are placed in an autoclave, where they are steam treated, stabilising the curl and giving greater elasticity to the material.

Untwisting (Step 3)

The steamed fibre rope is then passed through an untwisting machine to obtain curled, loose fibres. It is important to note here that improved results are obtained, if the rope is allowed to rest as long as possible before being untwisted.

Preparation of compounded latex and laying of curled fibre (Step 4)

The following are few requirements of latex compounds.

(a) The vulcanizing system should be one which gives a high level of cure under processing conditions, so that the modulus of the vulcanized rubber may be as high as possible and its permanent set as low as possible.

(b) It is essential to include an efficient antioxidant in the compound. The rubber will be in the form of a very thin film which persists throughout an open structure. It will therefore be very vulnerable to oxidation.

(c) The latex compound is usually applied by a spraying operation. It is therefore necessary to ensure that the mechanical stability of the compound is adequate, and the compound is free from agglomerations which might block the spraying nozzles. Careful dispersion of all the compounding ingredients is essential.

(d) It may be necessary to include additional wetting agents in the compound, in order to ensure adequate penetration of the fibre pad. However, excessive additions of wetting agents and stabilizers cause the compound to spray as a fine mist which coats the entire fibre. Ideally, the latex should be deposited as fairly large droplets which run down the fibres and coalesce at the fibre intersections.

Most of the solid compounding ingredients are insoluble in water and hence the particle size should be reduced to that of the rubber in latex in order to get a uniform distribution of the ingredients in latex. Hence, all the water soluble solid ingredients are generally added into latex as dispersions.

The solid material is made to disperse in water, by grinding in the presence of a dispersing agent. The dispersing agent prevents the dispersed particles from reaggregation. For very fine particle size ingredients such as ZnO, the quantity of dispersing agent required is 1% by weight, whereas for ingredients such as sulphur, 2-3% by weight is required. The grinding equipment used for the preparation of dispersions includes ball mills, pebble mills, colloid mills, *etc.* 50% dispersions can be prepared according to the following formulations.

(1) 50% sulphur dispersion

	pbw
Sulphur	50
Dispersol LR (dispersing agent)	2
Water	48

Ball milling time 48 hrs

(2) 50% zinc oxide dispersion

	pbw
Zinc oxide	50
Dispersol LR	1
Water	49

Ball milling time 24 hrs

The water insoluble liquids, oils or waxes are generally added as emulsions. The formulation used and the procedure employed in the preparation of a 50% emulsion of the liquid antioxidant is given below.

		Wet wt.
Component A	Antioxidant SP	50
	Oleic acid	5
Component B	KOH	1.5
	Water	43.5

The emulsifying agent (potassium oleate soap) is produced in-situ. Components A and B are mixed with agitation. Subsequently, the mixture is sheared in an emulsifier, at high speed stirring.

A suitable formulation for manufacture of rubberized-coir mattresses is given below.

	pbw
60% Concentrated NR latex	67
10% KOH solution	5
20% Vulcastab LW	2.5
50% Antioxidant TQ (phenolic type) dispersion	2.0
50% ZMBT dispersion	2.0
50% ZDC dispersion	2.0
50% Sulphur dispersion	5.0
50% ZnO dispersion	6.0
50% China clay or whiting dispersion	as required

The rubber content of the product could vary between 30-50%. The greater the rubber content, the higher will be the load bearing capacity and dimensional stability of the mattress and the less its permanent set. Therefore, 50% rubber content in the final product is recommended to obtain best qualities.

After preparation of the compounded latex, it is kept for maturation at room temperature for at least 24 hours with continuous stirring with the aid of a mechanical stirrer.

The curled fibres are then fed in a random fashion to a laying machine to form a web.

Spraying of the latex compound on one side (Step 5) and drying (Step 6)

The web is then passed to the first spraying station where compounded latex is applied to its top surface. It is then passed through a drying oven, the temperature of which is maintained at 60-70oC.

Spraying of the latex compound on the reverse side (Step 7) and drying (Step 8)

Subsequently the compounded latex is sprayed on the other side before returning to the drier for a second time. It is very important to have good air displacement during drying. Otherwise there may be some over vulcanization on top layers. If drying is carried out without the use of a positive air flow,

then it is advisable for the temperature to be kept below that at which the curing system becomes active. In this way premature vulcanization at the more easily heated top layers can be prevented to some extent. If, however, a positive air flow is employed then drying and curing may be rapidly achieved, and higher air temperatures may be employed.

Hand spraying of latex on both sides (Step 9)

In order to produce mattresses with good properties, hand spraying is essential as it ensures that the curled fibre layers are completely covered with the latex.

Pressing of several layers of coir fibres in a heated press (Step 10)

After the drying stage, partially dried sheets are assembled on top of each other and pressed under heat at about 60-70oC to the required thickness. A hydraulic or a manually operated press can be used for this purpose.

Maturation and vulcanization (Step 11)

Cure time and temperature necessary to obtain satisfactory cures with any given accelerator level may be significantly reduced by room temperature maturation. An additional advantage of the room temperature maturation is the reduction of residual tack of the dried, vulcanized rubber. Reduction of residual tack by maturation is considered preferable to reduction by over cure, because the latter adversely affects the ageing resistance of the rubber compound.

Vulcanization of the pressed coir mattresses is carried out in a vulcanizing chamber at 1200C for about one and a half hours.

Cutting and finishing (Step 12)

Cutting of the mattresses to the required thickness and size can be carried out using an automatic cutting machine or a handsaw. Finishing operation includes covering the mattress with a fabric cover and a sewing machine is required for preparation of the same.

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Telawala Road
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January 2016