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Utilisation of Sunlight for Drying of Rubber

L.M.K. TILLEKERATNE*#, A. NUGAWELA*, M. JAYASURIYA*,
S. WEERAMAN* AND T.A.S. SIRIWARDENA*

An experiment was carried out to explore the possibility of utilising sunlight for drying raw latex grades of rubber. Results obtained indicate that sun drying of ribbed sheet rubber for three to four days for complete dryness will not adversely affect the physical or vulcanisate properties of the rubber. However, in order to eliminate mould contamination of the sheet rubber, smoking in a smoke house for one day is recommended.

In the case of latex crepe rubber, all grades including unfractioned and unbleached and fractioned and bleached, sun drying for up to two complete days would not have any adverse effects on their properties. However, overdrying in the sun for longer periods without overturning the lace causes tackiness.

It was a belief among rubber technologists that exposure of raw rubber to direct sunlight causes deterioration in quality causing tackiness. It was also believed that UV fraction of sunlight ranging from 200 nm to 400 nm can create free radicals on the molecule of rubber thereby initiating photodegradation reaction of the rubber molecule which ultimately causes tackiness[1] and deterioration of the vulcanising properties of rubber. Hence, it was a traditional practice among both crepe rubber and sheet rubber producers to protect freshly rolled wet laces of crepe rubber from direct sunlight during dripping, drying and storage. In view of this fear, instructions were always given to the smallholders and factories to drip their freshly rolled sheets only in the shade[2]. Further, in crepe rubber factories, precautionary measures were also taken to protect the laces from direct sunlight falling through glass windows by painting them with lacquer. Even in the case of washing mouldy RSS sheets for improving the quality, subsequent drying was not permitted in the sun as it was believed that it could deteriorate the properties of rubber. As a consequence, all the advisory publications and handbooks published by research institutes in the world carried a warning to the effect that sun drying should be prohibited and hence no one has made any effort during the last 50 years to utilise this source of energy which is freely available throughout the year in all the rubber producing countries for the purpose of drying rubber.

This paper reports the results of the research project carried out to study the effect of direct sunlight on drying of laces of latex crepe and ribbed smoked sheets purely with the idea of saving a large quantity of timber from being burnt every year for the purpose of smoking of sheets in smoke houses and for drying of crepe laces in hot-air-drying towers. Solar drying of rubber will therefore help to save large quantities of timber from being used as firewood for this purpose. Rubber firewood can now be made available for domestic purposes and for use in bread and brick kilns which will

*Rubber Research Institute of Sri Lanka, Dartonfield, Agalawatta, Sri Lanka
#Corresponding author

considerably ease the demand on firewood harvested from natural forests and therefore help to protect our environment as well.

EXPERIMENTAL

Two main grades of latex rubber produced namely, ribbed smoked sheets and latex crepe both unfractioned and unbleached and fractioned and bleached, were subjected to this test.

In order to make sun-dried and one-day smoked sheets (RSS), a field latex diluted with an equal volume of water was coagulated with formic acid and rolled into ribbed sheets each of 650 g – 670 g dry weight by passing twice through the smooth mill and once through the diamond mill.

Sheets rolled through the diamond mill were thoroughly washed with water to remove serum substances on the surface and then directly hung on cloth lines in hot midday sunlight. Drying continued for 3 days for one lot and four days for the second lot from 10 h to 15 h in the day. They were then smoked in a smoke house for two days and one day, respectively to get the honey-brown appearance on the sheet. Smoking will also ensure protection from mould growth on the surface and sheets which are only sun dried become more susceptible to mould contamination compared to the smoked sheets.

Sheets from the same day's production and from the same batch of latex fully dried for five days in the smoke house were taken as the control samples of the experiment.

Latex crepe laces were also made in two different ways for the test:

- By coagulation of the latex treated only with sodium bisulphite as an enzyme inhibitor, without removing the yellow fraction by fractional coagulation. These laces are called unfractioned and unbleached (UF and UB) laces[3].
- By removing a yellow fraction of around 10% – 12% from the sodium bisulphite-added latex and bleaching with sodium paratoluenethiophenate which was added at a concentration of 0.05% by weight. These laces are called fractioned and bleached (FB)[3] laces.

The laces from both the above types were hung for sun drying on reapers for two full days from 10 h to 15 h in the day in direct sunlight. Control laces from both the above types were dried in the drying tower at 35°C – 38°C, until the white spots completely disappeared from the surface.

Samples of sheet rubber and latex crepe laces of both types dried using methods described previously were then subjected to the following tests:

(a) Physical properties

(1) Physical appearance (colour)
(2) Initial Wallace plasticity (P_o)
(3) Plasticity retention index (PRI)
(4) % Volatile matter content (VM)
(5) Raw Mooney viscosity (V_R)

(b) Technological properties (on ACS 1 compound)

(1) Tensile strength (TS)
(2) Elongation at break (EB)
(3) Tear strength
(4) Cure characteristics by Monsanto rheograph
(5) Rheological properties by Brabender Plasticorder

Physical and vulcanisate properties of rubber dried in the sun and by traditional methods are given in *Tables 1* and 2, respectively.

TABLE 1. PHYSICAL PROPERTIES

Treatment	Parameters (mean)				
	P_o	PRI	%VM	VR	Colour
1. Sun dried for 3 days and 2 days in smoke house (RSS)	38	92	0.92	73	Light-honey brown
2. Sun dried for 4 days and 1 day in smoke house (RSS)	40	80	0.76	75	Very light-honey brown
3. 5 days in smoke house (RSS)	35	86	1.34	73	Brown
4. Sun dried for 2 days (UF and UB laces)	40	63	0.48	73	Light yellow
5. 3 days in drying tower (UF and UB laces)	36	100	0.67	71	Yellow
6. Sun dried for 2 days (FB laces)	38	63	0.41	74	White
7. 3 days in drying tower (FB laces)	35	74	0.55	69	White

DISCUSSION

From the above results it is clear that, drying latex crepe UF and UB or FB or even the sheet rubber continuously for complete dryness in the sun, does not adversely affect the physical or technological properties of the rubber. On the other hand, in the case of both RSS and UF and UB latex crepe rubber, this is due to less soot and creostic substances deposited on the surface of the rubber sheets. However, the light colour on the UF and UB laces dried in the sun was possibly due to the fact that carotenoid pigment on the rubber laces get bleached in the process of sun drying.

In none of these cases, deterioration of quality of the rubber due to the effect of sunlight was detected as it has been reported in the literature[2,6]. In the case of FB laces a slight lowering of the PRI was the only effect seen. Nevertheless, PRI had not been lowered below 60 in any of these cases.

In the case of RSS and lace crepe rubber, turning the sheet every day is advisable to prevent tackiness caused by over heating in certain areas of the sheet of the lace. Lace crepes need only two days of drying in the hot direct sun to lower its % VM below 0.5%. Excess exposure to sun may cause tackiness specially in the area of lace covering the wooden beam which is the area of the lace most exposed to the sun. But this was not detected in the case of RSS.

In the vulcanising properties of ACS 1 compound no marked change in the properties

TABLE 2. VULCANISATE PROPERTIES

Treatment	Parameters (Mean)					
	% Elongation at break	Tensile strength (MPa)	Scorch time (min)	Cure time (min)	Cure rate index	Max. torque (Nm)
1. Sun dried for 3 days and 2 days in smoke house (RSS)	750	6.74	4.5	37.0	4.08	45.80
2. Sun dried for 4 days and 1 day in smoke house (RSS)	750	9.13	3.75	37.0	4.08	45.30
3. 5 days in smoke house (RSS)	750	9.24	3.25	33.5	4.8	50.15
CD at 0.05 prob. level	125	3.05	2.2	4.0	–	3.40
4. Sun dried for 2 days (UF and UB laces)	750	9.21	7.75	66.5	2.16	32.00
5. 3 days in drying tower (UF and UB laces)	750	9.57	6.0	58.5	2.74	40.93
CD at 0.05 prob. level	75	2.80	1.9	4.2	–	3.26
6. Sun dried for 2 days (FB laces)	890	13.31	6.5	47.25	3.08	36.00
7. 3 days in drying tower (FB laces)	850	11.06	6.75	49.0	2.88	30.50
CD at 0.05 prob. level	80	2.65	2.1	3.8	–	3.00

CD = Critical difference

have been noted, except in the case of tensile strength, where there is a marked improvement in all grades of rubber dried in the sun. The same effect was observed in the maximum torque too in the rheograph for sun dried, fractioned and bleached laces. In RSS dried in the smoke house and in the drying tower dried UF and UB laces, the maximum torque values are higher than those of the sun dried sheets.

In the case of the rubber dried purely in the sun or for a longer period of time in the sun, followed by smoking for a day in the smoke house, a marked difference in cure time and cure rate index have been observed. Moreover, sun-dried rubber always showed a longer cure time and a reduced cure rate index. The identical results were observed in the samples tested in the Brabender Plasticoder at 140°C and at a rotor speed of 30 r.p.m. In other words, rate of scorching of the rubber is reduced when sun dried, compared to drying in the absence of light by conventional methods or in other words, processing safety is slightly higher in the sun dried samples compared to drying in the absence of light by conventional methods.

CONCLUSIONS

Sun drying of sheet rubber (RSS) for three or four days for complete dryness will not adversely affect the physical or vulcanisate properties of the rubber. However, in order to eliminate mould contamination and also to obtain the honey-brown colour, one or two days smoking in a smoke house is recommended.

In the case of latex crepe rubber, irrespective of the method of processing, sun drying for two complete days is not harmful to its physical or technological properties. Sun drying for over two complete days may cause slight tackiness, specially when the laces are not overturned daily. Sun drying of both these grades of rubber slightly lowers the cure time and cure rate index compared to conventionally dried samples.

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