*Rubber Science*, 33(2): 221-227, 2020 RESEARCH ARTICLE

# PREPARATION OF QUALITY SHEETS FROM AMMONIA PRESERVED FIELD LATEX

**Joy Joseph and Manoj Kurian Jacob**

Rubber Research Institute of India, Kottayam-686 009, Kerala, India

Received: 02 July 2020 Accepted: 09 August 2020

Joseph, J. and Jacob, M.K. (2020). Preparation of quality sheets from ammonia preserved field latex. *Rubber Science*, 33(2): 221-227.

Ribbed Smoked Sheets (RSS) are generally made from fresh latex and graded by visual grading as per the "Green book" specifications. As sheets in India are mostly made in the small growers sector the uniformity in quality of sheets is a concern. Good grading can be achieved by adopting recommended processing practices through group processing centres (GPCs). To ensure a regular supply of latex to the GPCs it is necessary to store latex and prepare sheets from preserved field latex (PFL). Present study is an attempt to develop a method to prepare sheets from stored latex without compromising the quality. Both low ammonia latex and high ammonia latex were pre-treated before adding the preservative and stored for various periods. The lattices were coagulated at regular intervals and the raw rubber properties were measured. The study revealed that the PRI values can be retained as a satisfactory level by pretreating the latex before adding preservatives. This method can be used for making sheets from stored latex without adversely affecting the rubber properties.

**Key words**: Natural rubber latex, Plasticity retention index, Ribbed smoked sheets, Stored latex

## INTRODUCTION

Natural rubber is generally collected from the rubber tree *Hevea brasiliensis* in the form of latex harvested through tapping the tree. Latex produced in the tree is sterile and when it comes out it is acted up on by micro organisms and spoils the latex (Twiss *et al.*, 1941). Therefore the latex as soon as it is collected has to be converted into suitable marketable forms like sheet rubber, block rubber, crepe rubber, centrifuged latex, creamed latex or preserved field latex (Zuhainis *et al.*, 2015).The first three are dry forms of rubber whereas the other three are liquid forms. Majority of the products like tyres, rubber mats, conveyer belts, bushes *etc.* are made from dry rubber whereas rubber products like gloves, condoms, foams, balloons *etc.* are made from liquid forms (Alex *et al.*, 2011). Around 70 per cent of the rubber is used in the tyre sector where natural rubber (NR) used is mainly sheets and block rubber (Morshed *et al.*, 2018). In this context it is important to make sheets out of latex.

Rubber sheets are generally made from fresh latex and graded as ribbed smoked sheets (RSS) by visual grading as per Green book specifications (Biffen, 1898). This is the simplest form of processing latex and do not require any sophisticated and expensive machinery and can be done by the tapper.

Correspondence: Joy Joseph (Email: joyjoseph@rubberboard.org.in)

This is the reason why preparation of sheets becomes the most popular form of latex processing in India. Rubber sheets (RSS) generally exhibit good raw rubber as well as technological properties. This makes the NR product manufactures to use sheets as the raw material for their production units. In this aspect uniformity of the sheets is very important. As sheets in India are mostly made in the small growers sector the uniformity is a concern. This uniformity in quality can be achieved through group processing centres (GPCs). To run a GPC in a smooth manner we have to ensure uninterrupted supply of latex. Generally this is not possible in lean periods. To ensure a regular supply of latex to the GPCs it is necessary to store latex and prepare sheets from preserved field latex (PFL). However, preserved field latex is not generally suitable for making sheets (William, 1946).

In addition to this, sometimes latex processing units experience situations where stored latex has to be converted into sheets due to low price of the centrifuged latex (Cenex) or creamed latex (John, 1947;1959). There are situations where the volatile fatty acid (VFA) becomes high as the latex becomes unsuitable for making cenex or cream. Also there are cases where the industry has to go for lay off for maintenance or due to labour problems. In such situations good price can be realized if the stored latex is converted into quality sheets. But stored latex does not have the required Plasticity Retention Index (PRI) and the coagulation is not smooth to get a good sheet (Rathnayake *et al.*, 2017; Ferreira*e t al.*, 2005). Other raw rubber properties are normally within the permissible limits. Here is an attempt to develop a method to prepare sheets from stored latex without compromising the quality.

## MATERIALS AND METHODS

The latex required for this study was collected from the research farm of Rubber Research Institute of India. Compounding ingredients such as zinc oxide (ZnO), stearic acid, TDQ, CBS, Sulphur, *etc.* used in this study were supplied by Bayer (India) Ltd. Naphthenic oil was supplied by Samira Chemicals Pvt. Ltd., Kottayam and carbon black (HAF) was supplied by Vision Enterprises, Mumbai. All other chemicals used were of laboratory reagent grade. The cure characteristics were studied using RPA 2000 (Dick and Liotta, 2004). The plasticity parameters ($P_0$ and PRI) were measured using a Wallace Rapid Plastimeter MK V-P14 and MRPRA ageing oven as per ASTM standards (ASTM 2005, 9.01 and 9.02). The Mooney viscosity [ML (1+4) 100°C] was measured using Mooney viscometer model V-MV 3000. The heat buildup was determined using Goodrich flexometer. Tensile properties, tear strength, heat buildup, compression set and hardness were tested as per the respective ASTM standards D 412, D 624, D 623, D 395 B, and D 792 / 2240.

The latex was preserved with 0.03 per cent ammonia along with 0.13 per cent TMTD and 0.13 per cent zinc oxide and 0.05 per cent ammonium laurate (LATZ latex). Another set of latex of same origin was also preserved with one per cent ammonia (HA latex). Both the lattices were stored for various periods and coagulated with 0.5 per cent formic acid and dried at 60°C and the raw rubber properties were studied. After five days of preservation a new technique was adopted for coagulation of latex to get good sheets. The dry rubber obtained was compounded using a standard formulation and the technological properties were also studied.

## RESULTS AND DISCUSSION

### Storage for short periods

Both LATZ latex and HA latex were stored for one to 10 days. The stored latices were coagulated using 0.5 per cent formic acid and dried. The samples were analyzed for $P_0$, PRI and Mooney viscosity and the results are shown in Table 1 and Table 2. The PRI was reduced even after one day of storage indicating that as soon as preservatives were added the raw rubber properties were affected (Stevens and Dick, 2001).

### Storage for long periods

The LATZ latex was further stored to 60 days and the initial plasticity ($P_0$), plasticity retention index (PRI) and Mooney viscosity (MV) were studied. The results are shown in Table 3. The PRI values were further reduced with storage upto 60 days. However

Table 1. **Quality parameters of low ammonia preservation system (LATZ) storied for different periods**

| Sample | Initial plasticity ($P_0$) | Plasticity retention index (PRI) | Mooney viscosity (ML(1+4) 100°C) |
|---|---|---|---|
| Control | 43 | 95 | 89 |
| One day | 43 | 58 | 81 |
| Two days | 41 | 56 | 70 |
| Three days | 43 | 48 | 71 |
| Four days | 42 | 36 | 68 |
| Five days | 39 | 32 | 63 |
| Six days | 37 | 31 | 63 |
| Seven days | 35 | 31 | 59 |
| Eight days | 35 | 19 | 46 |
| Nine days | 33 | 17 | 44 |
| Tendays | 34 | 16 | 46 |

Table 2. **Quality parameters of high ammonia preservation system (HA) stored for different periods**

| Sample | Initial plasticity ($P_0$) | Plasticity retention index (PRI) | Mooney viscosity (ML(1+4) 100°C) |
|---|---|---|---|
| Control | 43 | 95 | 89 |
| One day | 44 | 56 | 85 |
| Two days | 42 | 57 | 76 |
| Three days | 43 | 49 | 71 |
| Four days | 42 | 34 | 65 |
| Five days | 40 | 35 | 64 |
| Six days | 38 | 31 | 58 |
| Seven days | 36 | 32 | 50 |
| Eight days | 35 | 20 | 51 |
| Nine days | 33 | 19 | 46 |
| Ten days | 33 | 17 | 40 |

Table 3. **Quality parameters of low ammonia preservation system (LATZ) stored up to 60 days**

| Sample | Initial plasticity ($P_0$) | Plasticity retention index (PRI) | Mooney viscosity (ML(1+4) 100°C) |
|---|---|---|---|
| Control | 45 | 56 | 84 |
| 10 days | 36 | 20 | 81 |
| 20 days | 37 | 18 | 83 |
| 30 days | 33 | 19 | 72 |
| 40 days | 32 | 18 | 70 |
| 50 days | 34 | 16 | 64 |
| 60 days | 35 | 12 | 60 |

$P_0$ and Mooney viscosities were within the permissible limits. The reduction in PRI may be due to the fact that the natural antioxidants were lost by complexing with the preservatives added (Nadarajah *et al.*, 1971; Jitlada *et al.*, 2011).

## Coagulation behavior

The coagulation behavior of stored latex is shown in Table 4. Coagulation of latex was smooth up to five days of storage and thereafter coagulation was very difficult as the latex coagulates immediately at the point of contact of the coagulant and a lump is formed instead of sheets. Therefore the latex has to be coagulated using a different technique.

## Pretreatment

Both LATZ latex and HA latex were pretreated by using suitable agents and stored for various periods. The pre-treated lattices were coagulated using formic acid and dried at 60°C. The dry rubber thus obtained was analyzed for raw rubber properties and were compared with a control (Table 5 and 6). In this experiment lattices were stored up to six months (180 days) with and without pretreatment. The results showed that $P_0$ and Mooney viscosity were not much affected by storage (Jiri, 2011). However it can be seen that the PRI values were drastically reduced due to storage. That is why stored latex is not suitable for preparing Ribbed Smoked Sheets (RSS). When the lattices were pretreated using suitable agents it was found

Table 4. **Coagulation behavior of stored latex**

| No. of days stored | Low ammonia preservation system (LATZ) | High ammonia preservation system (HA) |
|---|---|---|
| 0 day | Smooth and uniform | Smooth and uniform |
| One day | Smooth and uniform | Smooth and uniform |
| Two days | Smooth and uniform | Smooth and uniform |
| Three days | Smooth and uniform | Smooth and uniform |
| Four days | Smooth and uniform | Smooth and uniform |
| Five days | Smooth and uniform | Smooth and uniform |
| Six days | Slightly difficult, uniform | Slightly difficult, uniform |
| Seven days | Slightly difficult, uniform | Slightly difficult, uniform |
| Eight days | Difficult, not uniform | Difficult, not uniform |
| Nine days | Difficult, not uniform | Difficult, not uniform |
| Ten days | Difficult, not uniform | Difficult, not uniform |

Table 5. **Quality parameters of pretreated LATZ latex**

| Sample | Untreated | | | Treated | | |
|---|---|---|---|---|---|---|
| | $P_0$ | PRI | MV | $P_0$ | PRI | MV (ML(1+4) 100°C) |
| 0 day | 64 | 95 | 98 | 65 | 95 | 99 |
| 7 days | 59 | 37 | 87 | 61 | 57 | 99 |
| 10 days | 56 | 22 | 80 | 58 | 55 | 94 |
| 15 days | 51 | 20 | 80 | 54 | 48 | 77 |
| 30 days | 48 | 18 | 81 | 51 | 48 | 80 |
| 60 days | 41 | 14 | 74 | 48 | 49 | 73 |
| 180 days | 38 | 11 | 71 | 39 | 46 | 76 |

Table 6. **Quality parameters of pretreated HA latex**

| Sample | Untreated | | | Treated | | |
|---|---|---|---|---|---|---|
| | $P_0$ | PRI | MV | $P_0$ | PRI | MV (ML(1+4) 100°C) |
| 0 day | 64 | 95 | 98 | 65 | 95 | 99 |
| 7 days | 60 | 38 | 87 | 63 | 59 | 98 |
| 10 days | 57 | 21 | 80 | 58 | 56 | 96 |
| 15 days | 51 | 18 | 80 | 55 | 50 | 80 |
| 30 days | 44 | 15 | 81 | 51 | 49 | 78 |
| 60 days | 41 | 12 | 74 | 50 | 48 | 73 |
| 180 days | 40 | 11 | 71 | 38 | 47 | 74 |

that the PRI values were retained to the processable levels even after six months (180 days) of storage. It was also found that both LATZ latex and HA latex showed same behavior on pretreatment.

### Acid requirement

The untreated fresh latex was coagulated by adding 400 ml 0.5 per cent formic acid for a 500g sheet. However the pretreated preserved latex required more acid for coagulation. Up to five days of storage the acid requirement for a 500g sheet was 600 ml of two per cent formic acid. After five days, the latex is coagulated by a new technique.

### Drying time of sheets

No difference in drying time was noticed between the sheets prepared from normal latex and pretreated preserved latex. Both the sheets got completely dried after four days.

### Colour of the sheets

The colour of the sheets prepared from stored latex is shown in Table 7. It was found that the sheets prepared from stored latex were bright golden yellow colour as prescribed by *Green book*. The sheets prepared using the pre-treated latex was honey colourand even without smoking. This showed that pretreated latex can be used for preparing sheets which conform to the colour prescribed in 'The Green book'.

Table 7. **Colour of the sheets prepared from stored latex**

| Nature of latex | LATZ latex | HA latex |
|---|---|---|
| Untreated | Light golden yellow | Bright golden yellow |
| Treated | Honey colour | Honey colour |

### Technological properties

The treated latex was coagulated and dried. The dry rubber thus obtained was compounded using a standard formulation

Table 8. **Formulation of the compound**

| Rubber | 100 (phr) |
|---|---|
| ZnO | 5 |
| Stearic Acid | 2 |
| Antioxidant | 1 |
| HAF black | 40 |
| Naphthenic oil | 4 |
| CBS | 1 |
| Sulphur | 3 |

Table 9. **Cure characteristics**

| Sample | Cure characteristics | | | | |
|---|---|---|---|---|---|
| Particulars | $S'M_L$ dNm | $S'M_H$ dNm | Tan d $M_L$ | Tan d $M_H$ | T90 (min) |
| LATZ latex | 1.86 | 13.48 | 0.88 | 0.11 | 5.03 |
| HA latex | 1.88 | 13.66 | 0.91 | 0.13 | 5.21 |
| Control | 1.91 | 13.51 | 0.89 | 0.12 | 5.08 |

as per Table 8 and various technological properties were studied. The results were compared with a control prepared from the same latex without pre-treatment.

The compound was analyzed for various cure characteristics and compared with a control. The cure characteristics are shown in Table 9. The results showed that the initial torque $S'M_L$ was slightly lower for stored latex compared to control. However the final torque $S'M_H$ was on par with that of control. Other cure characteristics were comparable with that of the control.

Table 10. **Technological properties of sheets produced from latex stored for 60 days**

| Properties | Control (0 day) | Pre-treated LATZ | Pre-treated HA |
|---|---|---|---|
| Tensile strength (MPa) | 27.01 | 26.42 | 26.44 |
| Tear strength (N/mm) | 98.24 | 97.17 | 97.11 |
| Modulus 100% (MPa) | 2.81 | 2.59 | 2.10 |
| Modulus 200% (MPa) | 5.84 | 5.83 | 4.80 |
| Modulus 300% (MPa) | 10.48 | 10.46 | 9.86 |
| EB (%) | 608 | 573 | 580 |
| Compression set (%) | 19 | 20 | 20 |
| Heat buildup ($^0$C) | 18 | 14 | 17 |
| Abrasion loss ($mm^3$) | 113 | 83 | 88 |
| Hardness (Shore A) | 60 | 58 | 57 |

The compounds prepared as per the formulation shown in Table 8 were analyzed for various technological properties and are shown in Table 10. The abrasion loss was lower for dry rubber prepared from stored latex. Other technological properties were more or less identical to that of the control which showed that pretreatment does not affect the technological properties of the sheets prepared from it.

## CONCLUSION

The PRI values were considerably reduced even latex was stored for one day. This means that as soon as preservatives are added the properties were affected. The PRI values were further reduced on continuing the storage. Hence the stored latex as such is not suitable to prepare sheets. Latex when pretreated with suitable agents and stored for various periods the PRI values were retained within the limits. Also it was found that coagulation of latex was smooth up to five days and after that the coagulation should be done with a new technique. Once the stored latex was made into sheets, they were identical to the normal sheets in appearance as well as properties. It was also found that both LATZ latex and HA latex showed same behavior on pretreatment. Hence this method can be used for making sheets from stored lattices preserved with HA as well as LATZ systems. This may help the processors to convert the stored latex into sheets in case of factory lock downs due to maintenance or some other reasons or due to low latex price.

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