
**Journal of Macromolecular Science, Part A**
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597274

# Evaluation of the Properties of Natural Rubber Latex Concentrated by Creaming Method for Gamma Ray Irradiation

N. C. Dafader[a]; M. E. Haque[a]; F. Akhtar[a]; M. U. Ahmad[b]; M. Utama[c]
[a] Nuclear Chemistry Division, Institute of Nuclear Science & Technology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh [b] Department of Chemistry, Jahangirnagar University, Dhaka, Savar, Bangladesh [c] Center for the Application of Isotope & Radiation, Jakarta, BATAN, Indonesia

**To cite this Article** Dafader, N. C. , Haque, M. E. , Akhtar, F. , Ahmad, M. U. and Utama, M.(1996) 'Evaluation of the Properties of Natural Rubber Latex Concentrated by Creaming Method for Gamma Ray Irradiation', Journal of Macromolecular Science, Part A, 33: 1, 73 — 81

**To link to this Article: DOI:** 10.1080/10601329608020361

**URL:** http://dx.doi.org/10.1080/10601329608020361

MACROMOLECULAR REPORTS, A33(SUPPL. 2), 73-81 (1996)

# EVALUATION OF THE PROPERTIES OF NATURAL RUBBER LATEX CONCENTRATED BY CREAMING METHOD FOR GAMMA RAY IRRADIATION

N. C. Dafader[1], M. E. Haque[1#], F. Akhtar[1], M. U. Ahmad[2] and M. Utama[3]

[1]*Nuclear Chemistry Division, Institute of Nuclear Science & Technology, Bangladesh Atomic Energy Commission, G.P.O. Box 3787, Dhaka, Bangladesh*
[2]*Department of Chemistry, Jahangirnagar University, Savar, Dhaka, Bangladesh*
[3]*Center for the Application of Isotope & Radiation, BATAN, Jakarta, Indonesia*



## ABSTRACT

Field latex from Bangladesh was concentrated by creaming method. The effects of concentration of creaming agent, concentration of preservative, standing time and temperature on creaming were studied in order to determine the optimum condition for creaming. The physico-chemical properties of the creamed latex were compared to the requirements of ASTM. The tensile properties of irradiated centrifuged latex and creamed latex films were compared. The irradiated creamed latex film exhibits almost similar tensile properties to those of the centrifuged latex film.

# *Author for correspondence*

## INTRODUCTION

Natural rubber latices are produced by a large number of countries but Malaysia dominates with about 75% share. Bangladesh produces about 10,000 metric tons of field latex annually[1]. In Bangladesh, sheets of dry rubber (smoke sheet) are made from field latex for various types of usage.

Latex, as it comes from the tree, has dry rubber content of 20-45%, the average being about 30%. The latex is concentrated in order to increase the rubber content to around 60% and to improve the economy of transportation. The concentrated latex also possesses more uniform quality than does the ordinary field latex. Concentrated latex is needed for producing 'dipped goods' such as hand gloves, balloons, contraceptives etc. The dipped goods cover about 60% of all natural rubber latex usage. Furthermore, many important latex processes such as foaming require a raw material of concentrated latex up to 60% rubber content. Three principal methods of latex concentration are in commercial use, namely, evaporation, creaming and centrifugation. In creaming method, a creaming agent is added into the latex to accelerate the tendency of the natural rubber latex to cream.



Now a days radiation vulcanization of natural rubber latex is being carried out both for research and practical purposes[2-6]. Usually centrifuged latex is used for this purpose. In this paper various aspects of concentrating the field latex by creaming method are described. The suitability of the creamed latex for radiation vulcanization was found out by comparing the tensile properties of radiation vulcanized creamed latex film with those of centrifuged one.

## EXPERIMENTAL

The latex was collected from Satgaon rubber garden of Bangladesh Forest Industries Development Corporation (BFIDC), Sylhet zone. Collected latex was preserved with aqueous ammonia. The clone of the latex is GG and the year of plantation of the rubber trees is 1984.

Sodium alginate, purified, Fisher Scientific Company, USA, was used as creaming agent. Lauric acid, pure, LOBA Cheme PVT. Ltd., India, was used to prepare ammonium laurate. Other chemicals used for analysis were of AnalaR grade, BDH, England.

200 mL of field latex was taken in a beaker to which creaming agent was added drop by drop and stirred for one hour. It was transferred to a separating funnel and allowed to stand for layer separation. Total solid content (TSC), dry rubber content (DRC), alkalinity, coagulum content, volatile fatty acid number, potassium hydroxide number, sludge content, mechanical stability, density were determined by the ISO/ASTM methods.



pH was measured by digital pH meter, model PW 9409, Philips, England. Viscosity was measured by Visconic ELD.R Tokimec Inc., Japan, fitted with viscometer controller E-200, Toki Sangyo Co. Ltd., Japan. Mechanical stability was measured by Mechanical Stability Meter; model B.S. 1672:1972, Klaxon Signals Ltd., England. Centrifuged latex was obtained by using laboratory scale centrifuge machine for natural rubber latex, model SPL-100, Saito Separator Limited, Japan. Metals were determined by UV-Visible spectrophotometer, model SP8-100, Pye Unicam, England, following ASTM methods.

Samples were irradiated for 15 kGy radiation dose at the dose rate of 10 kGy/h using 1110 TBq Co-60 radiation source at room temperature. n-Butyl acrylate (5 phr) was used as the sensitizer for irradiation. Tensile properties were measured by the INSTRON Testing Instrument, model 1011, England; using dumbbell shaped test pieces of the latex films.

Latex films were prepared by pouring irradiated latex on raised rimmed glass plates and drying at room temperature. The dried films were leached in water for 24 hours. After drying in air these were heated in an oven at 70°C for one hour.

Percentage recovery of total solids was calculated using the following expression: Recovery = [{Volume of creamed latex (ml) X TSC (%) of creamed latex}/{Volume of field latex (ml) X TSC (%) of field latex}] X 100

## RESULTS AND DISCUSSION

Natural rubber latex is a dispersion of rubber particles in water. For concentration of the latex by the creaming process sodium alginate dissolved in water was used as creaming agent.



Table 1 shows the effect of the concentration of sodium alginate on the total solids content and recovery of the creamed latex. Total solids content of the creamed latex becomes maximum when the concentration of alginate is 6 phr at the temperature of 30°C and standing time of 24 hours, but the percentage recovery is not maximum at that condition. On further increase of concentration of sodium alginate, the total solids content decreases.

Ammonium laurate is usually used with ammonia as a preservative of latex for its stabilization. It is also seen that the creaming activity is enhanced to some extent by the addition of ammonium laurate. Table 2 shows the effect of concentration of ammonium laurate on creaming. With the increase of concentration of ammonium laurate the total solids content and recovery of creamed latex increase but these become almost constant when the addition of ammonium laurate reaches 0.3% or more.

Table 3 shows the effect of standing time on creaming. From the results, it is evident that the creaming process is virtually completed within 24 hours. On

## TABLE 1

**Total solids content and recovery of creamed latex at various concentrations of creaming agent.** (Temperature = 30°C, Standing time = 24 hours, TSC of the field latex = 30%).

| Concentration of creaming agent (phr) | TSC in creamed latex (%) | Recovery of total solids (%) |
|---|---|---|
| 4 | 55.21 | 52.45 |
| 5 | 60.22 | 70.26 |
| 6 | 60.24 | 75.30 |
| 7 | 59.88 | 79.84 |
| 8 | 57.37 | 81.12 |

## TABLE 2

**Total solids content and recovery of creamed latex at various concentrations of ammonium laurate.** (Concentration of creaming agent = 6 phr, Temperature = 30°C, Standing time = 24 hours, TSC of field latex = 30%).

| Concentration of ammonium laurate (%) | TSC in creamed latex (%) | Recovery of total solids (%) |
|---|---|---|
| 0.1 | 61.57 | 66.70 |
| 0.2 | 61.93 | 72.25 |
| 0.3 | 62.48 | 83.31 |
| 0.4 | 62.65 | 83.53 |
| 0.5 | 62.68 | 83.57 |

## TABLE 3

**Total solids content and recovery of creamed latex at various standing times.** (Concentration of creaming agent = 6 phr, Temperature = 30°C, Concentration of ammonium laurate = 0.3%, TSC of field latex = 30%.)

| Standing time (h) | TSC in creamed latex (%) | Recovery of total solids (%) |
|---|---|---|
| 16 | 59.39 | 69.29 |
| 24 | 62.48 | 83.31 |
| 48 | 62.30 | 83.07 |
| 72 | 62.77 | 83.69 |

**TABLE 4**

**Total solids content and recovery of creamed latex at various solid contents of field latex.** (Concentration of creaming agent = 6 phr, Concentration of ammonium laurate = 0.3%, Standing time = 24 hours, Temperature = 30°C).

| TSC of field latex (%) | TSC in creamed latex (%) | Recovery of total solids (%) |
|---|---|---|
| 20 | No sepn. of layer | -- |
| 25 | 55.95 | 55.95 |
| 30 | 62.48 | 83.31 |
| 35 | 64.10 | 73.26 |



further allowing to stand up to 72 hours, there is no change in TSC or recovery of the creamed latex.

Table 4 shows the effect of total solids content of the field latex on creaming. At low solid content (20%) of the field latex, there is no separation of the layer i.e. creaming does not occur. On increasing the total solids content of the field latex, the concentration of the creamed latex increases, the maximum recovery being 83.31% for the field latex containing 30% TSC.

Table 5 shows the effect of temperature on creaming. The results indicate that the concentration of the creamed latex increases with temperature reaching maximum at 40°C, beyond which it decreases. However, it does not exhibit any particular trend in the recovery of solid content. The physico-chemical properties of creamed latex are given in table 6. These are consistent with the ASTM specification (ASTM D 1278-84).

Tensile properties such as tensile strength, Young's modulus, elongation at break, tear strength of irradiated creamed latex and centrifuged latex are compared. The results are shown in table 7. Tensile strength, tear strength and moduli of

## TABLE 5

**Total solids content and recovery of creamed latex at various temperatures.**

(Concentration of creaming agent = 6 phr, Concentration of ammonium laurate = 0.3%, Standing time = 24 hours, TSC of field latex = 30%).

| Temperature (°C) | TSC in creamed latex (%) | Recovery of total solids (%) |
|---|---|---|
| 20 | 59.02 | 78.69 |
| 25 | 59.55 | 79.40 |
| 30 | 62.48 | 83.31 |
| 35 | 62.74 | 78.43 |
| 40 | 64.37 | 75.10 |
| 45 | 62.93 | 78.66 |
| 50 | 61.85 | 77.31 |
| 55 | 61.86 | 77.33 |



## TABLE 6

**Properties of creamed latex and ASTM requirements.**

| Properties | ASTM requirements | Creamed latex |
|---|---|---|
| TSC (%) | 64.00 (min.) | 64.37 |
| DRC (%) | 62.00 (min.) | 62.72 |
| Non-rubber (%) | 2.00 (max.) | 1.65 |
| Alkalinity (%) as $NH_3$ in aqueous phase | 1.60 (min.) for HA | 1.70 |
| Mechanical stability (s) | 650.00 (min.) | 1410.00 |
| Coagulum content (%) | 0.05 (max.) | 0.028 |
| Volatile fatty acid number | -- | 0.023 |
| Potassium hydroxide number | 0.80 (max.) | 0.54 |
| Sludge content (%) | 0.10 (max.) | 0.01 |
| Copper content (%) of total solids | 0.0008 (max.) | 0.0002 |
| Manganese content (%) of total solids | 0.0008 (max.) | 0.0003 |
| Iron content (%) of total solids | -- | 0.0011 |
| Density (g/mL) at 25°C | -- | 0.935 |
| Viscosity (mPa.s) at 25°C | -- | 55.46 |
| pH at 25°C | -- | 10.45 |
| Color on visual inspection | No pronounce blue or gray | White |
| Odor after neutralization with boric acid | No putrefactive odor | No putrefactive odor |

TABLE 7

**Comparison of tensile properties of irradiated centrifuged and creamed latex films.**

| Properties | Centrifuged latex | Creamed latex |
|---|---|---|
| Tb (MPa) | 30.94 | 29.49 |
| M 300% (MPa) | 2.30 | 2.09 |
| M 500% (MPa) | 2.99 | 2.41 |
| Eb (%) | 900.00 | 1070.00 |
| TrS (N/mm) | 33.85 | 30.06 |

Tb = Tensile strength, M 300% = Modulus at 300% elongation, M 500% = Modulus at 500% elongation, Eb = Elongation at break, TrS = Tear strength



the creamed latex are slightly lower than those of the centrifuged latex film. But elongation at break is higher for the creamed latex. It can be concluded that the tensile properties of the irradiated creamed latex film are comparable to those of the centrifuged latex film. So, creamed latex is almost equally well for radiation vulcanization.

## ACKNOWLEDGMENT

The authors acknowledge the financial support of IAEA under its project number BGD/8/009.

## REFERENCES

1. Rubber division, Bangladesh Forest Industries Development Corporation, Dhaka, Bangladesh.
2. K. Makuuchi, M. Hagiwara and T. Serizawa, *Radiat. Phys. Chem.*, **24**(2), 203 (1984).
3. K. Makuuchi, M. Hagiwara, *J. Appl. Polym. Sci.*, **29**, 965 (1984).
4. K. Makuuchi, F. Yoshii, I. Ishigaki, K. Tsushima, M. Mogi and T. Saito, *Radiat. Phys. Chem.*, **35**(1-3), 154 (1990).

5. F. Yoshii, S. Kulatunge, K. Makuuchi, *Angew Makromol. Chem.*, **205**, 107 (1993).

6. K. Makuuchi, F. Yoshii, M. Kokuzawa, S. Kulatunge and A. Thiangchanya, *Radiat. Phys. Chem.*, **42**(1-3), 237 (1993).