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CHARACTERIZATION OF NATURAL RUBBER LATEX CONCENTRATE FROM BANGLADESH

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ABSTRACT

Natural rubber field latex has been concentrated by a laboratory scale centrifuge machine to attain ISO requirements. The optimum conditions for various parameters e.g., frequency of the power source, flow rate of the latex into the machine, ring dam diameter of the separator, total solid content of the field latex, concentration of the preservative in the latex, have been established. The characteristics of latex concentrate were compared to those as required by ISO 2004: 1974.

INTRODUCTION

Natural rubber latex (NRL) is obtained from the tree Hevea brasiliensis of the Euphorbiaceae family. The tree originates from Brazil, but now a days it is most intensively cultivated in the far eastern countries like Malaysia, Indonesia and in parts of Africa. In Bangladesh the production of field latex is about ten thousand tons per year[1].

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Generally, on the average, the field latex contains about 70% water, part of which is required to be removed to concentrate the latex for wide range of application. Usually the field latex is concentrated by evaporation, creaming, centrifugation etc. Among these the centrifuge method is most popular. During centrifugation a part of the non-rubber is lost in the serum and the latex with less non-rubber is obtained. For preservation i.e. to stabilize the latex different preservatives are added.

Concentrated NRL has found application in the manufacture of dipped goods, adhesive/binders, thread, carpet/rugs, molded foams etc. Of these the dipped goods which include hand gloves, balloons, condoms, bladders, catheters/tubes etc. account for some 60% of NRL usage. The recent upsurge in glove production has given it increased importance and its overall growth rate stands around 6% per annum[2].

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The dipping industry needs a fairly high level of consistency in properties of latex concentrate as prescribed by ISO 2004: 1974[3]. In Bangladesh, the field latex is consumed for manufacturing tyres, tubes, shoe shoals etc. The present study discusses the optimum parameters for concentrating field latex to attain required values for ISO 2004.

MATERIALS AND METHODS

Equipment and chemicals

A laboratory scale centrifuge machine obtained from Saito Separator Ltd. Japan, model SPL-100 with a capacity of 5 liters was used for concentrating the latex. The machine consists of mainly two parts; separator unit having maximum 12000 rpm and the motor.

A cone type rotary viscometer, model Visconic ELDR, Tokimec Inc., Japan, connected with viscometer controller E-200, Toki Sangyo Co. Ltd., Japan was used for measurement of viscosity. A natural rubber latices mechanical stability apparatus, TO B.S. 1672:1972 from Klaxon Signal Ltd., England was used for measurement of mechanical stability. A digital pH meter model PW 9409, Philips, England was used for measurement of pH. For the determination of metals an UV- visible spectrophotometer, model SP-100, Pye Unicam, England was used. The chemicals used for analysis of field and concentrated latex were of AnalaR / GR grade from BDH, England / E. Mark, Germany.

Latex and centrifugation

Field latex was collected from the 'Ramu' rubber estate in the district of Chittagong, Bangladesh Forest Industries Development Corporation. 2 liters field latex were used each time for centrifugation. After starting the centrifuge machine, clean water was added to the separator until it comes to be discharged from the separator. After this water sealing process, as it is called, the field latex was supplied gradually and the light liquid (serum) and the heavy liquid (concentrated NRL) were collected at the respective outlet.

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Analysis and test

The total solid content[4], dry rubber content[5], alkalinity[6], mechanical stability[7], coagulum content[8], volatile fatty acid number[9], potassium hydroxide number[10], copper content[11], manganese content[12], sludge content[13] were determined in accordance with ISO methods.

Calculation of efficiency

Efficiency of the machine was calculated as follows:
Efficiency (%) = [M / (V+v) (m / 100)]100 where,
M = total solids, in gram, in output concentrated latex,
V = volume of output concentrated latex,
v = volume of serum,
m = percentage of total solids in the input field latex.

RESULTS AND DISCUSSION

The centrifuge machine was optimized in terms of various parameters, such as frequency of the power source, flow rate of field latex into the machine, percentage of total solid content (TSC) of the field latex, concentration of preservative (ammonium laurate) and ring dam diameter of the separator to get the concentrated latex. Individual parameters were varied at constant sets of the other variables to determine their ideal settings for maximum efficiency of the machine.

The number of revolution (maximum 12,000 rpm) of the separator increases to some extent with the increase in the frequency of the power source. Table 1 shows the efficiency of the machine at different frequencies of the power source keeping other parameters fixed. The maximum efficiency (89.42%) is obtained at 50 Hz although the percentage of TSC in the concentrated latex continues to increase by further increase in frequency but with concomitant loss in efficiency. Table 2 shows the dependence of TSC of the out coming concentrated latex and efficiency of the machine on the flow rate of the latex into the separator at optimum frequency of 50 Hz of the power source. The concentration of the latex as well as the efficiency of the machine increases with the decrease of the flow rate of the latex. The efficiency, however, attains a maximum value of 89.42% at the flow rate of 2 liters/h. After that, it shows a downward trend with further decrease in the flow rate.

The TSC of the field latex has significant influence on the efficiency of the machine at lower concentrations (10%-30%), efficiency change being between 0% and 89.42% but has very little effect at higher concentrations (30%-40%). It is found from figure 1 that at 10% TSC of the field latex the efficiency of the machine is 0%. But at 15% TSC of the field latex the efficiency increases suddenly (from 0% to 61.58%) and it continues to increase gradually up to about 89% and becomes almost constant after 30% concentration of input field latex. It is evident from figure 2 that at 10% TSC of the field latex no concentrated latex was obtained i.e. separation of heavy and light liquid does not come into effect at this concentration of field latex. But at 15% concentration of the field latex the TSC of the output concentrated latex is quite significant (55.42%). After that concentration TSC in the concentrated latex increases gradually with the increase of TSC in the field latex; the increase being negligible when the TSC of the field latex increases from 35% to 40%. From this figure it is also seen that the TSC in serum increases with the increase of TSC in field latex and becomes constant

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TABLE 1

Efficiency of machine and properties of the latex at various frequencies of power source.

(Latex used = 2 liters, ring dam dia. = 31.5 mm, flow rate = 2 liter/h, TSC of field latex = 30%, Ammonium laurate = 0.2 phr)

Frequency (Hz)	TSC in conc. latex (%)	TSC in serum (%)	DRC (%)	NR (%)	Efficiency (%)
40	60.29	10.05	58.65	1.64	83.73
50	61.76	9.98	60.21	1.55	89.42
60	63.29	9.60	61.79	1.50	85.63
70	64.23	9.48	62.75	1.48	82.30

phr = Per hundred rubber, DRC = Dry rubber content, NR = non-rubber

TABLE 2

Efficiency of the machine and properties of latex at various flow rate of field latex.

(Frequency = 50 Hz, Latex used = 2 liters, Ring dam dia.= 31.5 mm, TSC of field latex = 30%)

Flow rate (l/h)	TSC in conc. latex(%)	TSC in serum(%)	DRC (%)	NR (%)	Efficiency (%)
3.40	61.06	9.94	59.25	1.80	70.93
2.70	61.27	9.90	59.53	1.74	79.26
2.00	61.76	9.89	60.21	1.55	89.42
1.75	63.23	9.56	61.98	1.25	77.34
1.50	65.58	9.28	64.51	1.07	62.96

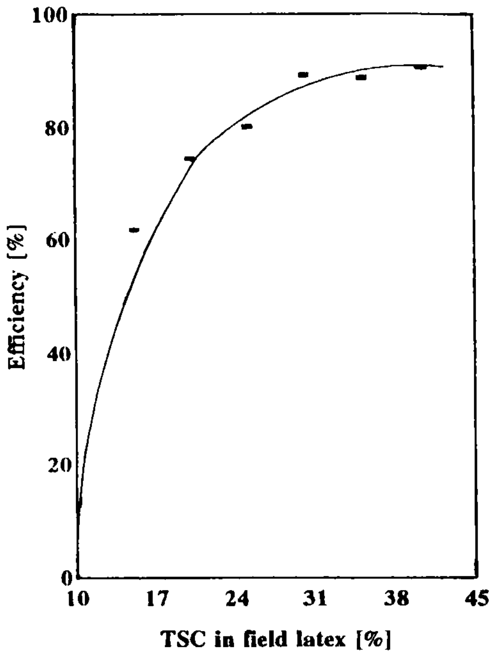

Fig. 1. Efficiency of the machine at various concentrations of field latex.

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at 25% TSC of the input latex. Less than 10% total solids drain out with the serum for every settings.

Figure 3 shows the DRC and NR in concentrated latex at various concentration of field latex. As the DRC is dependent on the TSC of the latex, same trend in DRC of concentrated latex versus TSC of field latex curve as that of the TSC of concentrated latex versus TSC of field latex curve is observed. The NR content is well below the ISO specified value (max. 2%) in every cases. Therefore, considering all the parameters especially the efficiency of the machine, the ideal input for efficient concentration would be a field latex containing 30% or more total solids.

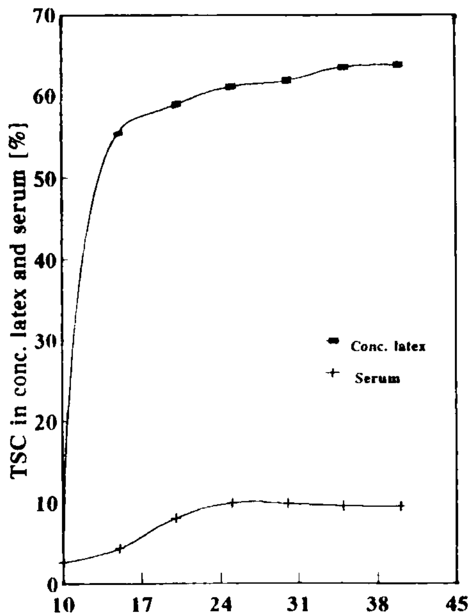

Fig. 2. TSC in concentrated latex and serum at various concentrations of field latex.

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Ammonium laurate were used as a preservative of the latex before and after centrifugation. Various quantities of ammonium laurate was used to study it effect, if any, on the efficiency of centrifugation. The results (Table 3) show that the effect is very insignificant and can be ignored.

In the separator the raw field latex is subjected to extremely strong centrifugal force by which it is to be separated into two layers consisting of the portion of light liquid and the portion of heavy liquid. The separating interface i.e. the boundary faces where the heavy liquid and the light liquid meet each other must be formed in a proper way, otherwise one liquid will enter into the other. The interface can be adjusted by changing the set of the regulating ring dam having varying inside diameter and through this adjustment, the best separation is accomplished.

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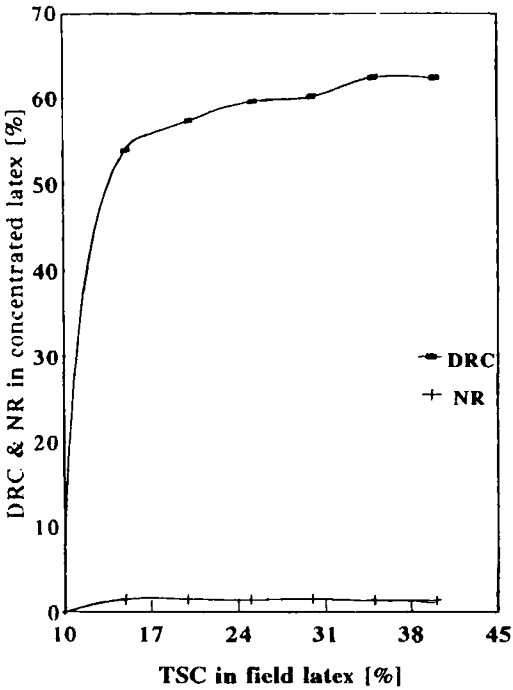

Fig. 3. DRC & NR in concentrated latex at various concentrations of field latex.

TABLE 3

Efficiency of the machine and properties of latex at various concentrations of ammonium laurate.

(TSC of field latex = 30%, Frequency = 50 Hz, Flow rate = 2 l/h, Ring dam dia. = 31.5 mm)

Conc. of ammon. laurate (phr)	TSC in conc. latex (%)	TSC in serum(%)	DRC (%)	NR (%)	Efficiency (%)
0.0	61.57	9.91	59.69	1.58	88.97
0.2	61.76	9.89	60.21	1.55	89.42
0.4	61.35	9.95	59.88	1.47	89.95
0.6	61.64	9.94	60.13	1.51	88.55

TABLE 4

Efficiency of machine and properties of latex at different ring dam diameters of the separator.

(Frequency = 50 Hz, flow rate = 2 liter/h, TSC of field latex = 30%)

Ring dam dia.(mm)	TSC in conc. latex (%)	TSC in serum (%)	DRC (%)	NR (%)	Efficiency (%)
30.50	56.05	11.58	54.30	1.75	86.79
31.00	57.38	11.30	55.56	1.82	85.93
31.50	61.76	9.89	60.21	1.55	89.42
32.00	67.10	6.53	66.24	0.86	61.94

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Table 4 shows the effect of the variation of ring dam diameter of the separator on the efficiency of the centrifuge machine with TSC of field latex = 30%, flow rate = 2 liters/h and frequency = 50 Hz of the power source, optimized earlier. The results show that the adjustment of ring dam diameter is very critical. Maximum efficiency of the machine is attained with the ring of 31.5 mm diameter and reaches 89.42%. Above and below this setting the efficiency of the machine decreases. The TSC of the concentrated latex, however, increases further with the increase of the ring dam diameter e.g., with 32.0 mm ring dam diameter it is 67.10% compare to 61.76% with ring of 31.5 mm diameter. It may be pointed out that the latex of 61.76% solid content obtained with ring dam diameter of 31.5 mm satisfy the ISO requirements.

The concentrated NRL was consequently produced under the optimum conditions of the variables established during the study i.e. frequency of power source = 50 Hz, flow rate of field latex = 2 liters/h, total solid content of field latex 30% and ring dam diameter of the separator = 31.5 mm. The concentration of ammonium laurate used as preservative was maintained at 0.20 phr. The results are shown in table 5 against the specification of ISO 2004[3] for centrifuged natural rubber latices. The alkalinity based on ammonia content indicates the latex to be of high ammonia. The data for various components of the concentrated natural rubber

TABLE 5

Analytical data for various components of centrifuged latex concentrate against ISO 2004 (1974) requirements.

Properties	ISO 2004 : 1974		Present study
	HA*	LA**	
Total solid content, min, (%)	61.50	61.50	61.76
Dry rubber content, min, (%)	60.00	60.00	60.21
Non rubber content, max, (%)	2.00	2.00	1.55
Alkalinity (wt.%), as NH_3 on latex	0.60 (min)	0.29 (min)	0.81
Mechanical stability, min, (s)	650.00	650.00	1400.00
Coagulum content, max, (%)	0.05	0.05	0.012
Volatile fatty acid number, max	0.20	0.20	0.023
Potassium hydroxide number, max	1.00	1.00	0.71
Copper content, max, (mg/kg solid)	8.00	8.00	0.45
Manganese content, max, (mg/kg solid)	8.00	8.00	1.20
Sludge content, max, (%)	0.10	0.10	0.005
Viscosity, at 10 rpm & 25°C, (mPa.s)	–	–	48.00
Color	No blue or gray		White
Odor	No putrefactive odor		No

*high ammonia, **low ammonia

latex of present study fully comply with ISO requirements. The present sample exhibited high mechanical stability and this may be due to high alkalinity.

CONCLUSION

The optimum parameters for the concentration of natural rubber field latex to attain ISO 2004 : 1974 requirement with a laboratory scale centrifuge machine have been established. Preliminary results for the production of various dipped goods with the concentrated latex prepared during this study are encouraging.

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5. ISO 126 (Dry rubber content)
6. ISO 125 (Alkalinity as ammonia)
7. ISO 35 (Mechanical stability)
8. ISO 706 (Coagulum content)
9. ISO 506 (Volatile fatty acid number)
10. ISO 127 (Potassium hydroxide number)
11. ISO / R 1654(Copper content)
12. ISO 1655 (Manganese content)
13. ISO 2005 (Sludge content)

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