

EFFECT OF ACID COAGULATION LEVEL ON THE PLASTICITY RETENTION INDEX (PRI) OF NATURAL RUBBER

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Abstract

Investigation into the effect of different acids used for coagulation of Natural rubber latex on PRI were carried out. Different concentrations of Formic, Acetic and Citric (lemon) acids were prepared and used to coagulate natural rubber latex. The coagulum were milled and dried. The plasticity retention index (PRI) test was carried out. From the results obtained. Citric acid coagulated samples have the highest PRI values. In addition, the type and concentration of the acids also have a remarked effect on the PRI values of the natural rubber samples. It is recommended that acetic acid from lemon juice should be used as an alternative coagulating acid, this is as a result of its ability to give higher PRI values; as an agricultural tree, it is a renewable resource and can equally create a source of employment opportunities for local farmers.

Introduction

Natural rubber latex is a gummy substance isolated from the white fluid of the Rubber tree, *Hevea brasiliensis*. It is a natural hydrocarbon polymer of 2-methy 1, 3- butadien (isoprene) and contain one double bond per repeat unit (Blackley.1988). The latex is a suspension of tiny particles of rubber in water, it consist of 35% rubber, 60% water. 5% resin; fatty acids, proteins and other substances. To get rid of the high water content, acids (usually formic acid) is added which makes the emulsion to coagulate- separating water from the solids (coagulum). The solid is used to prepared different forms of natural rubber grades which are further used for some specific manufacturing applications.

Natural rubber has long been recognized as a major raw material for the production of various consumer rubber goods such as automobile tires and tubes, latex dipped goods like surgical gloves and hoses just to mention a few. Several works have been carried out on *Hevea brasiliensis* and its latex in other to have good quality latex; better product development and good service life performances (UNIDO;1989). The attainment of all these characteristic lies on the raw material. If the raw material is of inferior quality or the processing method and procedures are had, such better characteristics will be difficult to attain and bearing in mind that the performance of any product to a great extent depends on the raw material, (Okieimen and Akinlabi, 2002). Since the raw material determines the properties expected of the product, its therefore imperative to study how to improve the quality of the product.

Plasticity Retention Index (PRI) is a measure of the resistance of raw Natural rubber to oxidation (Baker, 1980). The PRI test has been used to control the quality of rubber, it has proved of value in raising the quality of the rubber. PRI is high for good grades, indicating low oxidizability. It gives an indication of the relative rates of breakdown of rubber in mixing and mastication at relatively high temperatures e.g. 150⁰C where oxidation makes an appreciable contribution to breakdown. (Allen, 1983).

At the same initial viscosities, a rubber with high PRI value shows less rapid decrease in viscosity than rubber of low PRI values (Brydson, 1987). He further reported that resultant

vulcanisate compound viscosity will therefore be higher for the PRI rubber and this, other things being equal, will be reflected in improved vulcanisate properties e.g. higher tensile strength, higher resilience and lower heat buildup.

Materials and Method

Materials

Natural rubber latex (*Hevea brasiliensis*) was obtained from Rubber Research institute of Nigeria, Iyanomo, Benin-city. The chemicals (acids) used were laboratory grades and as specified by the Standard African Rubber (SAR) Manual, (SAR, 1998). Lemon (citric acid) was sourced locally from Uneme village, Edo State.

Method

The field latex used was preserved with ammonia, 300ml of the preserved natural rubber latex was measured with a measuring cylinder and poured into a coagulation vessel. The acids formic, acetic and citric (Lemon) acids were diluted to concentrations of 0.02, 0.05, 0.10, 0.15, 0.20, 0.25 and 0.30 moles respectively. The diluted acids were used in the coagulation of the different samples. The coagulum was milled and smoked dry, during drying they lose their white colour and took on the dark amber shade characteristics of smoked sheets (Cheong, 1980).

Initial Plasticity (P₀) - SAR 008 of 1998 procedure for determining and calculating the initial plasticity of natural rubber was used.

Plasticity Retention Index(PRI)-: The same procedure for initial plasticity (P₀) as described in SAR 008 of 1998 was adopted. But before compression, the sample was first aged in an oven chamber at 140°C for 30 minutes. The result was recorded (P₃₀). The plasticity relation index (PRI) was calculated using the expression.

$$PRI = (P_{30}/P_0) 100$$

Where P₀ is the initial plasticity of the unaged test piece.

P₃₀ is the plasticity of the aged test piece sample after ageing for 30 minutes at 140°C.

Results

Table 1. Showing Initial (P₀) and Aged (P₃₀) Plasticity's for the Different acid Coagulations

S/No	Acid Conc. (M)	Formic acid		Acetic acid		Citric (Lemon) acid	
		P ₀	P ₃₀	P ₀	P ₃₀	P ₀	P ₃₀
1	0.02	49	38	48	38	_____	_____
2	0.05	42	27	43	29	_____	_____
3	0.10	36	19	35	19	46	30
4	0.15	34	17	32	16	44	34
5	0.20	30	14	29	14	43	35
6	0.25	29	13	28	13	41	35
7	0.30	28	12	26	11	40	36

Table 2: PRI Values from Different acid Coagulant

S/No.	Acid conc. (M)	Formic Acid	Acetic Acid	Lemon (Citric)
1	0.02	77	79	—
2	0.05	64	68	—
3	0.10	52	54	66
4	0.15	50	50	77
5	0.20	46	48	81
6	0.25	44	46	85
7	0.30	42	42	90

Discussion

From the result obtained, the study has shown that acids at different concentration levels have remarked effect on the Plasticity Retention Index of natural rubber. The formic and acetic acids which are the most commonly used acids for coagulation shows a tremendous reduction of PRI values as the concentration increases, however, the reverse is the case for citric (lemon) acid; rather the PRI values increases as the acid concentration increases.

In the table1, the P_0 values of the three acids also shows a decrease as the acid concentration increases, the same effect is notice for the P_{30} (aged plasticity) except for the citric (lemon) acid where there is an increase in the P_{30} values as the material is aged, this phenomenon is in contrast with the P_{30} of the other two acids. It shows that ageing increase the P_{30} value of citric (lemon) acid coagulated natural rubber sample. The initial lower concentration of 0.02 and 0.05 moles were unable to coagulate the latex. This can be explained as a result of the weak nature of the acid at those concentrations levels.

The importance of this study cannot be overemphasized, as stated earlier, several researches and author's have enumerated the effect of PRI on vulcanisate properties. Derek; 1983 stated that PRI also correlates with oven ageing and reversion properties of the vulcanisate when the crosslinking system is of the conventional type. (high sulphur/low accelerator combination). He further reported that aging and reversion can affect heart build-up performance, which is a desirable property on the sidewalls of automobile tires.

Conclusion

The result of this study and the analysis made from it show that acids used for coagulation should be controlled to ascertain a predetermined level and concentration to be used for coagulating purposes. Also acetic acid should also be popularized instead of the usual formic acid, since it gives a fairly higher PRI values than formic acid. Equally lemon fruits containing citric acid is of value in increasing the PRI of natural Rubber. It shows that it offers a certain resistant to oxidative ageing, hence the increase in the P_{30} values. Lemon tree is an agricultural tree widely available in our villages, its effects on the PRI value is a course for concern in the positive direction, it's a renewable resource and can serve as a revenue earner.

This study provides the producers and consumers of raw rubber products (TSR, RSS and Crumbs) the need to use citric acid as a commercial coagulate as a result of it positive effect on the Plasticity Retention index. It is recommended that acetic acid from lemon juice should be used as an alternative coagulating acid, this is as a result of its ability to give higher PRI values; as an agricultural tree, it is a renewable resource and can equally create a source of employment opportunities for local farmers.

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