THE MANUFACTURE OF CONSTANT VISCOSITY NATURAL RUBBER FROM CLONES PRODUCING HIGH VISCOSITY RUBBERS

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SUMMARY

A cheap and simple method has been devised to reduce the viscosity of CV rubber produced from hard rubber latices. Results obtained both on raw rubber properties and technological properties, show that CV 50 rubber of satisfactory quality could be produced from high viscosity rubber, by using Renacit VII as peptiser, and hydroxylamine neutral sulphate as viscosity stabilising agent, at the required concentrations.

Economic considerations among other factors influence the selection of natural rubber (NR) or synthetic rubber (SR) for the manufacture of rubber products. Such selection is based not only on the market price of the rubber alone, but also on the total cost to the consumer on equivalent practical processing terms or on marketable end use properties. Synthetic rubber producers have paid special attention to the rigid control of specifications and viscosity limits.

When comparing the processing of NR and SR from the receiving room to the Banbury mixer it is clear that a number of additional steps are required in the case of NR. The most critical and energy consuming steps of these is the reduction of the high Mooney viscosity of NR by multiple passes through a Banbury, or a plasticator for optimum processability. This adds to the cost of the material and affects the economics of its use.

The spontaneous and irreversible increase in the viscosity of the crude NR is an important physico-chemical change which occurs during manufacture and subsequent storage of this product. This is often termed 'storage hardening' and its unpredictable rate of change renders it impossible to include Mooney viscosity in the normal technical specification scheme for NR. It has been suggested that the distribution of aldehyde groups along the cis 1, 4 polyisoprene chain is responsible for this storage hardening. Based on this, it has been possible to develop methods to manufacture natural rubber with predetermined viscosity, which would remain unaltered even after prolonged storage; such forms of rubber with stabilised viscosity are called viscosity stabilised or CV rubbers and when this rubber is used in industry the factory flow lines become similar to those for synthetic rubbers, except the hot room treatment. The viscosity of NR can be stabilised by the use of hydroxylamine hydrochloride which blocks the aldehyde and ketone groups present in the rubbery chain.

Owing to this special quality of the low viscosity CV rubbers the premastication process can be almost completely eliminated thereby effecting a cost reduction in its use. This makes CV rubbers a premium grade in the market and generally a premium is paid for this grade of rubber. The world production of the SMR 5 CV grade has increased from 12.6% of the total production in 1977 to about 25% of the total production in 1980. Consumer preference for this grade of rubber over others obviously depends on the saving of power in their flow lines and the increased output due to ease of handling.

In the commercial production of Technically Specified Rubber (TSR), it is necessary to blend clonal latices to achieve the homogenity of the product. In the Mawanella area where the only latex based block rubber factory in Sri Lanka is situated, nearly 80% of the rubber areas are planted with clone PB 86, which produces a high Mooney viscosity rubber. Such latex cannot be used for the production of low viscosity rubber, because the CV rubber manufactured from such latices will have a high Mooney viscosity in the region of CV 60 to CV 65 with a final Mooney viscosity ranging from 60 to 70 Mooney units. These Mooney viscosities are too high to eliminate the pre-mastication step in the manufacturing industries and hence they have a low demand. The trials carried out with the bulked latex at Mawanella have shown that the viscosity of the best grade of CV rubber that can be made there varies between 60 and 70; therefore, the proposal to manufacture CV rubbers at Mawanella factory was abandoned.

It was important therefore to devise a cheap and simple alternative way to reduce the viscosity of the CV rubber produced from hard rubber latices. An attempt was made to use the common peptising agents in the manufacture of CV rubber with low viscosity. TSR crumbs are usually dried at temperatures above 100°C, hence the peptiser used in the process should be active at this drying temperature. Further, the PRI requirement for this form of block rubber should not be less than 60 units; therefore precautions were taken in the process to maintain a high PRI. In order to comply with all these requirements, the peptising agent Renacit VII (pentachlorothiophenol) was used at concentration of 0·0074% by weight of dry rubber.

PROCEDURE

Mixed clonal field latex (2250 l) with a DRC of 27·65 preserved with ammonia and boric acid were placed in a coagulating tank after passing through a 40 mesh sieve. A 5% solution of sodium metabisulphite was added to the latex, bringing its concentration to 0·04% by weight of dry rubber in latex, which was continuously stirred during the process. A solution of 924 g of hydroxyl amine neutral sulphate (HNS) in 22·5 *l* of water was then added so that the final concentration of HNS in the latex was 0·15% by weight of dry rubber. Then the desired amount of Renacit VII was added as a 10% emulsion mixed in 10 *l* of water so that the final Renacit VII content in the rubber is between ·003% and ·015% by weight. The 10% Renacit VII emulsion was prepared by ball milling 10 g of the compound with 900 ml of water and 1g of Dispersol LR for about 8 hr continuously. The latex was finally coagulated with 2% formic acid kept overnight and processed in the usual way as for other grades of latex based block rubber. Drying was done in a unidryer for 4 hr at 100°C.

The white spotless dry crumbs were then pressed into bales of standard size and 33⅓ kg weight. 200 g samples were drawn from the diagonally opposite edges of each bale produced and these were blended together. The following tests were carried out and the results were compared with the control samples prepared similarly, but without adding Renácit VII:

(1) Normal TSR tests for block rubbers to check whether they conform to SLR 5 requirements.
(2) Accelerated storage hardening test to check the storage hardening behaviour using the B.S. test method.
(3) Raw Mooney viscosity using the Mooney viscometer (V_R)
(4) Tensile properties using tensometer
(5) Relaxed modulus at 100% elongation
(6) Curing characteristics using the Monsanto Rheometer
(7) Stress relaxation test
(8) Hardness using Wallace Deadload Hardness Tester
(9) Resilience using Lupke Impact Resiliometer.

Table 1. *Raw rubber properties*

Property *% Hydroxylamine neutral sulphate* (HNS)						*SMR CV*
% Renacit VII	0	0·15	0·15	0·15	0·15	0·15
	0	0	0·0037	0·0074	0·0146	0
Dirt (% wt)	0·022	0·024	0·025	0·029	0·029	·025
Volatile matter (% wt)	0·15	0·18	0·14	0·16	0·16	0·40
Wallace plasticity (Po)	38	32	32	30	25	32
Plasticity Retention Index (PRI)	75	68	68	66	60	82
Ash (% wt)	0·26	0·27	0·28	0·30	0·30	0·26
Nitrogen (% wt)	0·38	0·40	0·40	0·40	0·40	0·40
Mooney viscosity (ML 1 + 4 at 100°C)	66	60	54	49	40.5	63
Accelerated storage Hardening (Δ P)	22	5	3	2	2	3

RESULTS AND DISCUSSIONS

Raw rubber properties

The results indicate that all the rubber produced by this method using 0·074% Renacit VII meets SLR 5 requirements. However when the Renacit VII content is higher than 0·074% the rubber is too soft and sticky and does not meet the specifications of CV 50 rubber as given in Table 1 specially with respect to PRI. So the optimum concentration of Renacit VII to be used in this process for making SLR 5 CV rubber is 0·0074% by weight of dry rubber. The rubber thus obtained is viscosity stabilized.

Vulcanising characteristics

Vulcansing characteristics of each of these grades were assessed by mixing each of these samples to ACS 1 composition. The samples for tensile properties were cured at 140°C for 40 mins. Results thus obtained are given in Table 2.

Table 2. *The vulcanising characteristics of NR with different amounts of Renacit VII*

Property						
% Hydroxyl amine neutral sulphate (HNS).	0	0·15	0·15	0·15	0·15	SMR CV
% Renacit VII	0	0	0·0037	0·0074	0·0146	—
Tensile strength (kg/cm^2)	164	117	115	110	70	80
Elongation at break (%)	833	833	833	800	750	870
Relaxed modulus (kg/cm^2)	7·36	6·39	6·45	6·42	6·30	6·8
Lupke impact resilience	64	56	57	58	60	60
Hardness (IRHD)	36	32	32	32	32	32
Scorch time (min)	3·5	7·5	6·5	6·75	7·25	7·0
Cure time (min)	51	67	63	54	53	55

From these results it is clear that Renacit VII at 0.0074% concentration has no significant effect on the physical properties such as elongation at break, hardness, resilience and tensile strength, compared to the HNS treated sample. But at higher concentrations there is a marked drop in the tensile properties and relaxed modulus due to the effect of, HNS and Renacit VII. Cure times obtained from the Monsanto Rheographs indicate fast curing behaviour associated with the Renacit VII incorporated samples. Scorch time for the treated samples are higher resulting in higher processing safety. The stress relaxation curves of these samples (Fig. 1) indicate that the Renacit VII added at 0.0074% by weight on dry rubber slightly improves the ageing properties of the rubber while maintaining the viscosity within the permitted limits for CV 50. Results obtained both on raw rubber properties and technological properties show that CV 50 rubber of satisfactory quality could be produced from high viscosity rubber by using Renacit VII as a peptiser at about 0.0074% concentration and hydroxylamine neutral sulphate at 0.15% concentration as viscosity stabilising agent. However care should be taken to ensure that these chemi cals are added at the required concentrations.

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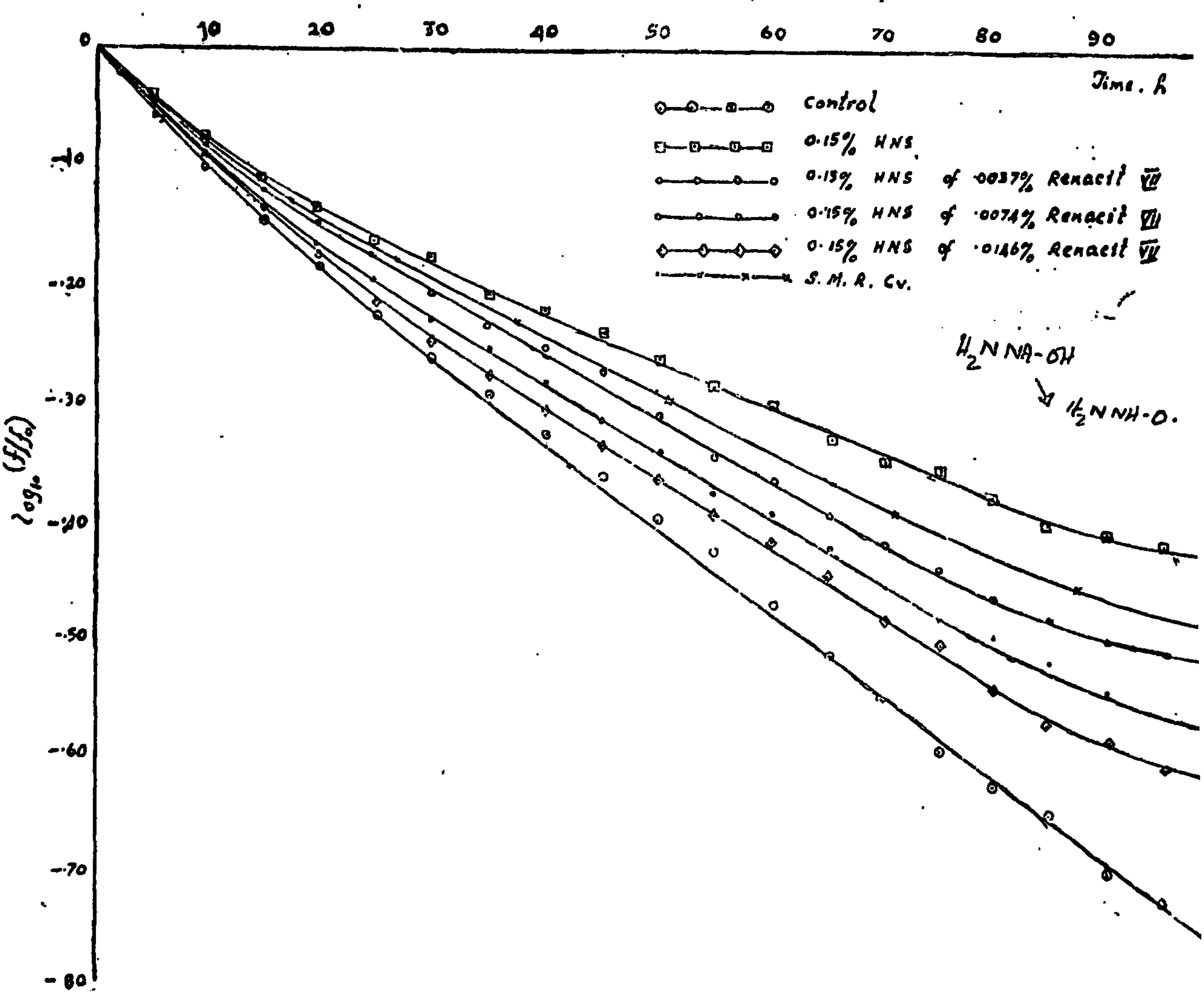

Fig. 1. Stress Relaxation Curves

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