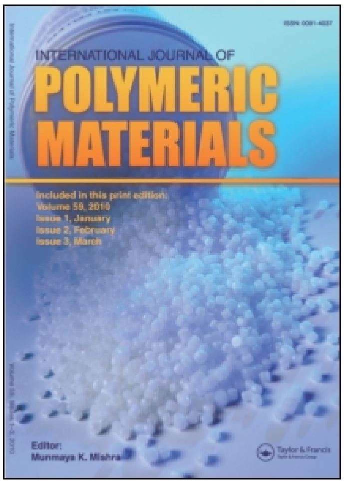

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Modification of Polychloroprene with Polyvinylchloride

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Polychloroprene (neoprene) has been blended with polyvinylchloride (PVC) in different proportions using a new stabiliser system (magnesium oxide and zinc oxide with stearic acid) for PVC. The physical properties of the blends show that they can advantageously replace neoprene in many applications.

INTRODUCTION

Polymer blends help optimise the cost and performance of polymers by combining the useful properties of the constituent components. Extensive research is going on to study the compatibility of different polymers and hence their ability to form blends. Neoprene and PVC are likely to be compatible[1] to form blends for practical applications. One difficulty in developing successful blends between these two polymers is the lack of suitable stabilisers for PVC which do not affect neoprene. However, it has recently been shown that magnesium oxide and zinc oxide combination used for vulcanising neoprene can itself be used for stabilising PVC along with a common lubricant, stearic acid.[2] So in the present study neoprene was blended with PVC upto 40% and the performance of the blend studied in comparison with that of pure neoprene. Magnesium oxide and zinc oxide combination was used to vulcanise the neoprene phase and also to stabilise the PVC phase.

EXPERIMENTAL

Different combinations of neoprene and PVC were mixed in a Brabender plasticorder model PL3s in presence of other ingredients. The ingredients used were: neoprene (Mooney Viscosity (ML1+4, 100°C)-42), PVC resin (powder, suspension polymer, K value—65), magnesium oxide (light magnesia, rubber grade), zinc oxide (white seal, rubber grade), stearic acid (rubber grade) and ethylene thiourea (NA_{22}, rubber grade).

Neoprene requires 4.0 phr MgO and 5.0 phr ZnO for efficient vulcanisation.[3] The same combination with 2–3 phr of stearic acid is found to be very effective for stabilising PVC also.[2] Ethylene thiourea is an efficient accelerator for vulcanisation at the level of 0.5 phr of neoprene.[3] Considering these factors the following formulation was used in this study:

Neoprene and PVC	Polymers, different combinations
MgO	4.0 phr total polymer
ZnO	5.0 phr total polymer
Stearic acid	3.0 phr total polymer
Ethylene thiourea	0.5 phr neoprene polymer.

The ingredients were mixed in the Brabender plasticorder using a roller mixer type 30 employing a motor speed of 30 rpm at a temperature of 110±2°C for six minutes. All the ingredients except the accelerator were added initially and the accelerator was added only after 4 minutes to prevent premature vulcanisation. The cure time of the various compounds were determined at 150°C in a Monsanto rheometer model R100. The optimum cure times are shown in Table I. Test samples for evaluating the various physical properties of the blends were vulcanised upto the respective cure times at 150°C. The tensile properties of the various samples were determined in a Zwick universal testing machine as per ASTM D412 (1968). The ageing characteristics of the vulcanisates were determined by keeping the samples at 100°C for 96 hours in an ageing oven and measuring the retention in tensile properties.

The ozone resistance was determined according to ASTM D1171 (1968). Shore-A type durometer was used for determining the hardness of the vulcanisates as per ASTM 2240 (1968). The swelling index was determined in ASTM reference oil No. 3 as per ASTM 471 (1983).

RESULTS AND DISCUSSION

Figure 1 shows the variation of tensile strength with PVC content. It is observed that presence of PVC upto 30% improves the tensile strength of neoprene. This is expected since PVC has better tensile strength than neoprene.[4] However, the tensile strength of the vulcanisates are found to be lower than that of neoprene at higher loadings of PVC which may be due to the poor compatibility of the polymers at higher concentrations of PVC. The elongation at break (Figure 2) is also found to improve with the addition of PVC. This

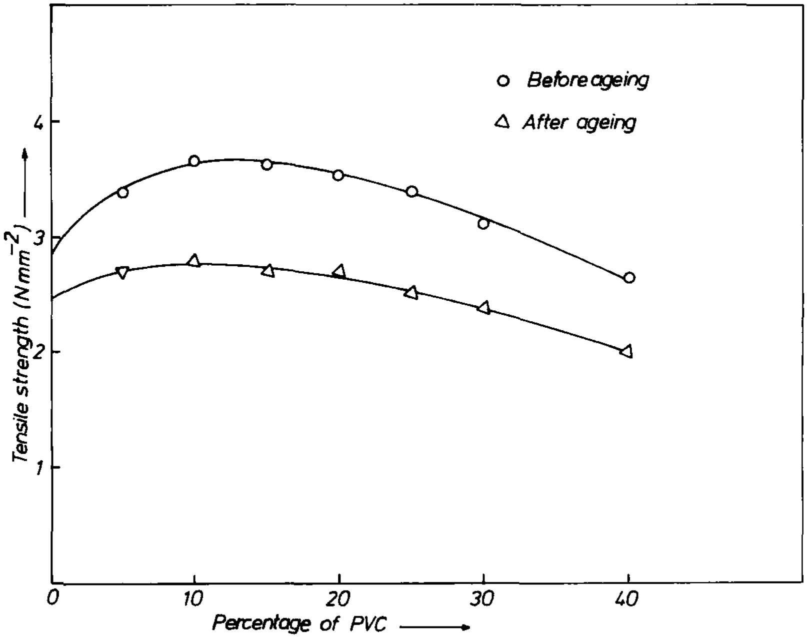

FIGURE 1 Variation of tensile strength with PVC content.

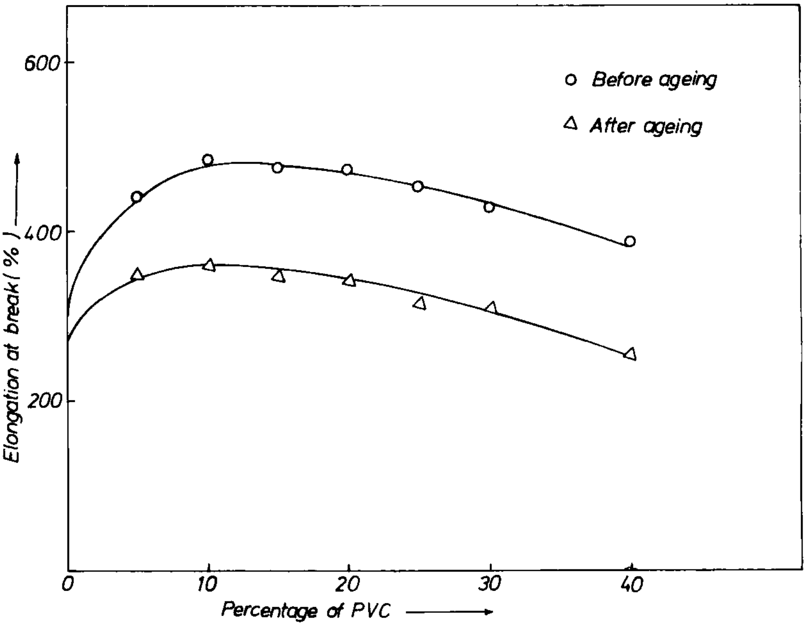

FIGURE 2 Variation of elongation at break (%) with PVC content.

behaviour seems to be abnormal, but is in agreement with the behaviour observed for NBR–PVC blends.[5] After ageing, the PVC rich vulcanisates do not seem to be capable of retaining the tensile strength and elongation at break as pure neoprene. However, the retention in these properties is found to be reasonably good for these blends for practical applications. The vulcanisates are found to get harder with increasing concentrations of PVC (Table I). This is to be expected since PVC is harder than neoprene.[4] The swelling index (Table I) is found to decrease slightly with increasing percentage of PVC as expected and is similar to the behaviour of NBR–PVC blends.[5] The ozone resistance of the samples (Table I) seems to be abnormal, since better quality retention should be observed with higher percentage of PVC, it being a saturated polymer. However the values are within reasonable limits for practical use. The deterioration in the ageing resistance may be due to the decrease in resistance to bending of the vulcanisates due to poor compatibility of neoprene and PVC at higher loadings of PVC. This

TABLE I

Variation of curetime, hardness, swelling index and ozone resistance with PVC content

PVC content	Optimum curetime (minutes)	Hardness (Shore A)	Swelling index change in wt. in 24 hrs. (%)	Ozone resistance: Quality retention in 10 hrs (%)	Ozone resistance: Quality retention in 20 hrs (%)
0	20	44.0	6.97	100	95
5	20	47.5	6.77	100	90
10	23	48.0	6.70	100	90
15	20	50.5	6.65	95	80
20	20	52.0	6.49	90	75
25	25	57.5	6.38	85	65
30	23	59.0	5.89	85	65
40	20	67.0	5.54	sample broken in 6 hrs.	—

reasoning is exemplified by the fact that a sample containing 40% PVC broke in the ozone chamber in six hours.

CONCLUSION

The present study indicates that combinations of neoprene and PVC (upto 30% of PVC) can safely replace pure neoprene in many applications where the latter is employed. The blends will be cheaper than neoprene due to the low cost of PVC resin. They can be advantageously used where a higher hardness and lower swelling index are required. The study further shows that MgO and ZnO in presence of stearic acid can act as cross-linking system for neoprene and also as stabiliser system for PVC.

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