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EFFECT OF BLEND RATIO AND CROSSLINKING SYSTEM ON THE ENGINEERING PROPERTIES OF NATURAL RUBBER - ETHYLENEVINYL ACETATE COPOLYMER BLENDS

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Abstract: **Blends of Natural rubber (NR) and ethylene-vinyl acetate (EVA), in varying proportions, were prepared with three different cure systems and evaluated for physical properties. Most of the important technological properties were better for the blends vulcanized using the mixed cure system compared with those cured with DCP. The blends showed better abrasion resistance, higher hardness, modulus and tear resistance as the proportion of EVA increased.**

1. Introduction

A large number of polymer blends have been developed during the course of the past five years in different branches of industry. At or below room temperature, elastomer blends remain in seperate phases, of which minor component forms a dispersed phase. Size and distribution of the dispersed phase depend on several factors such as mooney viscosity, density and solubility parameter of the components, rate of shear during blending and temperature. Properties of elastomer blends depend not only upon the size of the dispersed phase, but also on the extent of cure of each. It is common practice to prepare and use of blends of two or three elastomers so as to achieve desired processing characteristics and physical properties. Blends of NR and EVA are being used for many applications, such as footwear, cables, etc. A systematic study on the influence of different cure systems and blend ratio on the engineering properties of NR-EVA blends is lacking. In this paper the influence of different crosslinking systems with a view to suggest a cure system suitable for particular blend ratio which has the desired physical properties.

2.Experiment

Materials used

NR used for the study was ISNR_5 and the EVA employed was Exxon 218 having vinyl acetate content 18% by weight. All ingredients are of commercial grade.

Preparation of blends

The blends are prepared in a laboratory model intermix set at a temperature of 80 °C and a rotor speed of 60 rpm. NR was masticated for 2.0 min and blended with EVA for 2.5 min. The blends were compounded in a two roll mixing mill as per the test recipe in Table 1. Compounds which contained sulpher cure system were designed A1, B1, C1... and those of DCP as A2, B2, C2 .....etc.

Compounds which contained mixed cure system consisting of S and DCP as A3, B3, C3 ......The blends were moulded to optimum cure in a steam heated hydraulic press at 160°C. Blends with 50% or more of EVA could not be vulcanised fully with sulpher, and hence could not be evaluated for physical properties. The physical properties are evaluated according to ASTM standards.

3. Results and Discussions

Tensile strength, modulus and elongation

The changes in tensile strength, 300% modulus and elongation at break with increase in EVA content in the blend and the effect of the three different cure systems on these properties are shown in Figs. 1,2 and 3 respectively. Tensile strength of those blends which contained sulphur and mixed cure systems was maximum when the proportion of NR in the blend was in the range of 70 to 80 percent, whereas the tensile strength of the DCP cured blends increased steadily with increase in EVA content in the blend. When the proportion of the minor component in the blend is in the range of 20 to 30 per cent, it remains as dispersed particles and the bulk of the curative gets dispersed in the continuous phase. In the present case, this is more pronounced because sulpher is highly reactive with NR and not at all effective in curing EVA. This will facilitate migration of sulphur which is dispersed in the EVA phase to the NR phase during vulcanization. Thus a higher extent of crosslinking of the NR phase of the blends B to D may be the reason for the observed higher tensile values of these blends in the case of sulphur and mixed cure systems.

At higher proportions of NR in the blend, the tensile strength values were in the order: sulphur cure ⟩ mixed cure ⟩ DCP cure. This observation can be explained based on the type of crosslinks normally obtained when such systems are used. In sulphur cure with conventional dosage, the crosslinks formed are mainly polysulphidic in nature whereas, DCP cure gives carbon-carbon type crosslinks. The more flexible polysulphidic linkages facilitate higher extensions and higher tensile strength during stretching by reforming the ruptured crosslinks in preferred configurations whereas the less flexible C-C type linkages provide only lower tensile strength[1]. In the case of the mixed cure system there is a possibility that both the types of corsslinks are formed and the blends attain a higher crosslink density compared to the other cure systems. When mixed crosslinks are present, the tensile strength will be lower because of the unequal distribution of load during stretching[2]. This explains the lower tensile strength of the blends cured with the mixed cure system compared with that of the sulphur cured blends. The higher flexibility of the polysulphidic linkages is also evident from the higher elongation at break of the blends cured with the sulphur and the mixed systems compared with those containing DCP (Fig. 3).