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Utilization of *Diospyros peregrina* as a Natural Antioxidant in Radiation Vulcanized Natural Rubber Latex Film

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Abstract

A study of the effect of natural antioxidant on the aging property radiation vulcanized natural rubber latex (RVNRL) film has been done. The aqueous extract of *Diospyros peregrina* (Gab) was used as natural antioxidant. Radiation vulcanization of natural rubber latex (NRL) was done by using Co-60 gamma radiator at room temperature, using n-butyl acrylate (n-BA) as sensitizer. Various concentrations of natural antioxidant were blended with NRL just before irradiation. It was found that addition of natural antioxidant into NRL would much improve the mechanical properties of rubber film after aging at 100°C temperature for 24 hours. Decreasing in tensile strength of rubber film with 10 phr natural antioxidant and 15 kGy absorbed dose after aging was found 9.34 % compared to 13.89 % for the film having no antioxidant. The improved tear resistance of the rubber film was also found with the natural antioxidant.

Keywords: Natural rubber latex, Radiation vulcanization, Tensile strength, Tear resistance.

I. Introduction

Natural rubber decomposes when exposed to air, heat, light and oxygen. Antioxidants protect the rubber goods from attack by air, heat, light and even ozone in the atmosphere. Commercial antioxidants are generally either of the amine type or of the phenolic type such as, N-phenyl-2-napthylamine, alkylated diphenylamine, p-p-diamino-diphenylmethane. But all of these synthetic antioxidants are health hazardous organic substances. The dipped rubber goods are directly related to our health. So, use of natural antioxidant for radiation vulcanized[1, 2] natural rubber latex film is required to minimize the health hazard.

Abad *et al.*[3] worked with some non-water soluble amino acids such as, cystine, tyrosine, alanine, phenyl alanine as an antioxidant for radiation vulcanized natural rubber latex (RVNRL). Gregorvá *et al.* [4, 5] tested the thermo oxidative aging properties of natural rubber filled with carbon black containing Lignin. Lignin from wood exerts better stabilizing effect in carbon black filled natural rubber than the conventional synthetic antioxidant (IPPD). Moreover the activity of the commercial antioxidant (IPPD) can be enhanced by the addition of lignin. Rodrigues *et al.* [6] worked with cashew nut shell liquid (CNSL), a natural source of unsaturated long chain phenols, and used this as an antioxidant for synthetic cis-1,4- Poly isoprene. CNSL contains cardol, cardanol, H.cardanol, methyl cardanol, anacardic acid which caused an increase in the induction period and decreased the rate constant of thermal oxidation at 140°C. In this work, we tried to utilize the aqueous extract of *Diospyros peregrina* (Gab) as a good source of natural antioxidant for radiation vulcanized natural rubber latex film.

II. Experimental

Natural Rubber Latex (NRL)

The natural rubber field latex was collected from the Atomic Energy Research Establishment (AERE) rubber garden, Savar. Immediately after collection of NRL from rubber tree, it was preserved with ammonia solution obtained from BDH, England. NRL was concentrated to 60% total solids content (TSC) using a laboratory scale centrifuge machine model SPL-100, Saito Separator Ltd., Japan.

Irradiation of NRL

The concentrated NRL was diluted to 50% TSC by adding 1.5% dilute ammonia solution. A 5 parts per hundred rubber (phr) *n*-butyl acrylate (n-BA) obtained from Kanto Chemical Co. Inc., Japan was added dropwise to the diluted NRL as radiation vulcanization accelerator (RVA) and stirred with a magnetic stirrer for 1 hour. The RVA mixed NRL was irradiated [7] by Co-60 gamma source at room temperature.

Preparation of Rubber Films

Irradiated rubber latex with varying proportion of natural antioxidant were cast on raised rimmed glass plates to make rubber films. They were leached with distilled water for 24 hours at room temperature and then air dried until transparent [8]. Then the films were dried in an oven at 70ºC for one hour.

Aging of Rubber Film

Accelerated aging of the radiation vulcanized natural rubber latex films was carried out in the thermostat aging oven at 100°C for 24 hours. The rubber films were hung on the revolving drum. Then the temperature was set to 100°C. After reaching that temperature, the hot air flow and the rotation of drum was started to promote the aging of the rubber films.

Measurement of Properties of Rubber

Dumbbell-shaped and trouser shaped test pieces of rubber film were used to measure the tensile strength (TS) and tear resistance (TR) respectively by ISO 37 -1977 (E) method [9] before and after aging at 100°C for 24 hours, using a universal testing machine (Instron, model 1101, England) interfacing with a computer.

III. Results and Discussion

The Figure 1 shows that the tensile strength of radiation vulcanized natural rubber latex (RVNRL) film increases with the increasing concentration of natural antioxidant, but the increase rate is not significant. For 0 kGy absorbed dose,

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without natural antioxidant TS is found 7.02 MPa and with 20 phr natural antioxidant TS is found about 9.07 MPa. The rubber film prepared at 15 kGy absorbed dose and with 10 phr antioxidant it shows maximum tensile strength (32.21 MPa). Further increase in radiation dose causes slightly decrease in tensile strength due to brittleness of higher cross linking polymer.

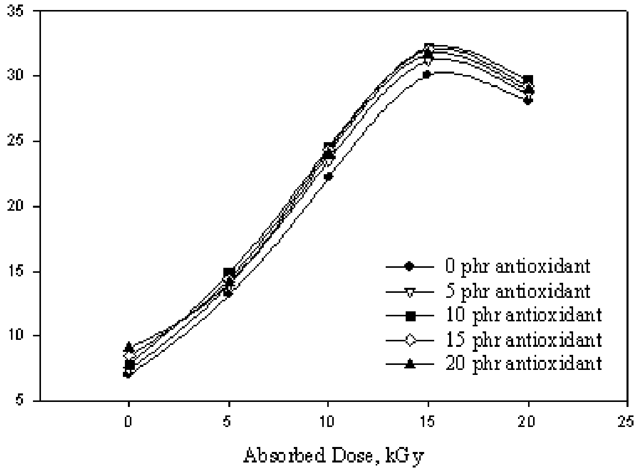

Fig. 1. Tensile strength of rubber film at different concentrations of antioxidant as a function of absorbed doses before aging.

Figure 2 shows that the effect on tensile strength of rubber film without antioxidant at various absorbed doses before and after aging at 100ºC temperature for 24 hours. After aging the tensile strength of the film prepared by without radiation and without antioxidant is reduced from 7.02 to 2.36 MPa (66.38% decreased) and for the film prepared at 15 kGy absorbed dose and without natural antioxidant it is decreased from 30.10 to 25.92 MPa (13.89% decreased).

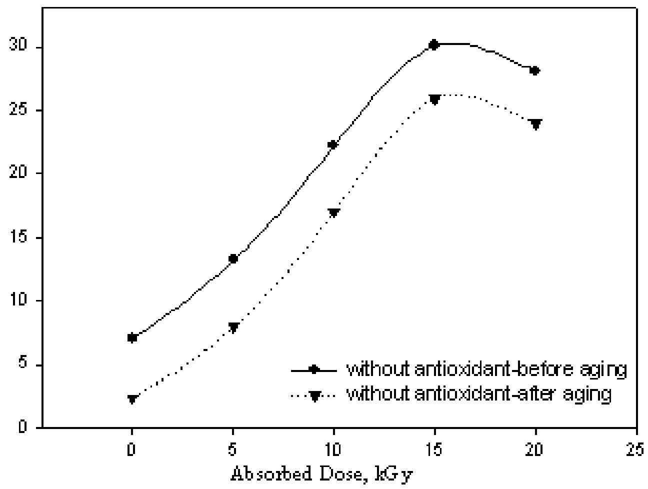

Fig. 2. Effect on tensile strength of rubber film without antioxidant at various absorbed doses before and after aging at 100ºC temperature for 24 hours.

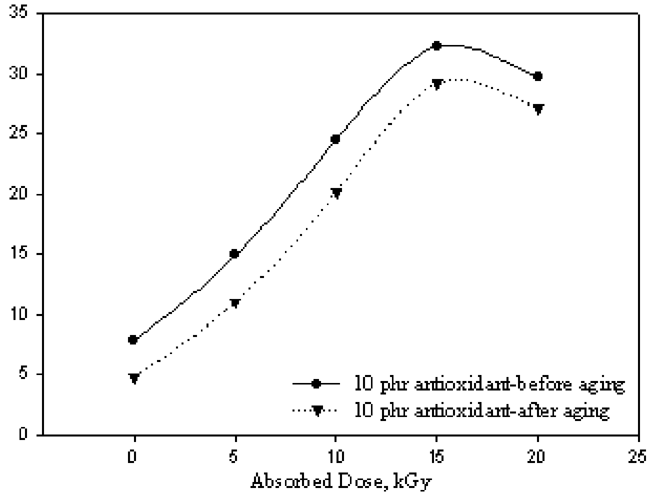

Fig. 3. Effect of antioxidant on tensile strength of rubber film at various absorbed doses before and after aging at 100ºC temperature for 24 hours.

Figure 3 shows that addition of natural antioxidant into the latex shows a better aging property of the rubber film. At 15 kGy absorbed dose and with 10 phr natural antioxidant the tensile strength is decreased from 32.21 to 29.20 MPa (9.34 % decreased).

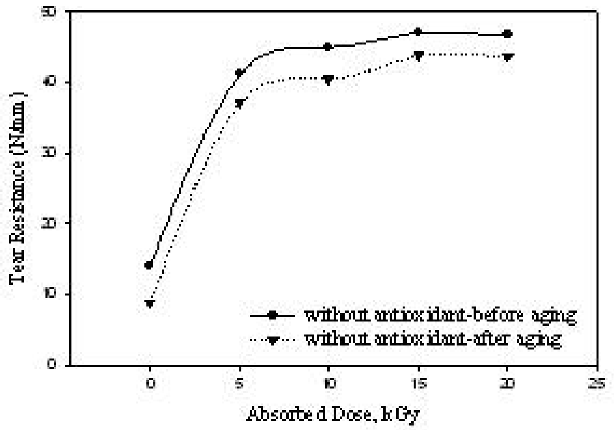

Fig. 4. Effect on tear resistance of rubber film without antioxidant at various absorbed doses before and after aging at 100ºC temperature for 24 hours.

Without natural antioxidant the tear resistance of the rubber film is decreased drastically after aging, which is shown in the Figure 4. The tear resistance of the film prepared without radiation and without natural antioxidant is reduced from 14.02 to 8.84 N/mm (36.94% decreased) and for the film prepared at 15 kGy absorbed dose and without natural antioxidant the tear resistance is decreased from 47.10 to 43.87 N/mm (6.86% decreased).

From the Figure 5 it was found that with the addition of 10 phr natural antioxidant and at 15 kGy absorbed dose the tear resistance of the rubber film was reduced after aging from 51.85 to 49.68 N/mm (only 4.19% decreased).

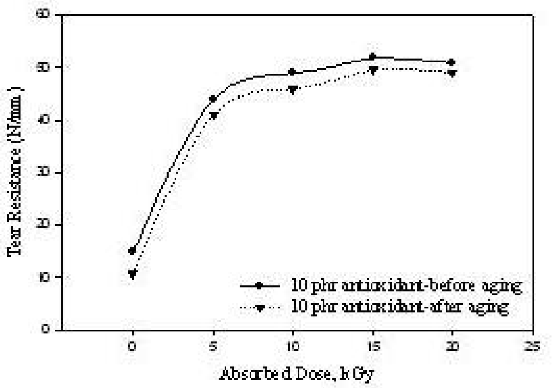

Fig. 5. Effect of antioxidant on tear resistance of rubber film at various absorbed doses before and after aging at 100ºC temperature for 24 hours.

IV. Conclusion

The mechanical properties of natural rubber latex film prepared with various concentrations of natural antioxidant and at various absorbed doses after aging have been studied. At 15 kGy absorbed dose and with 10 phr antioxidant the film showed maximum tensile strength (32.21 MPa) and at the same condition after aging the decrease in tensile strength and tear resistance of the rubber films were found 9.34 and 4.19% respectively. So, with the optimum condition the natural antioxidant can be used as a good alternative source of synthetic antioxidant for radiation vulcanized natural rubber latex film.

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