EFFECT OF ANTIOXIDANTS ON RADIATION VULCANISATION NATURAL RUBBER LATEX (RVNRL) FILM

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Abstract

This paper presents the results on the effects of different antioxidants used in Radiation Vulcanization Natural Rubber Latex (RVNRL)) films between 0 to 10 weeks monitoring. Antioxidants used for the RVNRL formulation were Aquanox LP, Irganox and Wingstay L. Color difference evaluation by using Chroma Meter CR-400 found that RVNRL film with Irganox was the most stained yellowish after 8 weeks monitoring. Tensile strength for RVNRL with Aquanox found achieved the optimum strength between 25.4 to 27.13 mPa. The scanner electron microscopic (SEM) indicated more Aquanox molecules to penetrate and interact with the rubber molecule, thus becoming more effective inhibitor against its oxidative ageing.

Keyword: RVNRL film, antioxidant, aging properties

Abstrak

Kertas kerja ini membentangkan keputusan mengenai kesan penggunaan antioksidan yang berbeza ke atas filem Getah Lateks Asli Tervulkan Penyinaran (RVNRL) di antara minggu 0 hingga minggu 10 pemantauan. Bahan antioksida yang digunakan dalam formulasi RVNRL berikut ialah Aquanox LP, Irganox dan Wingstyle L. Penilaian perbezaan warna menggunakan alat Chromameter CR-400 mendapati filem RVNRL dengan Irganox adalah yang lebih menyerlah warna kekuningan selepas minggu ke 8. Kekuatan regangan filem RVNRL dengan Aquanox didapati mencapai nilai optima pada kekuatan antara 25.4 hingga 27.13 mPa. Pengimbas Elektron Mikroskopik (SEM) menunjukkan lebih molekul Aquanox menembusi dan berinteraksi dengan molekul getah, membuktikan kesan perencatan terhadap oksidasi penuaan itu.

Kata kunci: filem RVNRL, antioksida, pencirian penuaan

INTRODUCTION

The aging of the RVNRL film is a result of auto oxidation reaction. The RVNRL film exhibits excellent stability, though the leached film tends to deteriorate. The radiation vulcanization contains only the naturally occurring antioxidant that is leached out in the ammonia solution during leaching (K. Makuuchi 2003). One of the reasons for the poor aging properties of the radiation vulcanization is the absence of dithiaocarbamates that function as strong antioxidants. Though the aging properties of the RVNRL films can be improved by the addition of such an antioxidant, the addition of a dithiocarbamate will negate the advantages of RVNRL film (Wan, M.W.Z et al. 1996 and L.V. Abad et al. 1996). Through this reseach, three types of antioxidants which are Irganox, Aquanox and Wingstyle were selected as the most suitable antioxidant for RVNRL. The actual effects of Irganox and Aquanox on the aging properties of the RVNRL films were examined by measuring the retention of the color changed, tensile strength, modulus strength and elongation at break of the vulcanized at 12 kGy radiation.

EXPERIMENTAL

2.1 Material

The high ammonia NR latex used in this studies was obtained from Ladang Sungai Terah. For formulation purpose, there was 1,6-hexanediol diacrytlate (HDDA) as sensitizer, Pottasium Laurate as stabilizer and Irganox 1520 (40%), Aquanox LP and Wingstay L as antioxidant agent added.

2.2 Preparation of RVNRL

The latex of 60% tsc needed to dilute to 50 – 52% tsc. It was then followed by the addition of 0.2 phr of potassium laurate and HDDA with continuous stirring. After the addition of stabilizer and sensitizer, the

stirring was continued for 3 hours before the latex was irradiated to the required dose 12 kGy using gamma-ray from Co-60 source.

2.3 RVNRL Film Preparation

The films were prepared by dipping RVNRL on a glass plate (12 x 18 cm^2). The films were left to dry until transparent through heated in an oven at 100ºC for an hour. The films needed to storage in room temperature at least 16 hours before they were cut into dumbbell shape for tensile test measurement.

2.4 Physical Properties Test

2.4.1- Total Solid Content (TSC)

TSC influence the latex compound in 2g sampling. It is reflect to the amount of purity of the latex. The amount of TSC will affect latex for tensile sample preparation during dilution process.

2.4.2 – Color Difference Test

The Chroma Meter CR-400 is a color measuring instrument. The RVNRL film color changing was monitored by using chromameter to set a benchmark for RVNRL film aging properties along 10 weeks. Color difference calculation as SAMPLE-STANDARD value as shown in Figure 1.

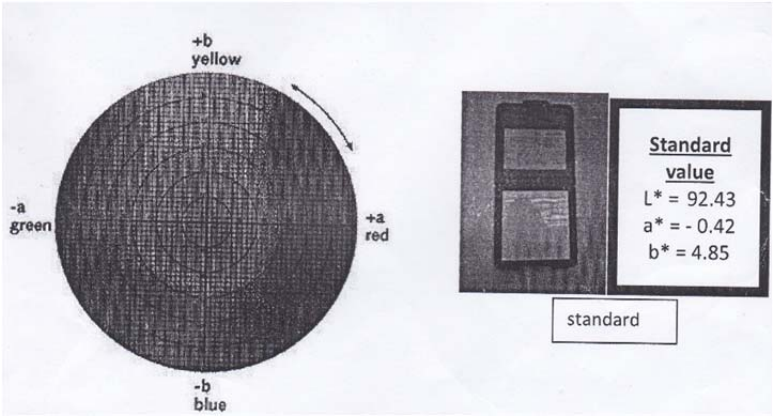

Figure 1: Diagram CIElab colour chart

2.4.3 Tensile Properties

The dumbbell shape test pieces were measure for tensile properties (tensile strength,Ts; Modulus at 500%,M500; and Modulus at 700%,M700).

2.4.4 – Morphology Test

Examination of RVNRL film surface using a scanning electron microscopic (SEM) model Fei Quanta 400. All samples were examined after sputter coating with gold to avoid electrostatic charging and poor image resolution.

RESULT AND DISCUSSION

Figure 2 shows the maturation effect between RVNRL films with difference antioxidants. The color of films found to be brighter after a storage period of 5 weeks, then decrease towards storage period of 8 weeks. Changes in the latter half are supposed to be caused by oxidation due to inadequate storage conditions. The continuous decrease due color changed at stained yellowish brown at week 5 until week 8. The NR latex can be expected becomes stables after 2 or 3 month storage (Sofian I. et al. 2009). This is termed maturation. Several complex reactions occur in the latex during the maturation period (Keizo Makuuchi & Song Chen 2012) . Delta D* detected RVNRL film with Irganox antioxidants is brighter than other films after a storage period of 6 weeks until 8 weeks.

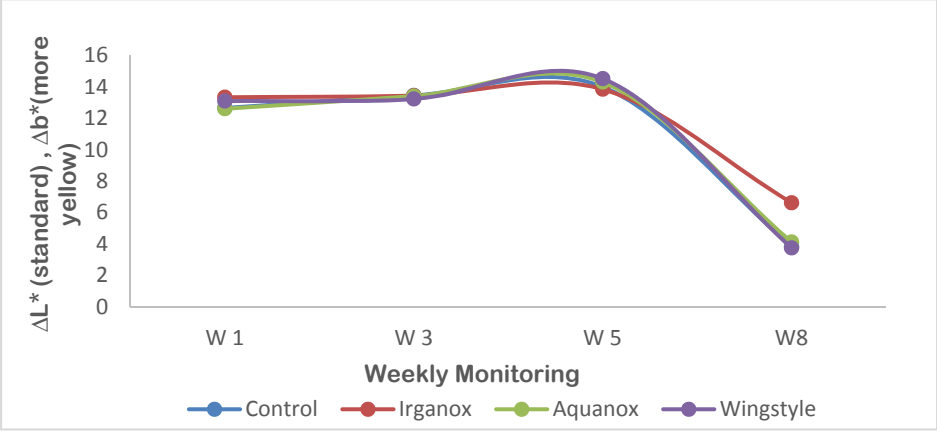

Figure 2: Chroma Meter for color measuring of RVNRL films

The effectiveness of antioxidant on the color changed of RVNRL film can be referred from SEM analysis. There were diverse reports about effective antioxidants. Attempts to find the most effective between Irganox, Aquanox and Wingstyle for the RVNRL were carried out. Figure 3 a) showed that RVNRL film control exhibit no interaction between antioxidant with the rubber molecule. RVNRL film with Irganox has less antioxidant molecules disperse into the NR latex. Antioxidant found to be effective on RVNRL films on color changes. From the Figure 3 b), it showed that Irganox has small particles was the antioxidant with less dispersion into RVNRL film. It was approved by The result of high Delta B from chroma meter . The effectiveness of the antioxidant depends on its size and dispersion into the RVNRL and its film. This observation indicates the sensitivity of antioxidant on RVNRL film. The activity of an antioxidant into RVNRL on the treatment is the coloring of the film ((K. Makuuchi 2003, Sofian I. Et al. 2009,Y. S. Rohana et al. 2012). The film is stained yellowish at higher distribution (Figure 3 c,d) of Aquanox and Wingstyle antioxidant in the RVNRL film suspected the activity of the antioxidant for the RVNRL irrespective of the dispersion conditions.

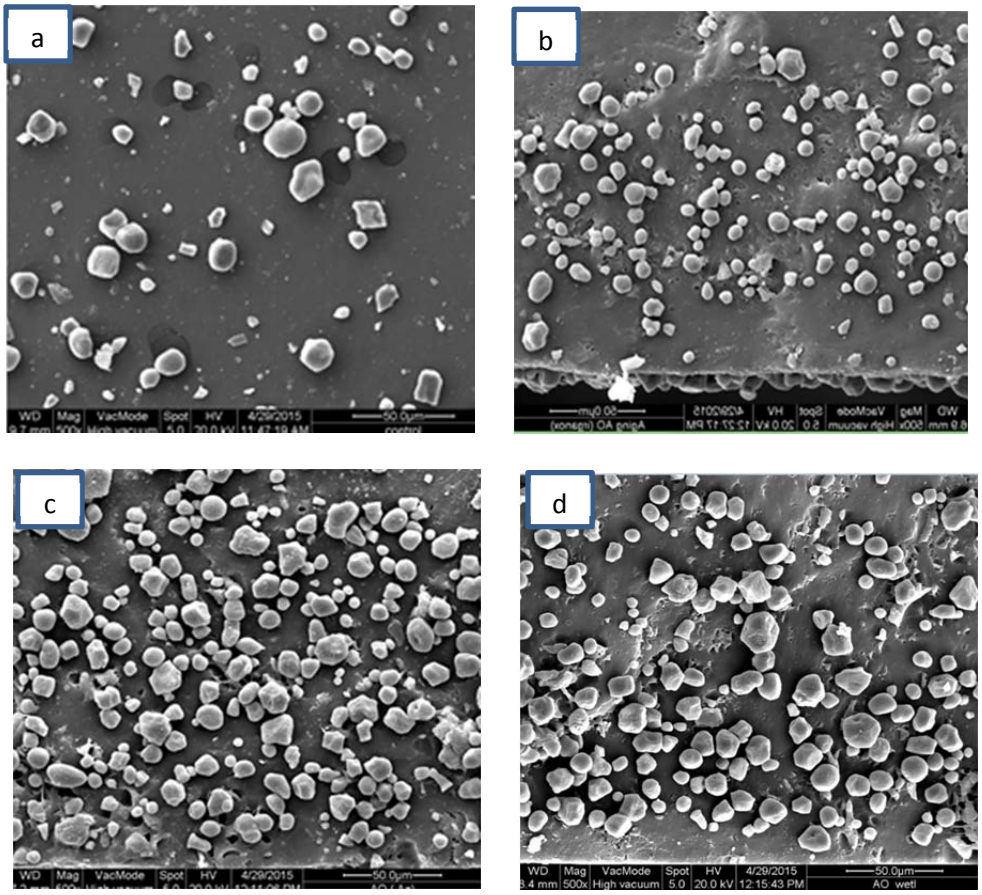

Figure 3: SEM micrographs of the RVNRL film surface with difference antioxidants a) RVNRL film

control, b) RVNRL film with Irganox, c) RVNRL film with Aquanox and d) RVNRL film with Wingstyle

The aging properties of NR is the phenomenon of degradation of the crosslinked structure and is dependent on the degree of crosslinking. Figure 3 shows the changes in tensile strength of RVNRL films without antioxidant and RVNRL films between Irganox, Aquanox and Wingstyle antioxidant. Clearly, the RVNRL film with Aquanox exhibits excellent stability between 25.24 mPa to 27.24 mPa compared to antioxidant Irganox and Wingstyle. On the other hand, the tensile strength of RVNRL film control decreased very rapidly. A similar trend of tensile strength for Wingstyle to Aquanox from storage period week 1 to week 8. The same dispersion and distribution characteristics for both Aquanox and Wingstyle from SEM analysis (Figure 3 c and d) could support to stability of RVNRL film tensile strength. This indicate that Aquanox and Wingstyle have a polar end –COOH and –NH2 on one end and a non-polar –CH on the other end. This hydrophobic property could easily penetrate and interact with the rubber molecule, thus becoming a more effective inhibitor against its oxidative aging (L.V. Abad et al. 1996, S. Ramli et al. 2012).

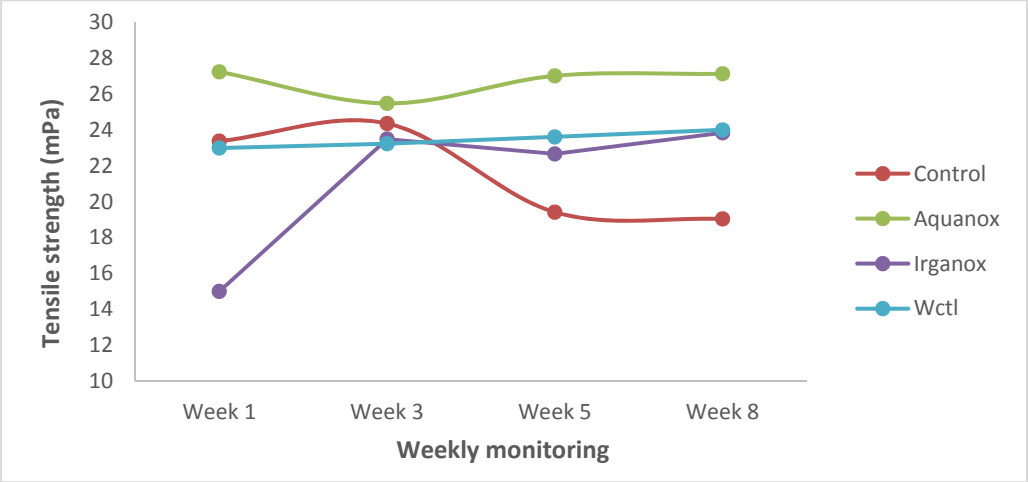

Figure 4: Tensile strength of RVNRL film at different antioxidant

Oxidation deterioration was significant in the RVNRL film even in addition several types of antioxidants. The tensile of the RVNRL film with Aquanox remarkable the most constant at higher level tensile strength within storage period 8 weeks. Table 1 showed the correlation of tensile strength, modulus properties

and elongation at break for RVNRL film with difference antioxidant after storage period 8 weeks. A similar to tensile strength, RVNRL film for control showed the weakness for all tensile, modulus and elongation at break properties. However, the improvement of the tensile strength, modulus properties and elongation at break was recognized with antioxidant addition. The result exhibit there are no much significant different on elongation at break properties between Irganox, Aquanox and Wingstyle antioxidant.

Table 1: Tensile and Modulus Properties RVNRL Film with difference antioxidants after storage period at week 8

Sample RVNRL Film with antioxidant	Tensile strength (mPa)	M500 (mPa)	M700 (mPa)	Elongation at break (%)
Control	19.03	1.28	4.01	850
Irganox	23.84	1.84	6.63	1100
Aquanox	27.13	2.05	7.72	1150
Wingstyle	24	1.88	6.40	1000

The activity of antioxidant found to retard thermal oxidative degradation (K. Makuuchi 2003 and Warneke et al. 2007) was evaluated by the chroma meter test tensile strength and modulus properties of the vulcanization RVNRL film. This suggests that the RVNRL film or latex products protected by antioxidant can be kept for a longer period between 8 to 10 weeks, if there are stored under dry conditions.

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CONCLUSION

RVNRL film with antioxidant can be a treatment retard the oxidation deterioration. SEM analysis showed that Aquanox and Wingstyle could easily penetrate and interaction with the rubber molecule. The RVNRL film with Aquanox exhibits excellent tensile strength and modulus properties stability within storage period 8 weeks. Irganox found as retardant the stained yellowish color changed for RVNRL film.

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