

Effect of vulcanizing and antioxidant systems on aged tensile properties of MicrOptic gloves

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Introduction

MicrOptic glove is a powder free surgical glove which is made out from the natural rubber latex. Thin nature of MicrOptic glove facilitate exceptional dexterity and tactile sensitivity and at the same time outstanding strength and barrier protection (Ansell Medical GBU, 2014). Aged tensile properties of the glove cannot be maintained in a stable level due to the thin nature of the glove. Natural rubber vulcanizates can be given adequate heat-aging resistance by a suitable choice of vulcanization and by using ammine or phenolic antioxidants (Morton, 2010). The study was conducted to disclose the effect of vulcanizing system, antioxidant system and their combined effect on aged tensile properties of MicrOptic glove.

Materials and Methodology

The study was carried out centralizing to Ansell Lanka (Pvt) Ltd, EPZ - Biyagama. Aged tensile test was done at Quality Control (QA) laboratory at Ansell Lanka (Pvt) Ltd. Nine trials with different treatments were conducted during this study. 0.5 pphr elementary sulphur(V1), 0.25 pphr elementary sulphur with 0.5 pphr sulphur donor compound (V2) and 0.25 pphr elementary sulphur with 1.0 pphr sulphur donor compound (V3) were utilized as three different vulcanizing systems in MicrOptic formula. 1.5 pphr primary antioxidant (A1), 1.0 pphr primary antioxidant with 0.25 pphr secondary antioxidant (A2) and 1.0 pphr primary antioxidant with 0.5 pphr secondary antioxidant (A3) were utilized as three different antioxidant systems in MicrOptic formula.

All the dispersions of vulcanizing agents and antioxidants were made by using laboratory scale ball mill. Nine glove compounds with three replicates were produced according to MicrOptic glove formula except the vulcanizing agent and antioxidant system. Vulcanizing agents and antioxidant were added according to the treatment combinations. The compounded latex was kept for 36 hours to obtain optimum degree of crosslinks. 65 - 75 % toluene swelling index (TSI) was used as optimum degree of crosslinks. Sample gloves are made under laboratory conditions. Clean former was heated up to 65 °C by using an oven and then former was dipped in a MicrOptic glove coagulant solution at 65 °C with constant time of 22 seconds. Coagulant solution was dried by using an oven and heated up to 55 °C. Then former was dipped in latex solution with constant time of 23 seconds and bead of the glove made by manually. After that gloves were leached in hot water (70 °C) for 2 minute. Finally, formers with gloves were cured at 120 °C for 35 minutes.

Aged tensile properties (ATP) such as force at break (FB), elongation at break (EB) and 500 % modulus (MOD) were measured according to the BS EN 455-2:2000 standards. Factor factorial in complete randomized design was conducted and data obtained from aged tensile properties were subjected to analysis of variance (ANOVA) using the general linear model procedure of

MINITAB 16. Significant means of treatments were separated using the least significant difference (LSD) ($P < 0.05$) test.

Results and Discussion

The study revealed that the effect of vulcanizing system on force at break, elongation at break and 500 % modulus were significant ($p < 0.05$). Also combine effect of vulcanizing system and antioxidant system on force at break, elongation at break and 500 % modulus were significant ($p < 0.05$). Further, this study disclosed, the effect of antioxidant system on elongation at break was significant ($p < 0.05$). However, effect of antioxidant system on force at break and 500 % modulus were not significant at 5% significant level.

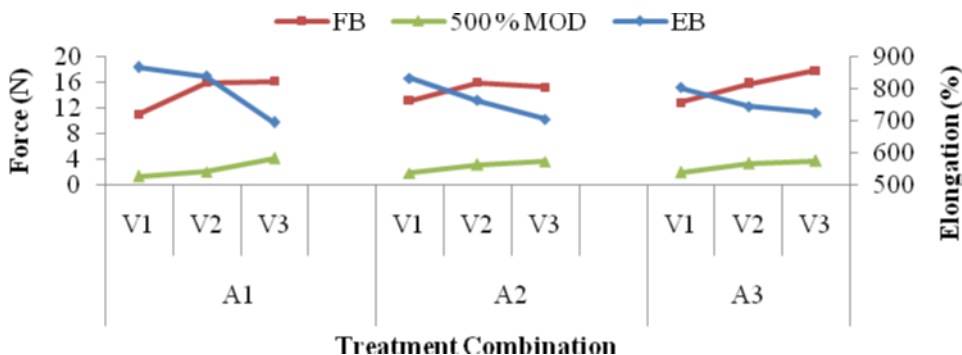


Figure 01: Effect of Vulcanizing Systems on ATP under different Antioxidant Systems

All the antioxidant systems show gradual recession of elongation at break, when increasing the amount of sulphur donor content while reducing elementary sulphur content in MicrOptic formula. But, the elongation values were significantly different for different vulcanizing systems separately in all antioxidant systems. Also, all the antioxidant systems (except A2 antioxidant system) showed gradual development of force at break, when increasing the amount of sulphur donor content while reducing elementary sulphur content in MicrOptic formula. Further, all the antioxidant systems show gradually development of 500 % modulus, when increasing amount of sulphur donor content while reducing elementary sulphur content in MicrOptic formula.

According to Subramaniam (2002), elementary sulphur is more prone to produce poly-sulphide crosslinks among rubber molecules. Further, higher number of poly-sulphide crosslinks contribute to increase stretching ability of the vulcanizate. Lesser amount of elementary sulphur cause to reduce number of poly-sulphide crosslinks and it abates stretching ability of the glove and lesser force is required to stretch the vulcanizate. Also, Morton (2010), showed that the amount of cyclic sulphur and the excessive sulphur in the crosslinks contribute to the poor aging properties of the vulcanizate.

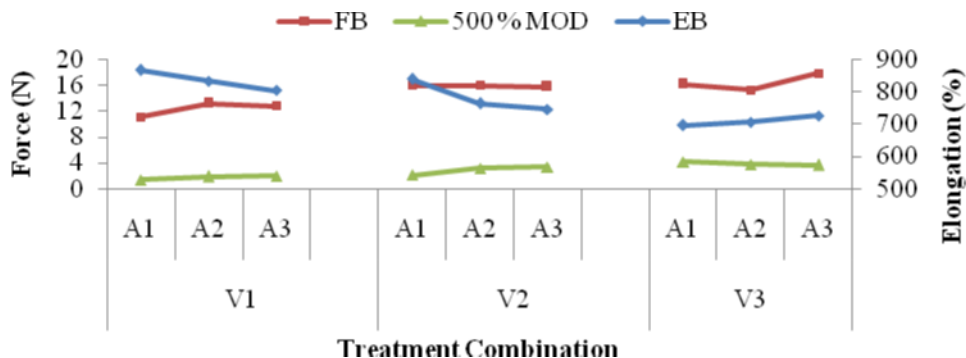


Figure 02: Effect of Antioxidant Systems on ATP under different Vulcanizing Systems

V1 and V2 vulcanizing systems showed gradual recession of elongation at break, when increasing the amount of secondary antioxidant content while reducing the primary antioxidant content in MicrOptic formula. But, the V3 vulcanizing system showed development of elongation at break, when increasing the amount of secondary antioxidant content while reducing the primary antioxidant content in MicrOptic formula. Also, V2 and V3 vulcanizing systems showed development of force at break, when increasing the amount of secondary antioxidant content while reducing the primary antioxidant content in MicrOptic formula. Further, V1 and V2 vulcanizing systems showed development of 500 % modulus, when increasing amount of secondary antioxidant content while reducing primary antioxidant content in MicrOptic formula. But, the V3 vulcanizing system shows recession of 500 % modulus, when increasing the amount of secondary antioxidant content while reducing the primary antioxidant content in MicrOptic formula.

According to Brydson (1988), polyphenolic antioxidants are bound with the rubber molecules and a heavy network is produced compared to hindered phenolic antioxidants. Inducing a heavy network nature among the rubber molecules was reduced the stretching ability of the vulcanizate. According to Subramaniam (2002), the simple hindered phenolic antioxidants do not show particularly good heat resistance and equivalent molecular weight are more volatile than the polyphenolic antioxidants. He also presented that higher molecular weight and less volatile polyphenols show better antioxidant properties compare to simple hindered phenols.

Conclusions

The study revealed that the possibility of improving aged tensile properties of MicrOptic glove manufactured using only elementary sulphur and primary antioxidant by combining elementary sulphur with sulphur donor compound as the vulcanizing system and primary antioxidant with secondary antioxidant as the antioxidant system.

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