MECHANICAL PROPERTIES AND THERMOGRAVIMETRIC ANALYSIS OF PEROXIDE PREVULCANIZED NATURAL RUBBER LATEX INDUCED BY CO-60 γ RADIATION

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ABSTRACT

To enhance the crosslinking of prevulcanized natural rubber latex, combination of irradiation and peroxide vulcanizations were used. Thru this method, hexanediol diacrylate (HDDA) from irradiation vulcanization acted as the main sensitizer, while cumene hydroperoxide (CHPO) from peroxide vulcanization will act as the co-sensitizer. The effects of irradiation doses on the mechanical properties of latex film were investigated. 16 kGy irradiation dose, 2.5 parts perhundred rubber (pphr) of HDDA, 0.1 pphr of CHPO and 2.5 phr of Aquanox LP antioxidant were found to be the optimum conditions for compounding formulation. The rubber film obtained had tensile strength, modulus at 500% and modulus at 700% of 27.7, 3.5 and 12.4 MPa respectively, which is more than 21% increment compared to control film. Besides, the crosslink percentage of the rubber film showed 7 % increment from 90.7% to 97.7%.

INTRODUCTION

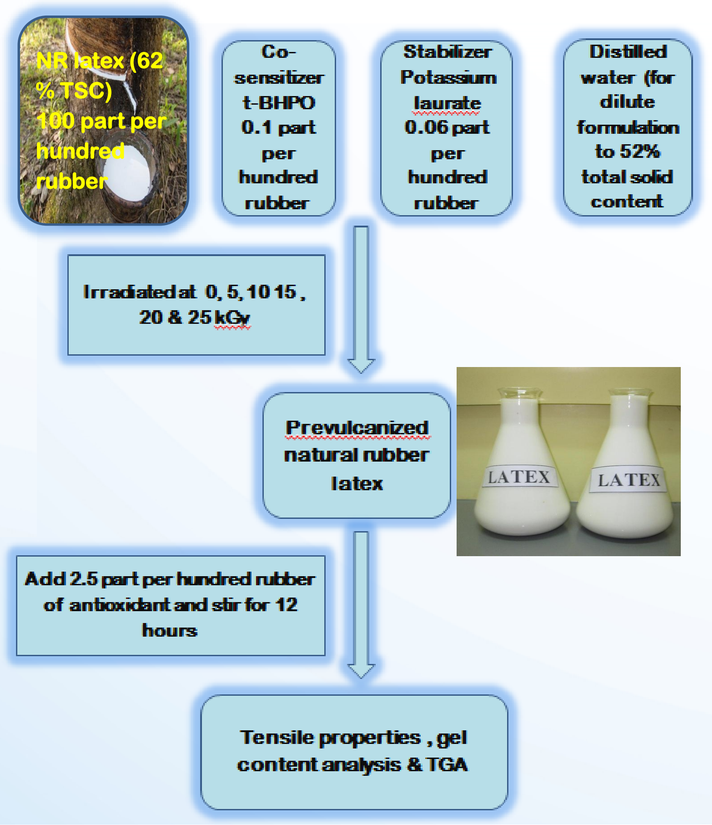
The peroxide vulcanization of natural rubber latex (NRL) was introduced by the Malaysian Rubber Board (MRB) since the early 1990s. Alike the Radiation Pre-vulcanized Natural Rubber Latex (RVNRL) that was introduced by the Malaysian Nuclear Agency, peroxide vulcanization also produced low tensile strength latex. This makes it unsuitable to be use in the production of premium latex products such as surgical glove and etc. Moreover, there are some cases where the use of activators in peroxide vulcanization tends to produced NRL film with darken color during the drying process [Roslim *et al.*, 2015].

Based on our previous study, the activators in peroxide vulcanization are no longer needed when using gamma radiation [Sofian *et al.*, 2018]. For this study, the optimum radiation doses for vulcanization of NRL via peroxide vulcanization system are determined based on the mechanical properties (tensile strength) of the films. This study also extended to examine the effects of radiation on crosslinking density and thermal stability of the Peroxide Prevulcanized Natural Rubber Latex (PVNRL) films.

OBJECTIVES

- **To investigate the radiation doses required to vulcanized the natural rubber latex via peroxide vulcanizations.**
- **To examine the effects of radiation on crosslinking density and thermal stability of the Peroxide Prevulcanized Natural Rubber Latex (PVNRL) films.**

EXPERIMENTAL



RESULTS

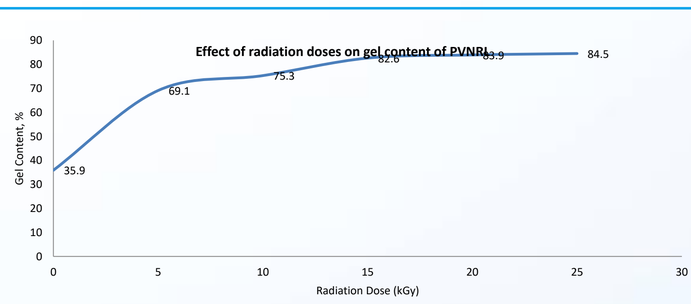
Radiolysis of NR	$RH \rightsquigarrow RH\cdot + H\cdot$	(1)
Radiolysis of water	$H_2O \rightsquigarrow H\cdot, OH\cdot, e^-$	(2)
Hydrogen abstraction	$RH + OH\cdot \longrightarrow R\cdot + H_2O$	(3)
Decomposition of peroxide	$B \rightsquigarrow 2B\cdot$	(4)
Hydrogen abstraction from polymer	$B\cdot + RH \longrightarrow BH + R\cdot$	(5)
Termination	$R\cdot + R\cdot \longrightarrow R\text{-}R$	(6)

Mechanism for decomposition of peroxide by radiation

Sample	Radiation dose (kGy)	Modulus @ 500% (MPa)	Modulus @ 700% (MPa)	Tensile strength (MPa)
PVNRL (Control)	0	0.31	1.52	3.1
PVNRL	5	0.83	2.85	12.4
PVNRL	10	0.97	3.19	17.5
PVNRL	15	1.51	4.54	19.0
PVNRL	20	1.35	4.28	20.0
PVNRL	25	2.23	5.06	21.7

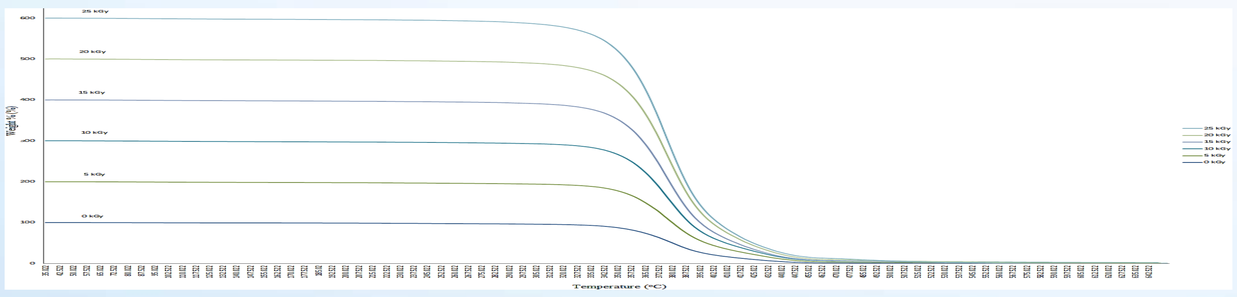
Tensile strength

Tensile strength, modulus at 500 % and modulus @ 700 % of the films increase continuously with increasing radiation dose. The rubber film obtained from radiation at 25 kGy had a tensile strength, modulus at 500 % and modulus @ 700 % of 21.7, 2.23 and 5.06 MPa respectively; which is more than six times increment compared to control.



Gel content

the extent of gel formation increases with the increasing of radiation dose, indicating increases in crosslink density of the polymer. At 25 kGy of radiation dose, PVNRL film produced 84.5 % crosslink percentage compared to the control sample at; 35.9 %.



TGA thermograms for PVNRL prepared at various radiation doses

The thermograms clearly show a less steep gradient for the entire PVNRL sample that was prepared from 5 to 25 kGy compared to the control (0 kGy). These results were attributed to an enhancement of the C-C crosslink density of PVNRL as consequence of the dose effect; whereas increasing of the C-C bond density also increase the thermal stability of the latex.

CONCLUSION

- **Radiation of latex formulations based on 0.1 pphr of tert-butyl hydroperoxide (*t*-BHPO) and 0.06 pphr of potassium laurate as stabilizer at various radiation doses showed the increment of the tensile strength as the increasing of radiation doses.**
- **At radiation dose of 25 kGy, rubber film with tensile strength of 20.7 MPa and crosslink percentage of 84.5 % has been successfully produced**

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