TITLE : Radiation Vulcanization of Natural Rubber Latex (RVNRL): A Potential Material for Nuclear Power Plant Gloves

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ABSTRACT

Radiation vulcanization of natural rubber latex has great potential for the production of nuclear power plant gloves due to its low ash and mineral content. And this is in-line with the role played by Malaysian Nuclear Agency as Technical Supporting Organization for Nuclear Power Program. This paper discussed the evaluation done to determine ash content in RVNRL and SVNRL films. Both samples were prepared using casting technique and the properties were compared. Films prepared from raw latex without any vulcanizing agent were regarded as a control.

Key words : ash content, RVNRL, SVNRL, nuclear power plant gloves

ABSTRAK

Lateks getah asli prapemvulkanan sinaran mempunyai potensi dalam menghasilkan sarung tangan kegunaan loji janakuasa nuclear memandangkan ia mempunyai kandungan abu dan mineral yang lebih rendah. Ini adalah sejajar dengan peranan yang dimainkan oleh Nuklear Malaysia sebagai institusi sokongan teknikal terhadap program kuasa nuclear. Kertas kerja ini membincangkan tentang penilaian dilakukan ke atas filem RVNRL dan SVNRL untuk menentukan peratus kandungan abu. Kedua jenis sampel disediakan dengan menggunakan teknik acuan (casting) dan sifat fizikal dan mekanikal dikaji. Filem lateks mentah disediakan sebagai sampel kawalan.

Katakunci : kandungan abu, RVNRL, SVNRL, Sarung tangan kegunaan loji kuasa nuclear.

1.0 INTRODUCTION

Radiation Vulcanization of Natural Rubber Latex (RVNRL) has several advantages over the conventional vulcanization with sulfur such as less or absence of toxicity, free from nitrosamines and accelerator induced allergies, low in cytotoxicity and cleaner process. Research and development work on RVNRL has been carrying out since 1980's. Most of the work was confined to the laboratory test while a little was examined in production scale operation (R. Davendra et al., 1996).

Unique properties of RVNRL meeting the requirement to produce gloves specially made for nuclear power plant program. RVNRL is well recognized as a green material makes it an ideal material for producing radiation gloves due to the fact that requirements for gloves used for Nuclear power plant need special method for disposal purpose. Gloves made from RVNRL are very easy to degrade and very friendly to the environment especially when subjected to disposing process like incineration.

A country consuming lots of energy must reduce greenhouse gas to a certain level by a specific date to relieve global warming. When operating nuclear power plant, all the materials used in there shall be burned up. However, the process generates gases such as dioxin, carbon dioxide, methane, carbon fluoride, hydrogen carbon fluoride, nitrogen dioxide etc. Environmentally friendly gloves like RVNRL gloves not generating harmful materials when burning up because of its chemicals accelerator free.

Environmental protection is a concern for every one of us. Manufacturers of rubber products want to do as much as they can and being realistic about it. One of the best ways is to evaluate what we consume and choose those that have the least harmful effect to the environment (Lim Kwee Shyan, 2008). To see the impact of the products to the environment, let us see what materials are used to make rubber products like gloves.

The effect of natural rubber gloves on the environment is an issue peoples should not take for granted. As we all know, latex gloves are in use widely today and have been for a significant period of time. Indeed latex gloves are used in very high numbers because of the way they are manufactured. Therefore, the volume of latex gloves that are ending up in landfills is very huge. While there are no specific statistics, the fact is that a significant number of latex gloves are ending up discarded each and every hour. Latex gloves oftentimes are utilized in medical and healthcare settings, a significant volume of latex gloves are contaminated and require special disposal.

Most of us forget the importance of disposal in making a choice to use product. Every products needs to be disposed at the end of its life span. Glove being disposable, is used only once resulting in huge quantities being disposed. One of the waste disposal methods is incineration.

Incineration is the best and practical way to destroy or dispose used latex gloves. Incineration is a process of destroying waste material by burning it. This process is carried out both on small scale by individuals and on a large scale by industry. It is

recognized as a practical method of disposing of hazardous waste materials, such as biological medical waste.

In this research work, attempts were made to study the content of ash produced by the test samples. Three different samples were prepared which are raw latex, sulfur vulcanized and radiation vulcanized. For radiation vulcanized, there were three types of formulation were prepared which are RI, RII and RIII. All the samples were tested to determine ash content and the results were compared.

2.0 MATERIALS AND METHODS

2.1 PREPARATION OF SAMPLES.

RVNRL was formulated and produced according to process described by Wan Manshol et al., in RAYMINTEX plant, Malaysian Nuclear Agency. RVNRL films were prepared by casting method. Three types of RVNRL cast films were prepared which were RI (using sensitizer nBA), RII (using sensitizer HDDA) and RIII (using sensitizer nBA and HDDA).

Five types of samples were tested in this study which were sample 1 regards as control which is without vulcanized, sample 2 is prepared using sulfur vulcanized and sample 3, 4 & 5 are prepared using radiation technique.

2.2 PROCEDURE

Heat the clean empty crucible of appropriate size for about 30 minutes in the muffle furnace, maintained at 550ºC ± 25ºC, allow to cool to ambient temperature in a desiccators and weight to the nearest 0.1mg. Take a test portion of about 5g of raw rubber or 1g to 5g of compounded rubber or vulcanized, according to the mass of ash to be expected, and weight to the nearest 0.1mg. Place the weighted test portion in the crucible mounted in the hole in the heat-resistant, thermally insulating board. Heat the crucible gently with the burner in a hood for proper ventilation, taking care that the rubber does not ignite. If any material is lost due to spurting or frothing, repeat the above procedure with a new test portion.

When the rubber has decomposed to a charred mass, gradually increase the heat from the burner until the volatile decomposition products have been substantially expelled and a dry carbonaceous residue remains. Transfer the crucible and its contents to the muffle furnace, maintained at 550ºC ± 25ºC, leaving the door of the furnace slightly open to provide sufficient air to oxidize the carbon.

Continue heating until the carbon is completely oxidized and a clean ash is obtained. Remove the crucible and its contents from the furnace, allow cooling to ambient temperature in the desiccators and weighting to the nearest 0.1mg. Then heat the crucible and its contents again for about 30min in the muffle furnace, maintained at 550ºC ± 25ºC, allow to cool to ambient temperature in the desiccators and re-weight to the nearest 0.1mg. This mass shall not differ from the previous mass by more than 1mg in the case of

raw rubbers or by more than 1% relative to the amount of ash for compounds and vulcanizates. If this requirement is not fulfilled, repeat the heating, cooling and weighing procedure until the difference between two successive weightings meets this requirement.

RESULTS AND DISCUSSION

Sample reference	Ash content (%)
A – Raw latex	0.36
B – Sulfur vulcanized	1.01
C – Radiation vulcanized, RI	0.45
D – Radiation vulcanized, RII	0.40
E – Radiation vulcanized, RIII	0.44

From the table above, we could see that the highest ash content was exhibited by the sample produced using sulfur vulcanized while raw latex without any vulcanization process exhibit lowest ash content. Percentage of ash content for sulfur vulcanized is 1.01% while for raw latex is 0.36%. Sample with sulfur vulcanized produced higher ash content due to the chemical residues contains in the film sample like sulfur, zinc oxide and chemical accelerators. These chemicals are widely used as sensitizers during formulation to produce sulfur vulcanized natural rubber latex. This type of chemicals may contribute to the increasing of total percentage of ash content during combustion process and this is very harmful to the users and environment.

For the sample produced using radiation, it was found that the percentage of ash content exhibited is 152% lower when compared to sample with sulfur vulcanized. From the result we may conclude that the sample with radiation vulcanized doesn't contain any chemical residues at all which may produce high concentration of ash content after combustion process. Monomers like n-BA and HDDA added into latex during formulation process are easy to degrade and not harmful to the environment and user friendly.

It was noted that raw latex contain low ash content and this is mainly due to the composition of latex itself which is only contain latex particles and other organic substances like protein, resins, sugar, sterol glycosides and water. As we already know that organic substances inside raw latex are green material and not harmful to the environment. The presence of organic materials without any chemical residues makes raw latex easy to degrade during combustion process and friendly to the environment.

CONCLUSION

1. RVNRL produce less ash content compared to sulfur vulcanized latex. Hence, it is proved that RVNRL is safer to the users and friendly to the environment.
2. Gloves made from RVNRL are the best choice for the application in Nuclear Power Plant since it is easy to degrade during combustion process with less ash content.

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