

UNIVERSITI TEKNOLOGI MARA

**COMPARISON STUDY ON THE
MECHANICAL, THERMAL,
CHEMICAL AND OIL RESISTANCE
PROPERTIES OF HYDROXYLATED
NATURAL RUBBER, SMR L AND
EPDM**

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ABSTRACT

Hydroxylated natural rubber (HNR) prepared from natural rubber (NR) is a new sustainable elastomer with better-swelling properties. Rubber modification technologies have created new approaches based on the hydroxylation process using hydroxofomic acid to reduce the double bond. NR latex was hydroxylated in one pot solution method with in-situ performic acid at different duration times; 10, 20, 30, 40 and 50 hours of reaction. The effect of the reaction time, stirring speed, temperature and pH value of modified NR latex were discussed. The result shows the optimum condition for producing 25% of hydroxyl number with a ratio of 10:1:1 during the reaction time at 40 hours. The observations also revealed from the synthesis the best performance was recorded when the stirring speed was 300 rpm, the temperature at 2°C and pH value to be 9. The determination of Total Solid Content (TSC) and Dry Rubber Content (DRC) of hydroxylated NR was studied and the average percentage of TSC and DRC decreased with increasing the different reaction times. Fourier Transform (FT) Raman spectroscopy was used to analyze the conversion of hydroxylation. The result shows the double bond's optimum conversions to hydroxyl functionality were recorded highest at 40 hours and remained constant, although the reaction was continued until 50 hours. Based on NMR characterization, the hydroxyl contents of the in situ hydroxylated natural rubber (HNR) were about 25% to 30 mol %. On the other hand, the onset of modified natural rubber's thermal degradation was recorded at 220°C compared to the unmodified natural rubber. HNR exhibited a shorter cure time due to the accelerator used is N-cyclohexylbenzothiazole-2-sulphenamide (CBS), compared to the SMR L and EPDM. EPDM gave the shortest scorch time, and optimum cure rate since used tetramethylthiuram disulphide (TMTD) as an accelerator. For both HNR and SMR L samples, it shows that SMR L has the highest hardness value. However, the tensile strength of HNR vulcanizate was drastically decreased compared to SMR L and EPDM compounded rubber. It has been reported the SMR L has a greater amount of gel content compared to HNR. Different compounded rubber's oil resistance was investigated by being immersed in two different solvent oil IRM 901 and IRM 903. HNR results in a higher swelling value than SMR L and EPDM. This is because HNR is a polar rubber; therefore, it exhibits excellent oil resistance and better crosslink density. HNR is considered to replace EPDM because it is low-cost, simple to obtain, can produce in mass manufacturing and easy to control. Finally, it can be recommended from the synthesized HNR can produce the chlorination rubber by introducing hydrochloric acid to the side reaction of HNR, which leads to rubber hydrochloride structures.

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CHAPTER ONE

INTRODUCTION

1.1 Background of Research

Over the past few years, modification of rubbers has emerged as a dynamic field of research because desirable chemical and physical properties can be achieved with modified polymers at a low cost. Chemical modification has become an important method for improving the properties of natural rubber (NR) and of widening its range of uses. NR is made from the sap of the *Hevea brasiliensis* (rubber tree). NR is known chemically as 100% cis-1,4-polyisoprene having a chemical structure, as shown in Figure 1.1. NR is widely used in various applications, from everyday items to engineering goods like rubber bearings. The industry needs high gum and tack strength, which NR provides. Samsuri A. (2002) reported these outstanding mechanical properties are due to the rubber's ability to crystallize on straining [1]. As a result, NR has a long history of success in the tyre industry, civil engineering, and latex-dipped products. However, one of NR's disadvantages is its low tolerance to oxidation, ozone and ageing resistance and its poor swelling resistance to hydrocarbon oil. These weaknesses are partly caused by the double bonds present in the rubber molecules

Since the NR main chain is unsaturated (residual double bonds), it is susceptible to oxygen, ozone, and light attack, much like other unsaturated rubbers, and compounds must be secured against these agents. The methyl group donates electrons to the double bonds, making them extremely reactive to oxidation and resulting in degradation. Since it is an autocatalytic process, the oxidation of polymer with elemental oxygen is known as auto-oxidation. It is a free radical chain reaction whose mechanism was first suggested by Bolland and Gee in 1946. Smith, Leesa M.; Aitken, Heather M.; Coote and Michelle L. (2018) studied temperature, the existence of a catalyst, and an