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RELATIONSHIP BETWEEN THE TEMPERATURE AND FREQUENCY DEPENDENCE OF THE DAMPING PROPERTIES OF NATURAL RUBBER WITH DIFFERENT EPOXIDATION LEVEL

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1 INTRODUCTION

Two common ways to control noise is either by reducing the power radiated by the source or through insulation[1]. The latter method is used widely whenever it is not practical to reduce the power of the source. This is done because the problem of air-borne noise and structure-borne vibrations has a negative influence on the human health and general quality of life [2,3]. Numerous studies have been carried out to develop new materials and technologies to improve the performance of vibration and noise control products. Nowadays, the viscoelastic materials such as rubbers have been used extensively in vibration and noise control applications. These materials provide elastic and viscous characteristic in a range of temperatures and frequencies. Important characteristics of these materials are their dynamic mechanical properties, i.e. the dynamic modulus (stiffness) and loss factor (damping). The stiffness represents the elastic nature of the materials while the damping represents the viscous nature of the materials. It is essential to evaluate the dynamic material properties because they control the ability of these materials to reduce noise and vibration levels[4].

Principally, material like rubber dissipates vibratory energy by converting it into heat energy. The internal friction between the long polymer chains that form the material is the main energy dissipation mechanism. This situation is known as 'mechanical hysteresis'[5]. The loss factor, often denoted as tan δ, is a parameter used to measure the vibration energy dissipation or damping behaviour of the materials. According to Lu and Li[6], materials with effective damping should display high loss factor in the broad temperature and frequency range. However, the loss factor is normally greatest over a narrow temperature range which is near to their glass transition temperature (Tg).

In this context, natural rubber with different epoxidation level or known as Epoxidized Natural Rubber (ENR) becomes the main focus in this study. This is an interesting alternative material to be studied instead of synthetic rubber. ENR is produced by epoxidation of natural rubber at the latex stage and is classified as a green material as it is produced from a renewable natural resource unlike synthetic rubbers which are derived from petroleum based resources[7,8]. In addition, the study would be an interesting subject as epoxidation level in the natural rubber has been reported to influence the increment in Tg[6,9].

Epoxidation is stereospecific process; which is also related to the replacements on the double bond of the polymer backbone[9]. In the case of natural rubber latex, a percentage of its double bonds react to form epoxide groups. Figure 1 shows the reaction of natural rubber (NR) latex with peracetic acid solution. In the reaction, the epoxide groups could be observed distributed randomly along the natural rubber backbone. Specific levels of ENR can be produced under right reaction conditions; acid concentrations and temperatures.

The reason for this work is because this material has been studied extensively in the tire industry[10], but its actual ability to control vibration and noise is poorly understood, particularly over a range of frequencies and temperatures. Thus, one aspect of our study is to investigate the effect of the