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RUBBER-SOLVENT INTERACTION PARAMETER ($\chi_{1,2}$) OF RUBBER BLENDS SOLUTION IN ORDER TO DETERMINE CROSSLINK CONCENTRATION OF VULCANIZED RUBBER BLENDS

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ABSTRACT

Rubber-Solvent Interaction Parameter known as 'chi' value denoted as χ is an important parameter to determine the crosslink concentration of vulcanized rubber by swelling measurement. χ value for single rubber was known but the rubber-solvent interaction parameter for rubber blends ($\chi_{1,2}$) is still unknown. The investigation covered a few selected common rubber blends used by the rubber industry which are SMR-L/SBR, SMR-L/NBR and SMR-L/EPDM in order to determine the $\chi_{1,2}$ for rubber blends. All rubbers were blend at different ratios and dissolved in toluene at different concentration. The $\chi_{1,2}$ value of each rubber blend was then determined based on intrinsic viscosity measurement. SMR-L/NBR with 50/50 blend ratios were said to have the strongest Rubber-Solvent Interaction with the highest $\chi_{1,2}$ value which is 0.4773, while the lowest value with 0.1410 obtained for 80/20 SMR-L/EPDM indicate a weaker interaction. $\chi_{1,2}$ values of rubber blend solution obtained from this experiment were used to determine the crosslink concentration of vulcanized rubber blend base on Flory-Rehner equilibrium swelling measurement. The value of crosslink concentration of vulcanized rubber blend obtained from this swelling measurement was compared against the value determined from stress-strain measurement base on Mooney-Rivlin Theory. This cross-checking is to check the accuracy and reliability of the $\chi_{1,2}$ values of rubber blends solution. Effect of crosslink concentration on tensile strength, hardness and resilience of vulcanized rubber blend were also be investigated.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

The physical properties and mechanical strength such as tensile strength, tear strength, hardness, resilience of vulcanized rubber and many others were known to be affected by crosslink concentration. Thus it is very important to determine or measure quantitatively the crosslink concentration of the vulcanized rubber.

There are two common methods to determine the crosslink concentration of vulcanized rubber network. First is by means of equilibrium swelling measurement and second by equilibrium stress-strain measurement. The swelling method was usually preferred to the stress-strain method. It was supported by the statement which the Flory-Rehner Equation in equilibrium swelling measurement that relates the effective concentration of network chains to the volume fraction of swollen polymer was widely used in the calculation of crosslinking parameters of vulcanized network. Moreover, the experimental procedures in determining the interaction parameter was usually based on the Flory-Huggins theory of rubber solution. This Flory-Huggins equation also includes the interaction parameter which depends on the intermolecular forces between the polymer and the solvent and the types and composition of the polymer.

Most polymers can be dissolved in common or specific organic solvents. This makes the study on polymer-solvent interaction is one of the most important aspects in polymer science and engineering. When polymers are dissolved in a solution, they typically expand to form spherical coils. In a dilute polymer solution it composed of polymer coils that surrounded by solvent. The hydrodynamic volume of polymer coils depends on average molecular weight and its thermodynamic interaction with the solvent. Polymer-solvent thermodynamic interaction depends upon polymer molecular structure, chemical composition, solvent molecular structure, solution concentration, and solution temperature. It is required to know their interaction parameters in common solvents in order to determine the network structure of vulcanizates for rubber blends.

Mixture of two or more rubbers in producing blends is a well-established approach in obtaining suitable materials for a specific end use. In general, polymer blending is a process of physically mixing two or more polymers to produce desired