UNIVERSITI TEKNOLOGI MARA

THE BLOOMING OF COMPOUNDING INGREDIENTS ONTO NATURAL RUBBER VULCANIZED SURFACE

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ABSTRACT

Blooming is a diffusion process whereby compounding ingredients in rubber compound migrate to the rubber surface and give problems such as poor appearance and loss of adhesion. Blooming of compounding ingredients onto un-filled vulcanized rubber surface were studied using simple weight changes. In this project, 2 types of natural rubber compounding formulations were used. The first type was the compounding ingredients, which were sulphur, paraffin wax and Zinc Diethyldithiocarbamate (ZDEC); being loaded with high loading content (10pphr) was mixed into the natural rubber individually. The second type was all these compounding ingredients were mixed together with natural rubber. All the formulations were cured using dicumyl peroxide vulcanization with 6 different dicumyl peroxide loadings. The rubber compounds were cured at 150°C and stored under different temperatures to allow the blooming process. The amount of bloom was measured by scrapping the rubber surface in function of time while the blooming rate was measured by divided the equilibrium point (where the amount of bloom do not show any increment) with square root of time. The amount of bloom and blooming rate were found to be affected by the temperature and dicumyl peroxide (DCP) loading. Blooming rate of sulphur, paraffin wax and ZDEC were increased as the loading of DCP increase. Blooming rate of sulphur and ZDEC also increase as the temperature increase except paraffin wax. Based on the results of FTIR and EDX, paraffin wax was found as the dominant compounding ingredients in blooming process. Besides that, crosslink concentration also affects the blooming rate of sulphur, paraffin wax and ZDEC. As the crosslink concentration increase, the blooming rate increase.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Rubber compounds are complex mixtures consisting of different chemical additives such as curing agents, accelerator, processing aids and activators which may be in solid and/or liquid forms. Many of these additives often blooms and diffuses to the surface during storage and service life. Blooming is a thin layer appearing on the rubber surface that occurs by a slow diffusion process. These blooms may appear in the forms of a powdery layer, a thin film layer or an oily layer. Blooms are resulted from the migration of compounding ingredient(s) to the surface from a bulk, cured or uncured rubber. Blooming in rubber may occur when partly soluble additive is used at a level in excess of its solubility at a given temperature. It is an outcome of a controlled diffusion process.

Diffusion can be defined as a movement of soluble additives driven by a distraction in the equilibrium. Solutions of the additives in rubber compound are known to act similarly to solutions of low molecular weight liquids and are characterized by the same laws as for normal solutions. When the concentration of a soluble component at the interface of a liquid is reduced, the soluble component diffuses to restore concentration equilibrium. Consequently, diffusion provides the required protection at the surface of the rubber. Additives do not bloom independent of need, but diffuses only when the surface concentration was diminished (Ignatz-Hoover, 2003). Almost all ingredients which are soluble in rubber possess the tendency to bloom.

The effects of blooming on rubber articles are sometimes adverse and sometimes beneficial. Blooming reduced the tackiness and adhesion of the bulk, which causes difficulties in production of multi-ply articles such as tyres, belts and much more. Alternatively, different surface treatments have been proposed in order to remove the weak boundary layers due to the blooming and improve the adhesion and tackiness of rubber properties, by washed off easily with water and in such cases of especially intense blooming, the surface is wet with rubber solvent wiping such as