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THE PREPARATION AND CHARACTERIZATION OF WHITE FLY ASH FILLED NATURAL RUBBER COMPOUNDS

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ABSTRACT

The preparation and characterization on natural rubber (NR) using 'Standard Malaysian Rubber' (SMR 10) grade with white fly ash (WFA) was undertaken. SMR 10 compounds were prepared by melt mixing on a two roll mill and followed by compression moulding. Carbon black (CB) and silica filled natural rubber compounds were used as a comparison. The effect of WFA with at filler loading up to 30 phr on curing characteristics, mechanical properties, hardness, swelling behavior of natural rubber compounds were studied. WFA was grinded with pulveriser and sieved to 45-75 μm. The size of CB and silica that was used is 80-90 nm and 120-150 nm. The main elemental composition (wt%) of WFA was analyzed by X-Ray flourescence (XRF) spectrometry as follows: SiO_2 (60.7%), Fe_2O_3 (14.8%), CaO (13.7%), K_2O (3.7%), P_2O_3 (1.5%) and other elements (5.6%). Both scorch and cure time were reduced whereas the maximum and minimum torque increased with the increased loading of WFA in NR. For carbon black, the scorch time and cure time was decreased with increasing filler loading whereas the scorch time of silica decreased with increasing filler loading. The tensile strength of NR increased up to 5 phr loading and then decreased with increasing WFA loading. For CB, the tensile strength was increased whereas the tensile strength for silica decrease with increasing filler loading. Elongation at break continuously decreased with increased WFA loading same as with carbon black and silica trend. As expected, the hardness and tensile modulus increased with increasing WFA loading. Swelling test indicated that WFA had the higher filler-rubber interaction. The dispersion of WFA filled natural rubber compounds shows the surface h.as many tear line with branching that indicates higher tensile strength whereas deeper matrix tearing are noticed for CB, that indicated high stress was needed. For silica, the tensile fracture is brittle and rough with many tear lines. It shows that the tensile strength of silica decreased with increasing filler loading. The effect of WFA loading with the presence of 3-aminopropyltrimethoxysilane (APTMS) in NR compounds was studied using two different method, insitu addition and surface treatment. The optimum content of APTMS is at 1.0 phr. Shorter scorch and cure time was achieved with the presence of APTMS when compared to NR without APTMS. Tensile strength of the WFA/NR compounds with APTMS content increased with filler loading until 5 phr and then started decrease with further increase in filler loading. Improvements of mechanical properties such as elongation at break and tensile modulus was also observed with APTMS content. Thermal aging was carried out on 2, 4 and 7 days at 100 °C and tensile testing was performed in order to determine the aging properties. It shows that, tensile strength of WFA increased after 2 days aging and further decreased after 4 days aging process.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Oil palm production is a major agricultural industry in Malaysia. It contributes about US$ 7.3 billion in export earnings each year, mostly from the export of palm oil. Currently, there are more than four million hectares of oil palm plantations (MPOB 2007). In total, about 90 million weight of renewable biomass (trunks, fronds, shells, palm press fiber and the empty fruit bunches) are produced each year, which at the moment are not fully utilized and face disposal problems (Basiron & Hussain, 2002).

Nowadays, waste management remains the greatest challenge for many developing nations. Survival of flora and fauna are daily threatened due to the improper disposal of waste while the quest for industrialization continues to pose serious challenges in the area of waste management. The utilization of local waste materials which are abundant and cheap, especially from clean resources have become more pressing than ever. The need for efficient utilization of waste a product is especially critical in the case of oil palm biomass (Bhat & Khalil, 2011). Basel Convention (1992) describes wastes as substances or objects which are disposed of or are intended to be disposed of by the provision of national law. Waste of known characteristics can be made useful whereas waste of unknown characteristics can be dangerous either in the short or long term. The burning process generates ash usually referred to Fly Ash (FA) which is generally dealt with as a waste material (Safiuddin, Mohd, Salam, Islam & Hashim, 2010; Mahlia, Abdulmuin, Alamsyah & Mukhlishien, 2001).

Interestingly, natural rubber (NR) is one of the versatile materials widely used in many applications. The main producers of NR are Thailand, Indonesia, Malaysia, and China. NR has several advantages such as low cost, low hysteresis, high resilience, excellent dynamic properties, and fatigue resistance (Teh, Ishak, Hashim, Karger-Kocsis & Ishiaku, 2004). However, raw NR has poor mechanical properties. To improve its