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Curing Characteristics and Tear Properties of Bentonite Filled Ethylene Propylene Diene (EPDM) Rubber Composites

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Abstract

The effect of bentonite clay loading on curing characteristics and tear strength of bentonite filled ethylene propylene diene monomer (EPDM) composite were studied. Compounding was carried out on two-roll mill and vulcanization was done at 150^0C. Torque values, scorch time and optimum cure time of the prepared rubber compound were assessed by using Mosanto Disc Rheometer (MDR 2000). Results indicated that the maximum torque of EPDM/Bt composite decreases at high bentonite loading. Increasing in values with increasing bentonite loading was recorded for minimum torque and optimum cure time of EPDM/Bt composite. The increase is related with the increase in viscosity due to the increasing of bentonite clay loading in EPDM matrix. Scorch time was found to be decreasing up to 30 phr bentonite clay. Results also show that tear strength of EPDM/Bt composite increased with increasing bentonite loading up to 90 phr. The reason is probably due to agglomeration occur causes the reduction in properties at high loading above 90 phr bentonite clay. The scanning electron microscopy (SEM) of tear fracture surface of EPDM/Bt composite illustrated that with increasing bentonite loading up to 90 phr bentonite clay, a better dispersion of bentonite clay is achieved as compared to lower loading, resulting in high tear strength value for EPDM/Bt composite.

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Keywords: Ethylene propylene diene monomer; bentonite clay; rubber composites

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Nomenclature

NR	Natural rubber
NBR	Nitrile Butadiene rubber
µm	micronmeters
sqm/g	squaremeters per gram
h	hour
gcm^{-3}	gram per centimetre cubic
^0C	degree celcius
phr	part per hundred rubber
mm	millimeters
ISO	International Organization for Standardization
ASTM	American Society for Testing and Material
N/mm	Newton per milimeters

1. Introduction

Ethylene propylene diene (EPDM) rubber is a saturated polymer that is mostly known as a rubber that have a greater resistance towards ozone and high temperature as compared to other general purpose rubber. Due to its high performance, EPDM rubber is often used in automotive application, building and construction, cable and wire, also as sheeting and sealing [1]. Although EPDM has high resistance towards oxygen, ozone and heat, the strength of unfilled EPDM actually are very poor and therefore, the incorporation of filler is required to increase its strength. The filler is usually added into rubber phase to either reinforce the properties of rubber, reducing the cost of production and/or to ease the processing. Among all the filler used, carbon black is more known thanks to its high reinforcement capability. However, its potential to pollute environment, besides low variety of colour usage, urge the researchers to find other more friendly white filler to be used, which among them is silicate layer clay such as bentonite and montmorillonite (MMT). Bentonite is a naturally occurring rock consisting majorly of MMT, sodium and other minerals such as quartz, feldspar and others. MMT have a structure such that the Aluminium octahedral sheet is sandwiched in between the silica tetrahedral sheet. The thickness of the layer is only 1nm which in between the gap gallery, the exchangeable cations take place. These exchangeable cations are important because it is responsible in altering the properties of the rubber [2]. The use of clay in nanocomposite rubber was initiated by Toyota R&D group in 1991 with their nanocomposite based on nylon rubber with MMT clay. The improvement in mechanical properties by the use of MMT clay discovered by Toyota had attract the attention of the researchers and the results are plentiful studies of nanocomposites has been reported [3-5]. In order to further understanding the benefit of bentonite, the work was focused on studying the effect of bentonite clay loading on curing characteristics and tear properties of EPDM/Bt composite.

2. Experimental

2.1. Material

The material used throughout this study are the same as used by Ismail et al, (2011) [6] (Table 1). EPDM, 778Z purchased from Keltan DSM Elastomers consist of ethylene content of 67%, ENB of 4.3% and ML (1+4) 125^0C of 63MM. Bentonite, Bt was supplied by Ipoh Ceramics (M) Sdn. Bhd. Zinc oxide,ZnO, stearic acid, tetramethyl thiuram dsulphide (TMTD), 2-mercapto benzothiazole (MBT) and sulphur were all obtained from Bayer (M) Ltd. The average particle size and specific surface area of Bt are 5.31µm and 0.975 sqm/g, respectively and the elemental composition of Bt are as shown in Table 2 [6].

Table 1: Compounding formulation of EPDM/Bt composite [6].