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Mohyeldin Ragab, Magdy Abdelrahman

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Enhancing the Crumb Rubber Modified Asphalt's Storage Stability through the Control of its Internal Network Structure

Mohyeldin Ragab[1] Magdy Abdelrahman[2*]
1. Pure Asphalt Company, Chicago, IL, USA.
2. Missouri University of Science & Technology, Rolla, MO, USA.

Abstract

The current research investigated the effect of the internal network structure developed in the crumb rubber modified asphalt (CRMA) on its storage stability. The authors investigated the influence of asphalt-crumb rubber modifier (CRM) interaction parameters (interaction time, interaction speed, and interaction temperature) on the development of the internal network structure in CRMA. The authors found that the existence of three dimensional (3D) network structures in the CRMA enhanced its storage stability. Fourier Transform Infrared (FTIR) Spectroscopy was utilized to determine the nature of CRM components responsible for the development of 3D network structure in the liquidFigure phase of CRMA. This was achieved by monitoring the changes of the IR distinctive peaks in the CRMA liquid phase. Dissolution tests and thermo gravimetric analysis (TGA) were carried out on the extracted CRM after interaction with asphalt to determine the role of CRM dissolved amounts and released components on the development of 3D network structure in CRMA. The asphalt-CRM interaction parameters were found to be essential to induce the formation of the 3D network structure within the liquid phase of the CRMA through controlling the swelling, dissolution and release of CRM components into the asphalt liquid phase. The existence of 3D network structure in the CRMA had determinant impact on the enhancement of its storage stability.

Keywords: Storage stability, three dimensional (3D) network, crumb rubber modified asphalt.

1 Introduction

Asphalt is made up of continuous three-dimensional associations of polar molecules that are dispersed in a fluid of nonpolar or relatively low-polarity molecules [2]. Associations of different strengths are created by the polar functions within asphalt [3]. The typical viscoelastic properties for neat asphalts are the result of continuous formation and breakage of these associations under the effect of external factors such as shear stresses and temperature variations [4]. During the mixing of a polymer with a compatible base asphalt, the absorption of the low molecular weight oil fraction of the base asphalt by polymer strands occurs [3]. A three dimensional (3D) continuous phase network is formalized as a result of interconnection between these swollen strands at domains or nodes. The mechanical properties of the binders and ultimately the asphalt concrete mixes are significantly affected by this network [4]. Wekumbura et. al. investigated the effect of addition of either Styrene-Butadiene-Styrene (SBS) or ethylene-vinyl-acetate (EVA) polymer, on the destruction and recovery of internal network structure of Polymer modified asphalt (PMA) [4]. Interrupted shear tests verified the existence of 3D polymer network structures within the PMA [4]. Such