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Material Properties

Evaluation of thermal and mechanical properties of recycled polyethylene modified bitumen

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ABSTRACT

This paper deals with the influence that polymer concentration exerts on the rheological and thermal properties and microstructure of recycled polyethylene modified bitumen. With this aim, a recycled polyethylene was used as modifying agent to improve the mechanical characteristics of a 150/200 penetration grade bitumen. The evolution of microstructure and thermal and rheological behaviour of the blends has been followed by optical microscopy, MDSC measurements, steady and oscillatory shear tests and dynamic mechanical thermal analysis (DMTA), respectively. Recycled polymer concentrations up to 15 wt.% lead to enhanced rheological properties of the modified bitumen, useful for paving applications. Larger recycled polymer concentrations yield modified binders suitable for roofing membranes.

1. Introduction

Asphaltic bitumen, from crude oil distillation processes, is widely used as a binder in road surfacing and, also, for roofing and waterproofing applications. It is generally believed that bitumen can be described as a colloidal dispersion, where the components having the highest molecular weights, the asphaltenes, are dispersed in a medium containing the remaining components, the maltenes [1]. The maltenic fraction can still be divided into three generic groups of different molecular weights and aromaticity, which decrease according to the sequence: resins, aromatics and saturates [2].

The addition of polyolefins to bitumen is known to enhance its in-service properties, yielding improved thermo-mechanical resistance, elasticity and adhesion [3–6]. Thus, polymer modified bitumens are designed to prevent the three main causes of deterioration of asphalts pavements: a) rutting, as a consequence of the accumulated plastic deformation due to high loads and/or high temperatures; b) fatigue cracking, caused by repetitive loading; and c) thermal cracking, due to embrittlement caused by low temperature [7]. For any meaningful study on the efficiency of polymer modified bitumens, it is necessary to understand the quality improvements associated with individual polymers [6].

Recycled polymers can substitute virgin polymers as bitumen modifying agents. In general, recycled plastics have poorer mechanical properties than the virgin ones, a fact that reduces their application fields as final products. This is a consequence of waste plastics recycling operations (washing, grinding, extrusion, etc.), and also related to environmental and thermo-mechanical polymer degradation during service [8]. However, when recycled polymers are used as bitumen modifying agents, the resulting mixture may show similar performance to those containing virgin polymers [4,5]. From an environmental point of view, bitumen modification with waste plastics is a good way of achieving waste disposal. In addition, it may be of interest from an economic standpoint, considering that polymer cost is an important aspect in bitumen modification [5].

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