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Heavy Oil Residues: Application as a Low-Cost Filler in Polymeric Materials

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Abstract

Deposits of oil sands, bitumen, extra-heavy oil, and heavy oil appear in more than 70 countries all over the world and the fraction of oil recovered gradually increases. High content of poly-condensed high molecular weight oil components (PHMOCs), which may amount up to 50-60% depending on conditions of oil formation, is the main difference of heavy oil and bitumen from conventional oil. PHMOCs can lay the foundation for the preparation of a large number of valuable materials due to their structural manifold and their potential still not discovered to full extent. This work is devoted to the study of the effect of PHMOCs on properties of the composition materials prepared from polyethylene matrix. An «asphalt» – industrial product of deasphalting of tar, as well as asphaltenes and resins isolated from heavy oil, were used as a source of PHMOCs. HDPE and fillers were characterized using MALDI, FTIR, DSC and TGA. For the new composite materials we evaluated the physicomechanical properties, the thermal decomposition characteristics (by TGA), and the accumulation rate of carbonyl groups in the oxidized polymer (on FTIR). Studies of new composite materials showed that the introduction of filler in an amount of up to 4% in a polyethylene matrix does not lead to a significant change in the physicomechanical properties, but for a number of parameters they are improved. It also figured out that the addition of PHMOCs to polyethylene makes it unnecessary to stabilize the resulting compositions with stabilizers of thermal oxidative degradation. Results of experimental studies indicate that industrial residue - «asphalt» is a promising filler and low cost of this stock renders it perfect source for the industry of polymer materials.

Keywords: HDPE; Filler; Composition; Heavy Oil; Residue; Asphaltenes; Resins; Thermo-Oxidative Destruction.

1. Introduction

Global oil reserves are 9 to 13 trillion of barrels according to International Energy Agency estimates, among which only 30% is conventional oil, while 70% corresponds to nonconventional oil (30% oil sand and bitumens, 25% extra-heavy oil, and 15% heavy oil). Deposits of oil sands, bitumens, extra-heavy oil, and heavy oil appear in more than 70 countries all over the world and the fraction of oil recovered gradually increases [1]. High content of polycondensed high molecular weight oil components (PHMOCs), which include asphaltenes and resins [2, 3], is the main difference of heavy oil and bitumen from conventional oil. Their total content may amount to 50-60% depending on the chemical nature of oils and conditions of oil formation [4]. Asphaltenes are special among oil components and represent the components with the highest molecular weight and the most complex elemental composition and molecular structure

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