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Oxidation Behavior and Kinetics of Light, Medium, and Heavy Crude Oils Characterized by Thermogravimetry Coupled with Fourier Transform Infrared Spectroscopy

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Abstract

© 2018 American Chemical Society. The oxidation behavior of three crude oils was characterized by thermogravimetry coupled with Fourier transform infrared spectroscopy (TG-FTIR) to investigate the oxidation mechanism of crude oils. The results indicated that the entire oxidation process can be divided into three main reaction intervals: low-temperature oxidation (LTO) interval (<400 °C), coking process (400-500 °C), and high-temperature oxidation (HTO) interval (500-650 °C). For the LTO interval, oxygen addition reactions to produce hydroperoxides were believed to be dominant at the early stage, while the isomerization and decomposition reactions of hydroperoxides became more significant at the later stage. For light and medium oils, the isomerization and decomposition reactions that release H2O started at about 200 °C and the isomerization and decomposition reactions that release CO2 and CO started at about 300 °C. However, no CO2 and CO were detected in the LTO interval of the heavy oil, which means that the reaction pathways of the heavy oil might be a little bit different from those of the light and medium crude oils in LTO intervals. Evaporation played an important role during the entire LTO interval. In the coking process, the coke formation by the oxidative cracking of the LTO residue is believed to be the main reaction with the release of gaseous products of CO2 (and CO), H2O, and hydrocarbons. In the HTO interval, the combustion of coke was considered as the only one significant reaction. For the LTO and coking process, the activation energies increased with the decrease of the American Petroleum Institute (API) gravity of crude oils. However, for the HTO stage, the activation energies were similar (100-125 kJ/mol) for different crude oils.

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