

Oxidation Behavior of Light Crude Oil and Its SARA Fractions Characterized by TG and DSC Techniques: Differences and Connections

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Abstract

© 2017 American Chemical Society. This research is intended to reveal the difference and connection of oxidation behavior between crude oil and its SARA fractions. Thermogravimetry (TG) and differential scanning calorimetry (DSC) techniques were used to characterize oxidation behavior. The results showed that the oxidation behavior of individual SARA components exhibited an obvious difference. Saturates showed a weak high-temperature oxidation (HTO) region. Asphaltenes generated more heat in HTO than in the low-temperature oxidation (LTO) region. Aromatics showed intense exothermic activity in both LTO and HTO regions. Heat release and mass loss showed a good correspondence in the HTO region for all SARA fractions, which means heat release and mass loss were caused by the same reaction mechanism that is believed to be the coke combustion as it is the only significant reaction in the HTO region. However, the good correspondence did not exist in the LTO interval where the reactions are more complicated and a multiple-step mechanism should be considered. In addition, it is not quite reasonable to determine the reactivity of SARA fractions only by TG data as little mass loss does not mean reactants are inactive. Kinetic parameters of LTO and HTO reactions were determined by Friedman and Ozawa-Flynn-Wall isoconversional methods. In general, for the crude oil and each fraction, the activation energies of HTO were higher than that of LTO. The additivity of DSC data could be applied quite well in the LTO region. However, the predicted curve seriously deviated from the actual situation after 350 °C, which implies the exothermic reaction process of individual components was influenced by the presence of other components. Nevertheless, the total heat release of the measured and predicted values was similar, which makes it possible to predict the heat effect of crude oil from individual SARA components.

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