Fuel 186 (2016) 122–127

Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel

Full Length Article

# Thermal decomposition of *Tatarstan Ashal'cha* heavy crude oil and its SARA fractions

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## HIGHLIGHTS

- One main region in heavy crude oil and its fractions.
- Higher heat of reaction in asphaltenes and resins fractions.
- Lowest mass loss in asphaltene fraction.
- Highest activation energies in asphaltene fraction.

## ARTICLE INFO

*Article history:*
Received 17 August 2015
Received in revised form 28 July 2016
Accepted 9 August 2016
Available online 23 August 2016

*Keywords:*
Crude oil
SARA fractions
Differential scanning calorimetry, thermogravimetry
Kinetics
In-situ combustion

## ABSTRACT

In this research, heavy crude oil from Ashal'cha field, Republic of Tatarstan, and its SARA (saturate, aromatic, resin and asphaltene) fractions were analyzed by differential scanning calorimetry (DSC) and thermogravimetry (TGA) methods. The experiments were performed at three different heating rates (10, 20, 30 °C/min) for DSC and at single heating rate for TGA analysis, all under the air atmosphere. In DSC experiments, two main reaction regions were detected at each heating rate known as low and high temperature oxidation reactions. On the other hand, in TGA experiments, one main region was observed. For all the SARA fractions studied, highest heat of reaction was observed in lowest heating rate. The kinetic analysis of the crude oils and their fractions was also performed using ASTM E-698 and Arrhenius methods, respectively. Activation energy values of the crude oil sample and the fractions varied between 69.2 and 201.8 kJ/mol in LTO region and 82.9–182.1 kJ/mol in HTO regions, respectively. In Arrhenius method, the activation energy values were in the range of 33.1–108.9 kJ/mol.



## 1. Introduction

Crude oil is mainly composed by hydrocarbons and derived organic sulfur, nitrogen, oxygen and metal-containing compounds. Generally, hydrocarbons and its derivatives in oil sample can be classified into four fractions, known as *S*aturated (alkanes and cyclo-paraffins), *A*romatics (hydrocarbons, mono, di and poly-aromatic), *R*esins (polar molecules with heteroatoms N, O and S) and *A*sphaltenes (higher molecular weight and polyaromatic core), shortly *SARA* fractions. The distinction between the asphaltenes and resins is that asphaltenes are insoluble in an excess of heptane or pentane, whereas resins are miscible with heptane or pentane [1].

Thermal analysis techniques such as thermogravimetry (TGA), and differential scanning calorimetry (DSC) became highly important research tools and constitute an important part from the point view of correlation between thermal behavior and kinetic studies of crude oils and their fractions.

Different °API gravity crude oils and their SARA fractions were studied by DSC to characterize the volatilization and decomposition temperature of crude oils. It was observed that the decomposition temperature was increased with the increasing average molecular mass of crude oil [2–4]. In DSC analysis of different origin crude oils and their SARA fractions, reaction intervals and corresponding peak temperatures, burn-out temperatures, heat flow rates and kinetics were also studied. The kinetic analysis showed similar activation energy for the combustion of coke produced [5–7]. Effect of catalyst and metal oxides on the thermal behavior and kinetics of crude oils was also studied [8]. The kinetic analysis using different methods showed similar activation energy values

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http://dx.doi.org/10.1016/j.fuel.2016.08.042
0016-2361/