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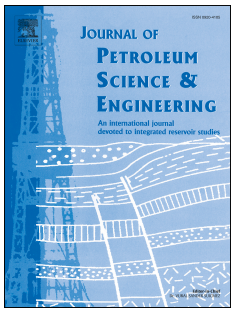

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Multivariable Statistical Analysis and Optimization of Iranian Heavy Crude Oil Upgrading using Microwave Technology by Response Surface Methodology (RSM)

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ABSTRACT

Conventional methods to upgrade heavy oil due to high pressure, low production efficiency, and low product quality have not been recognized as profitable methods. These complications resulted in using innovative technologies in this area. In this paper, the statistical analysis and process conditions optimization of Iranian heavy crude oil upgrading have been performed using microwave technology, for the first time. The heavy crude oil is from Iranian west Paydar field, with specifications including API 18.53, viscosity 78.76 cSt (at 20 ^{0}C). In order to optimize process conditions for upgrading heavy crude oil, independent variables include power level (40-70-100%), process time (5-12.5-20) (min), activated carbon as sensitizer (0-5-10) (wt%), and Fe as catalyst (0-3-6) (wt%). Surface temperature, API ratio, viscosity ratio, and asphaltene reduction have been considered as response variables. The Box-Behnken design and response surface methodology (RSM) have been applied to determine parameters levels and to model the responses, respectively. The results show that the optimal conditions to maximize surface temperature, API ratio, and asphaltene reduction, and to minimize viscosity ratio involve power level of 100%, process time of 20 min, activated carbon of 10 wt%, Fe catalyst of 4.06 wt% which leads to 23.31API ratio, 31.6% asphaltene reduction, and 43.37% viscosity reduction. The predicted conditions agreed with the experimental values, representing the models accuracy.

Keywords: Heavy Crude Oil, Upgrading, Microwaves, Response Surface Methodology

1. Introduction

Heavy petroleum upgrading issue and converting it into lighter and valuable products using microwave has attracted the attention of researchers in recent years. Some researchers have worked on the field of hydrocarbons recovery from sandstones, oil shales, tars, and coals using microwaves. According to their results, recovery has been significantly increased (Balint et al. 1983; Bosisio et al., 1977; Greff & Babadagli, 2013; Jeon et al., 2012; Lam & Chase, 2012). Oil separation from oil/water emulsions with different methods such as gravity sedimentation, conventional heating and microwave irradiation have been investigated by some authors (Chan & Chen, 2002; Fortuny et al., 2007; Martínez-Palou et al., 2013; Mohammed & Mohammed, 2013; Xiao-ya et al., 2004). In addition, microwave heating has been applied for