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Editorial

Special Issue "Heavy Oils Conversion Processes"

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It is common knowledge that the world's economic growth is mainly based on hydrocarbon exploitation and processing, regardless of the political efforts towards developing renewable energy. However, population growth and economic shrinking could be strong reasons for developing unconventional oil sources. Heavy oil resources are recognized as being a potential source of hydrocarbon generation. Nevertheless, this type of fuel is often undeveloped and still poorly studied. A major drawback of heavy oil is its high density and viscosity in addition to the presence of undesirable components in its composition. One of the main issues in our knowledge about heavy oil conversion processes is a lack of detailed explanation of the mechanisms and fundamental laws which govern the systematic transformation of its composition under different conditions and effects. The present Special Issue discusses the possible methods and investigation approaches that could be useful for the future exploitation of heavy oil reserves. In their work [1], Remi et al. studied the chemical characterization of a paraffinic base oil production line using different analytical techniques. The obtained data showed the importance and effectiveness of cross-checking results from different complementary analytical techniques to acquire valuable data on lubricating oil base samples. In another work [2], Rakhmatullin et al. demonstrated the importance of spectroscopy in studying the properties of heavy oil. The authors applied nuclear magnetic resonance (NMR) to determine the quantity of saturate, aromatic, resin, and asphaltene fractions in heavy oil. The authors found that 13C NMR spectroscopy is an efficient method for expressing the analysis of oil from physical properties to the composition of functional groups to follow oil-treatment processes. In addition, Zheng et al. [3] studied the properties of petroleum asphaltenes as a crucial component in the composition of heavy oil structure. The authors showed that the fractionation of asphaltenes is quite crucial to acheieve a better understanding of its composition and properties. This would reduce its complexity and provide proper distribution, rather than just averages. Mohd et al. [4] studied micellar fluid interactions via microemulsion rheological analysis. The authors demonstrated that the addition of alkaline, surfactant, and polymer (ASP) on one hand and surfactant and polymer (SP) on the other hand led to the formation of microemulsions of up to 29% for 50% water cut (WC) in the presence of ASP, and 36% for 40% WC in the presence of SP. This study showed that the addition of ASP and SP can be applied to flooding applications. Moreover, the applied rheological analysis showed that the microemulsions behaved as a shear-thinning micellar fluid by decreasing the viscosity with an increase in shear rate. It is worthy to note that asphaltenes are considerably believed to be a potential and perspective source of producing new raw materials. Afanasjeva et al. [5] presented a mechanistic approach for the thermal production of new materials from asphaltenes of castilla crude oil. The authors found that the pyrolysis process at 330 and 450 °C can be used as an easy route to attain new materials associated with specific structural units from the asphaltenes.

For the last few decades, the processes of heavy oil conversion have been generating considerable interest in terms of enhancing heavy oil recovery to improve recoverable

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hydrocarbon reserves. Different methods and techniques have been developed in recent years to optimize the production of unconventional oil and enhance heavy oil recovery. A growing body of literature has investigated the potential impact of heavy oil exploitation by means of enhanced oil recovery methods. In fact, the term enhanced oil recovery has been basically used for a set of techniques which are set to improve the oil production after the secondary and tertiary extraction. Enhanced oil recovery is classified into different methods based on the acquired and applied source of energy. In other words, some methods are based on generating external source of heat in-situ to increase the reservoir temperature and decrease the viscosity of oil in place, known as thermally enhanced oil recovery [6–8]. Other methods are based on injecting chemicals and polymers within the reservoir in order to modify the physico-chemical properties of the composition of formation and therefore ease the extraction of hydrocarbons [9,10]. Some methods are based on applying electromagnetic sources of energy [11] to change the electrical and magnetic properties of some minerals and metals presented in the oil and rock medium to generate heat in-situ and decrease the viscosity of oil therein.

In the present Special Issue, several authors have studied thermally enhanced oil-recovery methods by investigating the thermal impact on the conversion of heavy oil and kerogen. Nasyrova et al. [12] studied heavy oil and kerogen conversion in the presence of water at sub- and supercritical states using gas chromatography–mass spectroscopy (GC–MS), isotopic mass-spectrometry method, and Fourier Transform Infrared Spectroscopy (FTIR). The obtained results showed that water at sub- and supercritical states improves heavy oil component conversion in addition to causinng the destruction of insoluble kerogen light mobile crude oil. Moreover, this study revealed that supercritical water improves kerogen and resins-asphaltenes' conversion into light oils more than the effect of subcritical water. In addition, it was found that supercritical water is able to decrease oil-generation potential of oil-bearing rocks from 23.7 to 3.7 mg/g and increase the productivity index from 0.06 to 0.48 mg/g. Besides, supercritical water was found to increase saturated hydrocarbons by more than double. Apart from applying aquathermolysis technology, other works [13] have investigated the effect of microwave application for enhanced oil recovery. The authors of this study claimed that the application of microwave radiation can significantly improve the heavy oil reserves recovery due to the change in the oil chemical composition content reflected by the destruction of asphaltenes and resins by the power generated from microwave electromagnetic heating. The evidence from this review showed that it is worthy to consider the electromagnetic heating effect on the conversion of various hydrocarbon raw materials because of its potential application in terms of transportation and processing. The authors suggested that microwave heating might have prospective implications, not only for in-situ enhanced oil recovery, but also for industrial refining processes.

In the last century, enhanced oil-recovery methods have attracted the application of different catalytic systems including transition metal-based catalysts. In fact, the integration of catalytic agents during the application of thermally enhanced oil recovery has considerably improved the recovery factor of different heavy oil reservoirs in the world. In the present Special Issue, Petrov et al. [14] studied the influence of metal oxides and their precursors on the composition of final products of Aschalcha heavy oil aquathermolysis. The authors applied a set of physical and chemical methods of analyses to establish the mechanisms ruling the action of metal-based catalysts during the aquathermolysis process. Their work included the application of carbonate, kaolin, Al_2O_3, Ni^{2+} and Cu^{2+}, NiO mixed with poly-α-olefins, $C_6H_8O_7$, $C_2H_4O_2$ at 290–375 °C, and 10–135 bar. The obtained results showed no effect from carbonate on the process of aquathermolysis. However, the other catalytic agents showed an accelerated decomposition of resins and asphaltenes compounds at different conditions of temperature and pressure. In a similar work, Aliev et al. [15] studied the effect of a nickel-based catalyst on the catalytic aquathermolysis of Boca de Jaruco. The opted catalyst was characterized by a higher oil solubility, which allowed a better dispersion in the medium and therefore enhanced its catalytic effect at higher temperatures and pressures. The authors claimed that the nickel oil soluble catalyst has transformed into nickel sulfides as an active form at higher temperatures. The used catalyst has shown a significant decrease in the amount of resins and asphaltenes because of its intense impact on carbon-heteroatom bonds destruction. This study also reported that the used catalyst contributes in the destruction of aromatic ring bonds, which consequently led to increase the amount of saturates in the obtained products of aquathermolysis. The nickel-based catalyst showed a significant irreversible decrease in the viscosity of the produced oil after aquathermolysis. The authors further confirmed the effect of metal based catalysts on improving the quality of produced oil from aquathermolysis. In a review [16], some authors have reported that nanoparticles are an efficient way to improve the quality of thermally enhanced oil recovery methods especially aquathermolysis reactions. However, the nanoparticles are facing a crucial challenge when it comes to their application. As a result, the authors encouraged and recommended further intense investigation into the domain of nanoparticle synthesis and technological application in the future.

The present Special Issue focused on the problem of the heavy oil conversion processes. As stated in the Special Issue summary, our main objective was to widen our knowledge about the processes, mechanisms, and potential application of the heavy oil conversion processes. Therefore, future studies on the present topic are recommended in order to validate the obtained results of our Special Issue. We believe that the findings of the present Special Issue will serve as a useful aid for decision makers because of the achieved results and prospects. We gratefully acknowledge the help provided by the constructive comments of the anonymous referees, editors, and assistants. We also thank Ms. Tami Hu for her technical assistance during the realization of this Special Issue.

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