Acta Scientific Biotechnology

Volume 1 Issue 10 October 2020

Research Article

Empirical Study on the EOR and Evaluation of Precipitation of Waxy Compounds from Crude Nano Oil

Mahsa Shahbazi[1] and Farshad Farahbod[2]*

[1]Department of Chemical Engineering, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran

[2]Department of Chemical Engineering, Firoozabad Branch, Islamic Azad University, Firoozabad, Iran

***Corresponding Author:** Farshad Farahbod, Department of Chemical Engineering, Firoozabad Branch, Islamic Azad University, Firoozabad, Iran

Received: September 24, 2020

Published: September 30, 2020

Abstract

In this study, several samples of crude oil containing nanoparticles have been studied. However, light crude oil has been evaluated more than other samples. Also, the density of three samples of light, medium and heavy crude oil has been measured in the laboratory. Nano ferric oxide with a range of 75 - 89 nm in diameter is added in crude oil and changes in viscosity, recovery value percentage, precipitation of heavy hydrocarbons, molecular weight are surveyed with various temperature and pressure. Also, the data obtained in these experiments show that with increasing operating temperature, the percentage of deposition of heavy hydrocarbons in oil decreases. The results show the relationship between oils with different molecular weights and the percentage of precipitation of heavy hydrocarbons. Experiments in this section show that the higher the molecular mass of the oil, the higher the percentage of heavy hydrocarbons separated from the oil. The reason for this is that the higher the molecular mass of the oil, the more carbon-containing hydrocarbons there are. The longer carbon chain means a higher percentage of the heavy compounds in the oil, so it can be expected that the higher the molecular mass of the oil, the higher the percentage of heavy matter in it. In addition, the results of this chart also show that as the operating temperature of the oil passing through the sand bed decreases, the amount of heavy hydrocarbon deposits in the oil also increases. The reason for this is that as the operating temperature decreases, the amount of thermal flux and, of course, the amount of heat distribution in the oil decreases, and eventually the percentage of heavy hydrocarbon deposition from oil will also increase.

Keywords: Pressure; Temperature; Crude Oil; Heavy Hydrocarbons; Light

Introduction

Crude oil is a dark, viscous liquid comprising mainly branched and unbranched alkanes and cycloalkanes [1]. It also contains a small fraction of aromatic hydrocarbons and other compound containing sulphur, oxygen and nitrogen [2]. Nearly every aspect of our modern lifestyle is impacted by crude oil [3]. Crude Oil is used to power our vehicles, to create medicines that keep us healthy, and to make the plastics, cosmetics, and other personal products that enhance our daily lives [4]. However, none of these products would exist without the refining process known as crude oil processing [5]. For example, you would not put crude oil in the gas tank of your car because it has to be refined into gasoline first [6]. Hundreds of different crude oils (usually identified by geographic origin) are processed, in greater or lesser volumes, in the world's refineries [7]. Each crude oil is unique and is a complex mixture of thousands of compounds. Most of the compounds in crude oil are hydrocarbons (organic compounds composed of carbon and hydrogen atoms) [8]. Other compounds in crude oil contain not only carbon and hydrogen, but also small (but important) amounts of other ("hetero"-) elements-most notably sulfur, as well as nitrogen and certain metals (e.g. nickel, vanadium, etc.) [9]. The compounds that make up crude oil range from the smallest and simplest hydrocarbon molecule-CH_4 (methane)-to large, complex molecules containing up to 50 or more carbon atoms (as well hydrogen and hetero-elements) [10]. The physical and chemical properties of any given hydrocarbon species, or molecule, depends not only on the number of carbon atoms in the molecule but also the nature of the chemical bonds between them [11]. Carbon atoms readily bond with one another (and with hydrogen and hetero-atoms) in various ways - single bonds, double bonds, and triple bonds-to form different classes of hydrocarbons [12]. Paraffin's, aromatics, and naphthenic are natural constituents of crude oil, and are produced in various refining operations as well. Olefins usually are not present in crude oil; they are produced in certain refining operations that are dedicated mainly to gasoline production [13]. As Exhibit 1 indicates, aromatic compounds have higher carbon-to-hydrogen (C/H) ratios than naphthenic, which in turn have higher C/H ratios than paraffin's [14]. The heavier (denser) the crude oil, the higher its C/H ratio. Due to the chemistry of oil refining, the higher the C/H ratio of a crude oil, the more intense and costly the refinery processing required to produce given volumes of gasoline and distillate fuels [15]. Thus, the chemical composition of a crude oil and its various boiling range fractions influence refinery investment requirements and refinery energy use, the two largest components of total refining cost [16]. The proportions of the various hydrocarbon classes, their carbon number distribution, and the concentration of hetero-elements in a given crude oil determine the yields and qualities of the refined products that a refinery can produce from that crude, and hence the economic value of the crude. Different crude oils require different refinery facilities and operations to maximize the value of the product slates that they yield [17].

In this study, several samples of crude oil containing nanoparticles have been studied. However, light crude oil has been evaluated more than other samples.

Materials and Methods

In this study, three samples of light, medium and heavy crude oil have been used. The procedure is that all three crude oil samples are first homogenized in a tank containing a mixer, then combined in an ultrasonic device with metal oxide nanoparticles, and finally passed through a heat exchanger into a sandy bed. The sand bed is designed for a certain length and size and the precision instruments installed on the bed are capable of measuring temperature, pressure and flow rate variables. In this study, very important variables such as density, percentage of precipitation of heavy compounds and coefficient of oil recovery from the bed have been measured in the laboratory. In this study, the focus is more on crude oil sample and the behavior of this sample of crude oil during the sand bed crossing has been investigated.

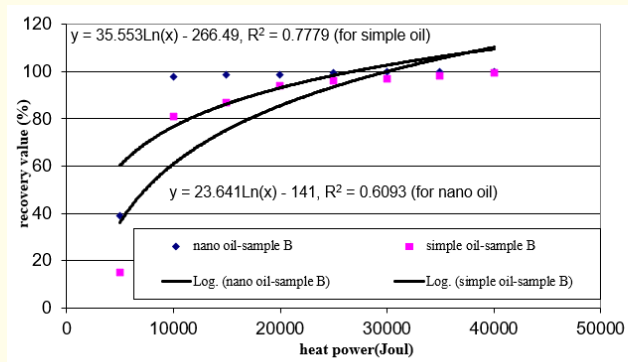

Figure 1: Recovery value percentage of light oil versus input energy.

Results and Discussion

The results presented in figure 1 show that light crude oil containing nanoparticles can pass through the sandy bed more easily than light heat exchanger after taking heat from nanoparticles. As a result, its recycling rate is higher than oil without nanoparticles. About 11.8% increase in the amount of recovery in heavy oil and about 5.8% for medium and 3.1% for light oil is seen. The figure 1 shows this relation. The operating conditions such as temperature and pressure are effective on the percentage of precipitation of heavy hydrocarbons. The figure 2 shows the amount of heavy hydrocarbons precipitation versus operating conditions. Furthermore, the effect of nano particles is investigated in the figure 2. The temperatures are 80°C, 100°C and 120°C and pressure changes from 30 atm to 150 atm. The increase in temperature decreases the amount of heavy hydrocarbons precipitation percentage in the oil sample even when contain nano particle. Figure 2 indicates the decrease in the amount of heavy hydrocarbons precipitation by the addition of nano particles. Sample B, light oil, shows smaller precipitation in comparison with heavy and mid oil at the same operating conditions and equal amounts of nano particle.

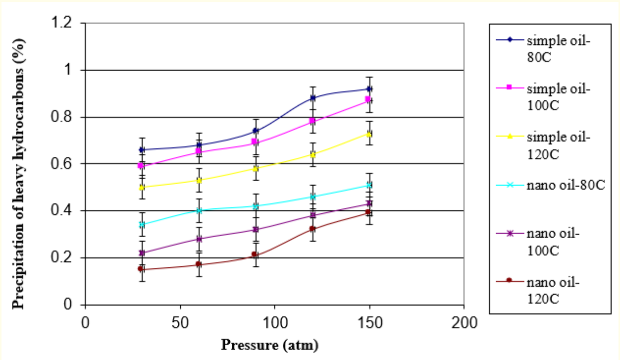

Figure 2: Heavy hydrocarbons precipitation in light oil, versus temperature, pressure with and without nano particles.

The laboratory results presented in figure 2 show that the percentage of precipitation of heavy hydrocarbons separated from crude oil increases with increasing pump outlet pressure. Also, the data obtained in these experiments show that with increasing operating temperature, the percentage of deposition of heavy hydrocarbons in oil decreases. According to figure 2, it can be concluded that the nanoparticles distributed in crude oil have a significant effect on reducing the hydrocarbons deposited by the oil. The reason for this could be the distribution and cohesion of the thermal flux in the oil molecular tissue in which the nanoparticles are dissolved. The lowest amount of heavy hydrocarbons precipitation is obtained at 110 g/gmole and 120°C for oil contains nano particle.

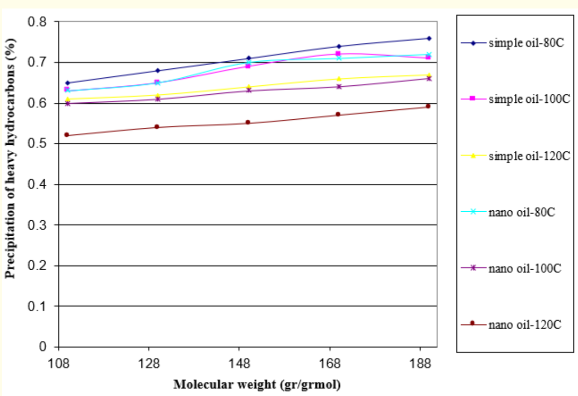

Figure 3: Heavy hydrocarbons precipitation versus molecular weight of light oil.

Figure 3 shows the relationship between oils with different molecular weights and the percentage of precipitation of heavy hydrocarbons. Experiments in this section show that the higher the molecular mass of the oil, the higher the percentage of heavy hydrocarbons separated from the oil. The reason for this is that the higher the molecular mass of the oil, the more carbon-containing hydrocarbons there are. The longer carbon chain means a higher percentage of the heavy compounds in the oil, so it can be expected that the higher the molecular mass of the oil, the higher the percentage of heavy matter in it. The results of this chart also show that as the operating temperature of the oil passing through the sand bed decreases, the amount of heavy hydrocarbon deposits in the oil also increases. The reason for this is that as the operating temperature decreases, the amount of thermal flux and, of course, the amount of heat distribution in the oil decreases, and eventually the percentage of heavy hydrocarbon deposition from oil will also increase. The experimental results show the amount of heavy hydrocarbon precipitation in nano oil is 8% to 13.6% less than simple oil.

The figure 4 shows the relationship between operating temperature and crude oil density. In principle, in this section, the effect of temperature on the density of all three crude oil samples has been investigated. What emerges from this chart is that with increasing operating temperature, the density of all three crude oil samples decreases. The reason for this could be to increase the inter-molecular distance of oil and thus increase the volume of oil. As we know, density is inversely proportional to volume, and density increases with increasing volume. Therefore, as the operating temperature increases, the inter-molecular distance and, of course, the inter-molecular volume increase, and as a result, the oil density decreases. The results of practical studies show that light crude oil has the lowest density, then medium crude oil, and finally heavy crude oil with maximum density. The amount of density is decreased with 50°C to 90°C. the range of densities for heavy, medium and light oil is 0.904 to 0.856, 0.887 to 0.843 and 0.872 to 0.831 gr/cm^3, respectively.

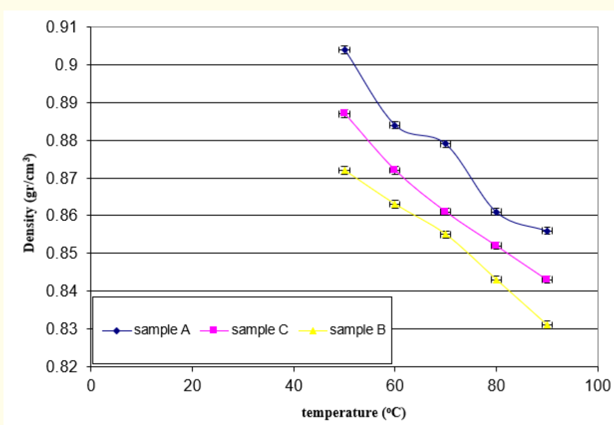

Figure 4: Density values versus operating temperature, sample A, B and C.

Conclusion

In this study, several samples of crude oil containing nanoparticles have been studied. However, light crude oil has been evaluated more than other samples. Also, the density of three samples of light, medium and heavy crude oil has been measured in the laboratory. The results presented in figure 1 show that light crude oil containing nanoparticles can pass through the sandy bed more easily than light heat exchanger after taking heat from nanoparticles. As a result, its recycling rate is higher than oil without nanoparticles. The laboratory results presented in figure 2 show that the percentage of precipitation of heavy hydrocarbons separated from crude oil increases with increasing pump outlet pressure. Also, the data obtained in these experiments show that with increasing operating temperature, the percentage of deposition of heavy hydrocarbons in oil decreases. According to figure 2, it can be concluded that the nanoparticles distributed in crude oil have a significant effect on reducing the hydrocarbons deposited by the oil. The reason for this could be the distribution and cohesion of the thermal flux in the oil molecular tissue in which the nanoparticles are dissolved. Figure 3 shows the relationship between oils with different molecular weights and the percentage of precipitation of heavy hydrocarbons. Experiments in this section show that the higher the molecular mass of the oil, the higher the percentage of heavy hydrocarbons separated from the oil. The reason for this is that the higher the molecular mass of the oil, the more carbon-containing hydrocarbons there are. The longer carbon chain means a higher percentage of the heavy compounds in the oil, so it can be expected that the higher the molecular mass of the oil, the higher the percentage of heavy matter in it. In addition, the results of this chart also show that as the operating temperature of the oil passing through the sand bed decreases, the amount of heavy hydrocarbon deposits in the oil also increases. The reason for this is that as the operating temperature decreases, the amount of thermal flux and, of course, the amount of heat distribution in the oil decreases, and eventually the percentage of heavy hydrocarbon deposition from oil will also increase. The experimental results show the relationship between operating temperature and crude oil density. In principle, in this section, the effect of temperature on the density of all three crude oil samples has been investigated. What emerges from this chart is that with increasing operating temperature, the density of all three crude oil samples decreases. The reason for this could be to increase the inter-molecular distance of oil and thus increase the volume of oil. As we know, density is inversely proportional to volume, and density increases with increasing volume. Therefore, as the operating temperature increases, the inter-molecular distance and, of course, the inter-molecular volume increase, and as a result, the oil density decreases. The results of practical studies show that light crude oil has the lowest density, then medium crude oil and finally heavy crude oil with maximum density.

Bibliography

1. Pi Jun-Ke., *et al.* "One-pot mussel-inspiration and silication: A platform for constructing oil-repellent surfaces toward crude oil/water separation". *Journal of Membrane Science* 601.1 (2020): 117915.

2. Tian Shujie., *et al.* "Effects of surface modification Nano-SiO_2 and its combination with surfactant on interfacial tension and emulsion stability". *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 595.20 (2020): 124682.

3. Khalid Mozamil., *et al.* "Effect of Nano-Clay Cloisite 20A on water-in-oil stable emulsion flow at different temperatures". *Journal of Petroleum Science and Engineering* 184 (2020):106595.

4. Du Fengshuang., *et al.* "Effect of vertical heterogeneity and nano-confinement on the recovery performance of oil-rich shale reservoir". *Fuel* 2671 (2020): 117199.

5. Afra Mohammad., *et al.* "Experimental study of implementing nano thermal insulation coating on the steam injection tubes in enhanced oil recovery operation for reducing heat loss". *Journal of Petroleum Science and Engineering* 189 (2020):107012.

6. Xu Baomei., *et al.* "Oil-in-water Pickering emulsions using a protein nano-ring as high-grade emulsifiers". *Colloids and Surfaces B: Biointerfaces* 187 (2020): 110646.

7. Dhahad Hayder A and Chaichan Miqdam T. "The impact of adding nano-Al2O3 and nano-ZnO to Iraqi diesel fuel in terms of compression ignition engines' performance and emitted pollutants". *Thermal Science and Engineering Progress* 181 (2020):100535.

8. Gayathri J and Elansezhian R. "Influence of dual reinforcement (nano CuO + reused spent alumina catalyst) on microstructure and mechanical properties of aluminium metal matrix composite". *Journal of Alloys and Compounds* 829.15 (2020): 154538.

9. Saini Vinay., *et al.* "Role of base oils in developing extreme pressure lubricants by exploring nano-PTFE particles". *Tribology International* 143 (2020): 106071.

10. Harsij Mohammad., *et al.* "Effects of antioxidant supplementation (nano selenium, vitamin C and E) on growth performance, blood biochemistry, immune status and body composition of rainbow trout (Oncorhynchus mykiss) under sub-lethal ammonia exposure". *Aquaculture* 521.15 (2020):734942.

11. Oushani Ali Khani., *et al.* "Effects of dietary chitosan and nano-chitosan loaded clinoptilolite on growth and immune responses of rainbow trout (Oncorhynchus mykiss)". *Fish and Shellfish Immunology* 98 (2020): 210-217.

12. Kusworo Tutuk Djoko., *et al.* "Performance evaluation of modified nanohybrid membrane polyethersulfone-nano ZnO (PES-nano ZnO) using three combination effect of PVP, irradiation of ultraviolet and thermal for biodiesel purification". *Renewable Energy* 148 (2020): 935-945.

13. Rezaei Amin., *et al.* "Integrating surfactant, alkali and nano-fluid flooding for enhanced oil recovery: A mechanistic experimental study of novel chemical combinations". *Journal of Molecular Liquids* 308.15 (2020): 113106.

14. Rathnaweera TD and Ranjith PG. "Nano-modified CO_2 for enhanced deep saline CO_2 sequestration: A review and perspective study". *Earth-Science Reviews* 200 (2020): 103035.

15. Zhou Tianchi., *et al.* "Construction of anti-flame network structures in cotton fabrics with pentaerythritol phosphate urea salt and nano SiO_2". *Applied Surface Science* 507.30 (2020): 145175.

16. Nematian Tahereh., *et al.* "Conversion of bio-oil extracted from Chlorella vulgaris micro algae to biodiesel via modified superparamagnetic nano-biocatalyst". *Renewable Energy* 146 (2020): 1796-1804.

17. Krishnamurthy KN., *et al.* "Optimization and kinetic study of biodiesel production from Hydnocarpus wightiana oil and dairy waste scum using snail shell CaO nano catalyst". *Renewable Energy* 146 (2020): 280-296.