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The Effect of Nano Particles on the Physical Properties of Heavy and Light Oils

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Abstract

In its strictest sense, petroleum includes only crude oil, but in common usage it includes all liquid, gaseous, and solid hydrocarbons. Under surface pressure and temperature conditions, lighter hydrocarbons methane, ethane, propane and butane occur as gases, while pentane and heavier ones are in the form of liquids or solids. Crude oil, liquid petroleum that is found accumulated in various porous rock formations in Earth's crust and is extracted for burning as fuel or for processing into chemical products. Although it is often called "black gold," crude oil has ranging viscosity and can vary in color to various shades of black and yellow depending on its hydrocarbon composition. At the beginning, the molybdenum nano particles (with the average size of 75-89 nano meter) are synthesized and then is added to crude oil. The some physical properties of light and heavy oil is evaluated, finally. The changes in viscosity, recovery %, asphaltene precipitation are surveyed in various temperature and pressure. Results are shown in Figures and the optimum values of properties are introduced.

Keywords

Crude Oil, Temperature, Black Gold, Fuel, Composition

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1. Introduction

In 1847, the process to distill kerosene from crude oil was invented by James Young [1]. He noticed a natural petroleum seepage in the Riddings colliery at Alfreton, Derbyshire from which he distilled a light thin oil suitable for use as lamp oil, at the same time obtaining a thicker oil suitable for lubricating machinery. In 1848 Young set up a small business refining the crude oil [2]. Young eventually succeeded, by distilling cannel coal at a low heat, in creating fluid resembling petroleum, which when treated in the same way as the seep oil gave similar products. Young found that by slow distillation he could obtain a number of useful liquids from it, one of which he named "paraffin oil" because at low temperatures it congealed into a substance resembling paraffin wax. Another early refinery was built by Ignacy Łukasiewicz, providing a cheaper alternative to whale oil. The demand for petroleum as a fuel for lighting in North America and around the world quickly grew [3]. Edwin Drake's 1859 well near Titusville, Pennsylvania, is popularly considered the first modern well. Drake's well is probably singled out because it was drilled, not dug; because it used a steam engine; because there was a company associated with it; and because it touched off a major boom. However, there was considerable activity before Drake in various parts of the world in the mid-19th century. A group directed by Major Alexeyev of the Bakinskii Corps of Mining Engineers hand-drilled a well in the Baku region in 1848 [4]. There were engine-drilled wells in West Virginia in the same year as Drake's well. An early commercial well was hand dug in Poland in 1853, and another in nearby Romania in 1857. At

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around the same time the world's first, small, oil refinery was opened at Jasło in Poland, with a larger one opened at Ploiești in Romania shortly after. Romania is the first country in the world to have had its annual crude oil output officially recorded in international statistics: 275 tonnes for 1857 [5]. The first commercial oil well in Canada became operational in 1858 at Oil Springs, Ontario (then Canada West). Businessman James Miller Williams dug several wells between 1855 and 1858 before discovering a rich reserve of oil four meters below ground [6]. Williams extracted 1.5 million liters of crude oil by 1860, refining much of it into kerosene lamp oil. William's well became commercially viable a year before Drake's Pennsylvania operation and could be argued to be the first commercial oil well in North America [7]. The discovery at Oil Springs touched off an oil boom which brought hundreds of speculators and workers to the area. Advances in drilling continued into 1862 when local driller Shaw reached a depth of 62 meters using the spring-pole drilling method [8]. On January 16, 1862, after an explosion of natural gas Canada's first oil gusher came into production, shooting into the is at a recorded rate of 3,000 barrels per day. By the end of the 19th century the Russian Empire, particularly the Branobel company in Azerbaijan, had taken the lead in production. Access to oil was and still is a major factor in several military conflicts of the twentieth century, including World War II, during which oil facilities were a major strategic asset and were extensively bombed [9]. The German invasion of the Soviet Union included the goal to capture the Baku oilfields, as it would provide much needed oil-supplies for the German military which was suffering from blockades [10]. Oil exploration in North America during the early 20th century later led to the US becoming the leading producer by mid-century [11]. As petroleum production in the US peaked during the 1960s, however, the United States was surpassed by Saudi Arabia and the Soviet Union [12]. Today, about 90 percent of vehicular fuel needs are met by oil. Petroleum also makes up 40 percent of total energy consumption in the United States, but is responsible for only 1 percent of electricity generation. Petroleum's worth as a portable, dense energy source powering the vast majority of vehicles and as the base of many industrial chemicals makes it one of the world's most important commodities. Viability of the oil commodity is controlled by several key parameters, number of vehicles in the world competing for fuel, quantity of oil exported to the world market (Export Land Model), Net Energy Gain (economically useful energy provided minus energy consumed), political stability of oil exporting nations and ability to defend oil supply lines. The top three oil producing countries are Russia, Saudi Arabia and the United States. About 80 percent of the world's readily accessible reserves are located in the Middle East, with 62.5 percent coming from the Arab 5: Saudi Arabia, UAE, Iraq, Qatar and Kuwait. A large portion of the world's total oil exists as unconventional sources, such as bitumen in Canada and extra heavy oil in Venezuela. While significant volumes of oil are extracted from oil sands, particularly in Canada, logistical and technical hurdles remain, as oil extraction requires large amounts of heat and water, making its net energy content quite low relative to conventional crude oil. Thus, Canada's oil sands are not expected to provide more than a few million barrels per day in the foreseeable future. In its strictest sense, petroleum includes only crude oil, but in common usage it includes all liquid, gaseous, and solid hydrocarbons. Under surface pressure and temperature conditions, lighter hydrocarbons methane, ethane, propane and butane occur as gases, while pentane and heavier ones are in the form of liquids or solids. However, in an underground oil reservoir the proportions of gas, liquid, and solid depend on subsurface conditions and on the phase diagram of the petroleum mixture. An oil well produces predominantly crude oil, with some natural gas dissolved in it. Because the pressure is lower at the surface than underground, some of the gas will come out of solution and be recovered (or burned) as associated gas or solution gas. A gas well produces predominantly natural gas. However, because the underground temperature and pressure are higher than at the surface, the gas may contain heavier hydrocarbons such as pentane, hexane, and heptane in the gaseous state. At surface conditions these will condense out of the gas to form natural gas condensate, often shortened to condensate. Condensate resembles petrol in appearance and is similar in composition to some volatile light crude oils. The proportion of light hydrocarbons in the petroleum mixture varies greatly among different oil fields, ranging from as much as 97 percent by weight in the lighter oils to as little as 50 percent in the heavier oils and bitumens.

The hydrocarbons in crude oil are mostly alkanes, cycloalkanes and various aromatic hydrocarbons while the other organic compounds contain nitrogen, oxygen and sulfur, and trace amounts of metals such as iron, nickel, copper and vanadium. The exact molecular composition varies widely from formation to formation but the proportion of chemical elements varies over fairly narrow limits as follows. Distillation, the process by which oil is heated and separated in different components, is the first stage in refining. Crude oil is any naturally-occurring flammable mixture of hydrocarbons found in geologic formations, such as rock strata. Most petroleum is a fossil fuel, formed from the action of intense pressure and heat on buried dead zooplankton and algae. Technically, the term petroleum only refers to crude oil, but sometimes it is applied to describe any solid, liquid or gaseous hydrocarbons. Petroleum consists primarily of paraffin’s and naphthenic, with a smaller amount of aromatics and asphaltic. The exact chemical composition is a sort of fingerprint for the source of the petroleum.

2. Materials and Method

Two samples of crude oil are used in this experimental work. Physical properties, and component assay of these samples are shown in Table 1-a. and 1-b.

10 gr nano molybdenum oxide is added into 1 kg oil using ultrasonic method. Surely, the conditions of reservoir are important on the properties of oils. So, Table 2 shows the conditions of reservoir.

Table 1. a) Physical properties of crude oil.

Property	Sample A	Sample B
Molecular Weight of Oil(gr/grmol)	168.34	74.78
Asphalten (W%)	15.53	0.94
Aromatics (W%)	38.99	37.03
Resins (W%)	13.62	2.71
Saturated (W%)	31.86	59.32
API	21.45	32.96
Gas/Oil ratio(sm3/sm3)	77.84	267.13
Wax Appearance temperature ©	40C	25C

Recovery of heavy oil from sand beds is investigated in this work, experimentally. Same sand beds are provided and set in the experimental vessel one by one for each light oil and heavy oil with and without nano particles, separately. Sand bed is weighted before experiment.

Table 1. b) Components of two samples of oil.

Component	Sample A	Sample B
C1	22.32	41.45
C2	8.81	8.74
C3	4.45	5.71
i-C4	0.81	1.33
n-C 4	3.21	2.12
i-C5	0.97	1.83
n-C5	1.3	2.56
C6	6.07	2.41
C7	2.96	2.28
C8	3.49	3.39
C9	2.23	2.75
C10	1.87	2.04
C11	3.72	2.11
C12	30.23	9.55
H2S	2.54	6.37
N2	0.37	1.41
CO2	4.65	3.95
Total (mol%)	100	100

Oil stream passed through the bed at the same conditions. Sand bed is weighted after passing the oil. The vessel, is heated till the amounts of oil recovery are leveled out at different temperatures.

Table 2. Thermodynamic conditions of reservoir.

Conditions	Sample A	Sample B
Initial Static Pressure (Psia)	9200	9420
Reservoir Temperature (C)	143	158
Bubble Point (Pb) (Psia)	4810	4852
Stock Tank Density (gr/cc)	0.867	0.797

3. Results and Discussion

Properties of crude oil are important in refinement processes in refineries. Investigations have been focused on separation methods which lead to the refined oil with acceptable quality. Addition of nano molybdenum particles in two kinds of medium and light oil samples is investigated and viscosity and recovery % of oils are surveyed. Also, H2S removal and asphaltene precipitation in different temperatures and pressures are investigated, experimentally.

Figure 1 shows the effect of nanoparticles in variations of oil viscosity for sample A, with various temperatures. Results show the increase in temperature from 50C to 90C decreases the amount of viscosity. Nano particle decreases the viscosity about 24%.

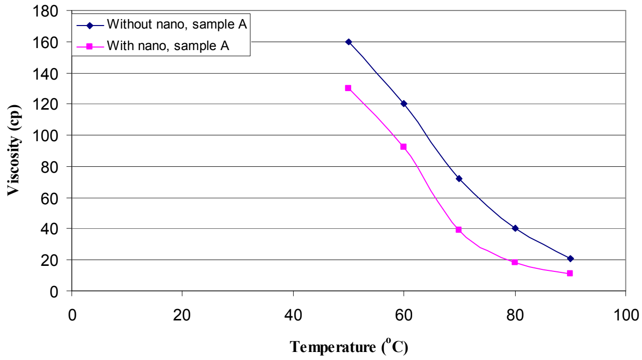

Figure 1. Viscosity versus temperature of sample A with and without nano particle.

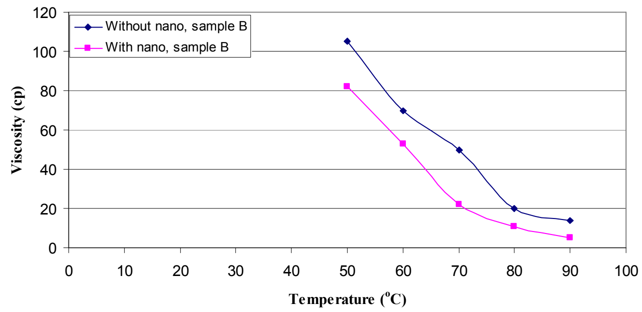

Figure 2. Viscosity versus temperature of sample B with and without nano particle.

Figure 2 shows the variations in viscosity of oil type B with temperature with and without nano particles. Increasing temperature from 50C to 90C decreases the viscosity from 110 cp to 15 cp and 82 cp to 5 cp for sample B without nano and with nano, respectively. The average value of decreasing the viscosity is 23%.

4. Conclusions

Application of nano particles to introduce the novel oil refinement techniques is studied, in this work. The effect of nano molybdenum oxide particle on the important factors in oil refinery process for light oil (API= 32.95) and heavy oil (API =21.45) is considered. Experiments are held to investigate the viscosity, the amount of asphltene precipitation, oil recovery from the sand bed and H2S removal percentage for oil samples containing nano particles. Results show the increase in temperature from 50C to 90C decreases the amount of viscosity of sample A. Also, nano particle decreases the viscosity about 24%. For sample B, the increasing temperature from 50C to 90C decreases the viscosity from 110 cp to 15 cp and 82 cp to 5 cp without and with nano, respectively. Results show the average value decreasing of viscosity is 23% for sample B.

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