International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 95-97

Received: 25-10-2018
Accepted: 09-12-2018

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Empirical study of major items in the sulfur removal process from heavy and light crude oil

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Abstract
Finding the properties of crude oil after addition of nano particle is considered in this work. The experiments are held to investigate the effect of nano particles on the physical properties of two kinds of heavy crude oil (API =21.45) and light crude oil (API= 32.95). 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. Nano copper oxide with range of 70-90 nm approximately in diameter is added in crude oil and changes in hydrogen sulfide removal is surveyed with various temperature and pressure.

Keywords: API, hydrogen, pressure, asphaltene precipitation, oil, molecular weight

1. Introduction

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 [1]. 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 [2]. Undoubtedly, crude oil is one of the powerful sources of energy provision in the world. In 1847, the process to distill kerosene from crude oil was invented by James Young [3]. 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 [4]. 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. Scientifics found that by slow distillation he could obtain a number of useful liquids from it, one of which he named "paraffine oil" because at low temperatures it congealed into a substance resembling paraffin wax [5].

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 [6]. 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 [7]. 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 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 [8]. 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 [9]. 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 [10]. The discovery at Oil Springs touched off an oil boom which brought hundreds of speculators and workers to the area [11].

Advances in drilling continued into 1862 when local driller Shaw reached a depth of 62 meters using the spring-pole drilling method [12]. 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 the Azerbaijan, had taken the lead in production [13-14].

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. 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. Oil exploration in North America during the early 20th century later led to the US becoming the leading producer by mid-century. As petroleum production in the US peaked during the 1960s, however, the United States was surpassed by Saudi Arabia and the Soviet Union [15].

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 [16].

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 [17]. 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 bitumen’s.

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 paraffins and naphthenes, with a smaller amount of aromatics and asphaltics. The exact chemical composition is a sort of fingerprint for the source of the petroleum. The novel papers state, the global average recovery factor for a typical oil field is approximately 40%. This results in a large amount of identified oil left behind despite an existing production infrastructure. So, the need to improve the recovery factor and the accelerating of the associated production is the main driver behind the many EOR schemes in practice around the world. The challenge to EOR lies in the complex interaction of injected agents with the existing reservoir fluids in an ever-changing down hole environment. Many of these challenges are well known from the development of the field. The difficulty is ensuring the proper chemical interaction and subsequent flow conformance of the EOR sweep front to recovery more oil, more quickly. Making the right parametric decisions regarding a chosen EOR technique, while evaluating dynamic economic conditions, compounds these complex challenges.

To ensure successful long-term recovery, the authors use the nano particles and pilot studies, and sophisticated monitoring tools to make the best decisions. Investigation of recovery factor, asphaltene precipitation, sulphure compound removal at presence of nanoparticle is investigated to help the enhanced oil recovery. So, reservoir data coupled with detailed production history that leads to the best decisions for these complex EOR problems.

2. Materials and Method

Two samples of crude oil are used in this experimental work.

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 copper particles in two kinds of medium and light oil samples is investigated and viscosity and recovery% of oils are surveyed. Also, H_2S removal and asphaltene precipitation in different temperatures and pressures are investigated, experimentally.

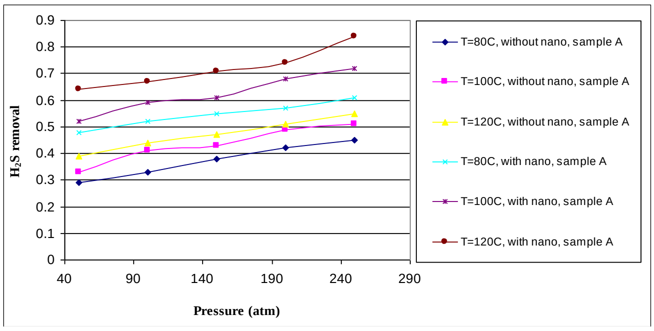

Fig 1: H_2S removal versus pressure for sample A.

Figure 1 and Figure 2 shows the effect of various temperatures and pressures on the amount of H2S removal from oil sample A and B, respectively. Results show the higher amounts of H2S removal from the oil including nano particles. The increase in temperature shows the increase in the amount of H2S separation. This may relate to the lower viscosity, and homogenize temperature which leads to proper oil distribution in the catalytic bed. All these are since of the nano particles. The optimum conditions for H2S removal from the oil containing nano particle are 120 C and 250 atm. The value of H2S removal for the heavy nano oil is 85% and for the light nano oil is 90% at the optimum conditions.

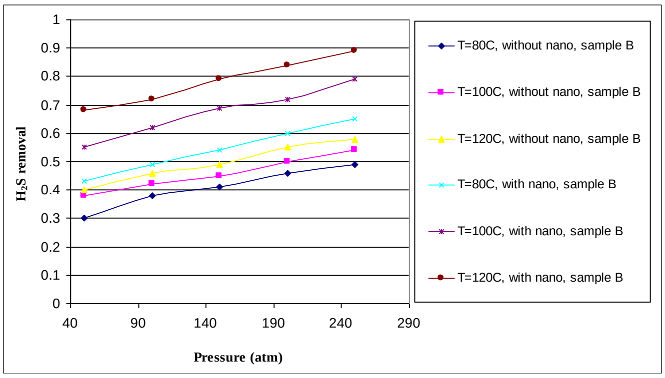

Fig 2: H2S removal versus pressure for sample B.

4. Conclusion
Application of nano particles to introduce the novel oil refinement techniques is studied, in this work. The effect of nano copper oxide particle on the important factors in oil refinery process for light oil (API= 32.95) and heavy oil (API =21.45) is considered. The amount of H2S removal increases when oil contains nano particles, 15% and 10% at 120 °C for heavy and light oil, respectively. The proper operation conditions for oil sweetening and asphaltene precipitation beside a new technique in oil refinement process are introduced in this research.

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