Section: # Heavy Oil

SPE WVPS

Reduction of Carbon Dioxide Emissions from Heavy Crude Oil by adding a Viscosity Bioreductor.

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Abstract

In recent times, more attention has been paid to emissions of toxic and greenhouse gases to the atmosphere. One of the main sources of CO_2 is from the burning of fossil hydrocarbons materials. Crude oil has a variety of organic and inorganic chemicals leading to a sophisticated process and treatments providing useful petroleum fractions in a more efficient way, causing the least possible damage to users. High viscosity has been a major challenge for the oil industry, due to the discovery of new deposits with extra heavy oil; heavy and extra heavy crude oil production is increasing, requiring better conditions for fluid transportation.

Mixtures with crude and BRV®, a viscosity reducer, were made to determine de percentage of viscosity reduction; samples were taken at the northen part of Mexico. We found that dosing 2% of BRV®-plus produced a viscosity reduction of up to 50%. This same dosage percentage had a positive impact on the emissions of CO_2 from the burning of crude, causing a reduction of 1.8% on these emissions. This is because BRV®-plus is made mainly from renewable materials that are naturally synthesized by plants from atmospheric CO_2, developing a highly sustainable value chain. Biodegradable, organic, and natural chemical products are key for this sustainable development.

1.0 Introduction

Since the early sixties, people started noticing an increasing number of climate changing conditions, from extremely cold winters experienced in the Northern Hemisphere, through devastating droughts in the Sahel (Sahara desert). These events turned on the red lights, thus leading to the conclusion that they were probably caused by global warming due to the greenhouse gas effect, consequence of the increased concentrations of carbon dioxide and other gases in the atmosphere. That was evident from those years in human activities, which began to cause certain impacts on the Earth's climate on a global scale. [1]

Between 1970 and 2004, carbon dioxide emissions increased by 80% and accounted for 77% of total emissions of greenhouse gases in 2004, of which 56.6% of the emissions of CO_2 are emitted by use and burning of the fossil fuels [2], making it one of the human activities that emit the highest levels of CO_2 to the atmosphere. [3]

Due to these events, different measures have been taken globally, such as changing government policies, looking for new sources of renewable energy, replacing fossil fuel sources, improving process efficiency and effectiveness of energy, as well as further research in the field of biofuels, activities for decreasing the amount of greenhouse gas emissions.[4]

On the other hand, the oil industry has tried to reduce the viscosity of extra heavy oil currently produced, in order to improve its transportation by offshore pipelines [5]; new technologies will improve this process, leading to avoid energy losses in production. Viscosity control [6] is crucial when considering activivities such as piping and pipeline construction, reservoir simulation, and oil structure determination. Several researchers have been playing an active role in the development of different models with acceptable accuracy, based on previous properties such as molecular weight, normal boiling point, critical temperature and acentric factor of the components used, among other variables; however, they have failed to predict oil viscosities in wide range of operating conditions such as pressure and temperature [7, 8].

The viscosity of oil may be affected by different variables such as: changes in temperature and pressure, the amount of paraffins and asphaltenes [9, 10], the source, type and chemical composition nature of the oil (particularly its polar components), as well as the thermal diffusion [11]; these large number of variables for reducing viscosity have been under several investigations. Within these research studies was found that heavy crude oil can be reduced by electrical pulses or pulses of magnetic fields, although this method is not very effective because it is not permanent and only works a few hours [5]. Another method that works better is the addition of chemical compounds [12] which may be from sunflower oil, canola oil, and soybean oil, mixed with adipates, oleates, polyolefins, mineral oils, as well as hydrocarbon polymers such as polyisobutylene, and ethylene-propylene [10, 13], however, there are more cost-efficient bioreductors compared with the previous compounds, including kerosene, which is one of the commonly used diluents [14].

2.0 Methods

Several mixtures were made adding different dosages of BRV®-plus (a viscosity bioreductor from vegetable oils) to dead crude oil of wells of wells located at in north Mexico, with 19076cP of viscosity, with quantities of <0.1% (w / w) of sediment and water emulsion. A Brookfield viscometer was used to determine the viscosity reduction percentage. A gas chromatograph coupled to a mass Spectrometer Perkin Elmer was also used for determining the initial amount of CO_2 emitted by crude oils at the time of combustion, quantifying the amount of the gas produced. The results in terms of reduction of carbon dioxide are consistent with our theoretical estimates.

3.0 Results

Figure 1 shows the viscosity reduction greater to 50% at dosages of 2 to 3% of BRV®-plus. It is important to note that this reduction depends on the characteristics of the analyzed crude.

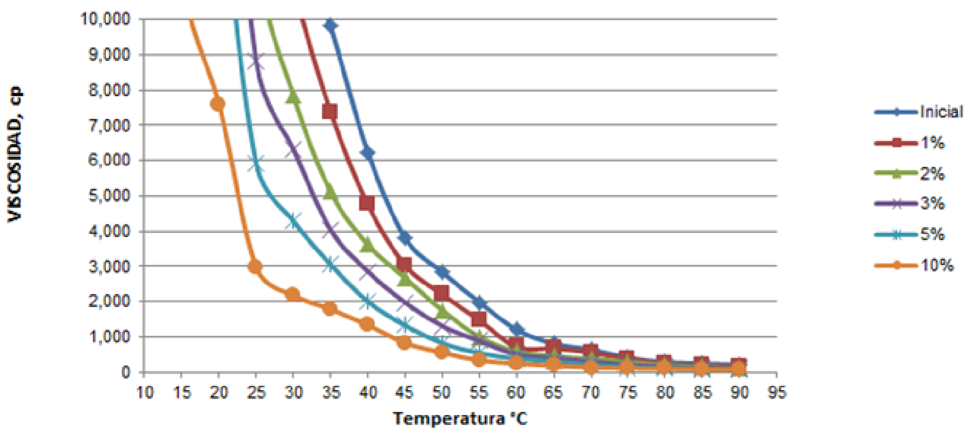

Figure 1.- Viscosity Reduction of a crude oil sample at different temperatures and dosages

Figure 2 shows the infrared spectrum of one of the active ingredients constituting the BRV®-plus.

Presence of polar carbon-oxygen type was found when analyzing one of the active ingredients of BRV®-plus. These compounds will be of further examination in a future research study.

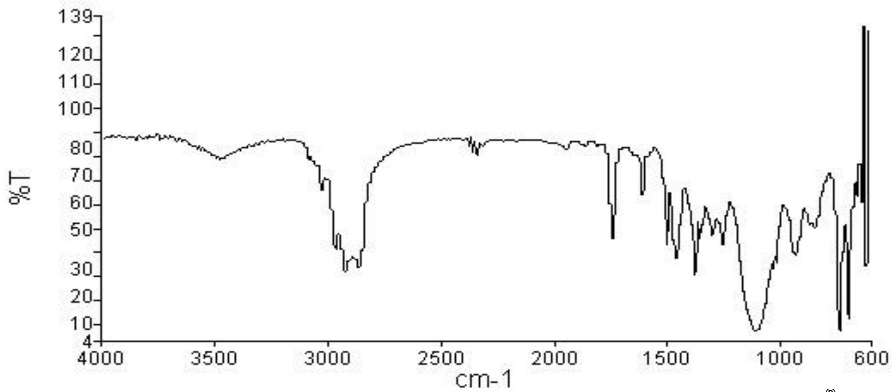

Figure 2 . Infrared spectrum for one of the active ingredients of the BRV®-plus

For the calculation of CO_2 emissions, it is estimated that 1 barrel of heavy crude density 0.95, which is 151 kg, to be used completely as fuel, generates 492 kg of CO_2 into the environment.

Suppose that the crops are at a steady state (during initial growth, plants absorb CO_2 to produce its own biomass and no oil is produced); CO_2 coming from the environment is incorporated then into the oil. Therefore, the use of this oil or its derivative (BRV® in this case), has a net zero carbon footprint, meaning that the amount of CO_2 released to the environment at the time of combustion is equal to the amount absorbed by the plant during its growth process).

A barrel of crude oil that is completely used as fuel contains 151 kg. Adding 2% of the BRV® to this barrel causes a reduction of 2.77 kg in the total amount of crude oil. The CO_2 emissions caused when burning these mixed barrel of crude and BRV® are of 483 kg, being 8.9 kg less that the emissions produced by the original barrel of oil (492 kg).

It was found that a dosage of 2% of BRV®-plus produces a viscosity reduction of up to 50% at normal laboratory conditions, causing as well a reduction of 1.8% of CO_2 emissions released at the time of combustion.

For experimental quantification, 1.5g triplicate sample oil and gases recovered at a steel bullet were calcined. According to the gas chromatographic analysis, we obtained 4.76 ± 0.03 g of presence of CO_2. The same process was performed to the sample with BRV®-plus, resulting in 4.68 ± 0.02 g of CO_2 which meant a reduction in the gas content.

4.0 Conclusions

It is possible to get viscosity reductions of percentages greater that 50% at dosages between 2 and 3% of BRV®-plus (V / V).

We saw that theoretical and experimental results show the reduction of approximately 1.8% in CO_2 emissions is because the content of BRV®-plus mixed in a barrel of crude oil. This formulation consists mainly of renewable materials that are naturally synthesized by plants, organic chemicals, natural and biodegradable, elements of great importance in sustainable development.

Aknowledgment

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5.0 References

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