iJET EXPLORE International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 2 No. 7, July, 2012

Experimental Study of the Change in Density, Viscosity and Acidity of Bonny Light Crude Contaminated with CO_2

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ABSTRACT

This research studies the effect of CO_2 on Bonny light crude during possible CO_2 storage in a Niger-Delta reservoir. It also correspond to dry CO_2 flooding of Bonny light. The result obtained indicated an increase in the apparent viscosity of the oil for the first few days followed by a reduction in the apparent viscosity. The specific gravity was constant for first two days and shows an interesting reduction for the next four days, followed by increase in the specific gravity thereafter. The only explanation is that the CO_2 must have become soluble in the crude for the first few days resulting into lower crude density by the third day since the gas is lighter than the crude but during this period, the mixture viscosity is expected to have reduced instead of the increase. After the sixth day, further injection of the CO_2 made the crude denser an indication that there might have been evaporation of lighter component of the crude which was expected to correspond to .increasing crude viscosity. The observed reduction in viscosity during this is an abnormality and could have resulted due to increase surface interactions between the CO_2 and the crude molecules in the mixture.

Keywords: *Bonnylight crude, CO_2 contamination, crude density variation, crude viscosity*

1. INTRODUCTION

Carbon Dioxide founds its way into the subsurface reservoirs in two artificial ways, through CO_2 flooding and through Carbon Capture and Storage (CCS) process.

Due to the numerous characteristic growth faults of the Niger-Delta, the study assumes that stored Carbon Dioxide (CO_2) could leak out of the storage reservoir to a producing reservoir. This can occur when stored CO_2 reacts with reservoir grains according to a study by Rochelle et al [1] or could be as a result of natural flow through a non-sealing fault. They discovered that CO_2 will be stored as a free phase within the reservoir rock immediately after injection, but assumed that after sometime it will dissolve into the local formation water initiating different geochemical reactions. These reactions are expected to either help in trapping or detrimental to the trapping of the CO2. The leakage could also be as a result of fracturing due to pressure of injection of CO_2 in that reservoir since the gas is injected at high pressure [2]. Srivastava and Harpalani [3] investigated the permeability variation with CO_2 injection in coal-gas reservoirs and also studied its impact on methane production.

Carbon Sciences Inc [4], developed a patent on using CO_2 gas flooding of associated gas for the production of synthetic crude, called Carboncrude. This is a Gas-To-Liquid (GTL) product. The gas was injected into the crude-associated gas stream to strip off the gas from the gas-oil stream instead of the gas going into flaring. This is a very recent research that studies CO_2 interaction with crude oil associated gas. Their main aim is to produce a fuel cleaner than conventional fuel.

Houston et al [5] stated that CO_2 sequestration could actually be applied as means of pushing out more oil from existing and producing oilfields. This is based on the assumption that the CO_2 will react and remain in the reservoir while its volume and pressure generated due to injection will enhance oil production.

2. METHODOLOGY

The methodology followed in the course of this research is as follows:

1. Standard oil-based and water-based fluids were prepared.
2. Simple apparatus such as viscometer, density balance and pH were used in the measurement of the initial properties of the mud such as the density, shear stress, yield point, resistivity and acidity.
3. CO_2 was injected into the crude intermittently for a short period everyday for a total period of 9 days. The crude sample is sealed and allowed to react with

the injected CO_2 for a period of 24hours before measurement is taken.

4. The effect of the injected CO_2 on the density, shear stress and the pH of the Crude Oil was measured daily before new CO_2 injection.
5. The apparent viscosity of the Crude Oil was calculated from obtained data

3. RESULTS

The results obtained in the cause of the experiments are as stated in the tables. Table 1 is the table of the shear stress of the Crude Oil as days of exposure to CO_2 increases while Table 2 gives the pH variation with CO_2 injection. Table3 indicated the variation in the crude density with increasing CO_2 contamination. The results of the measured and calculated data are as shown in the graphs 1, 2 and 3 below.

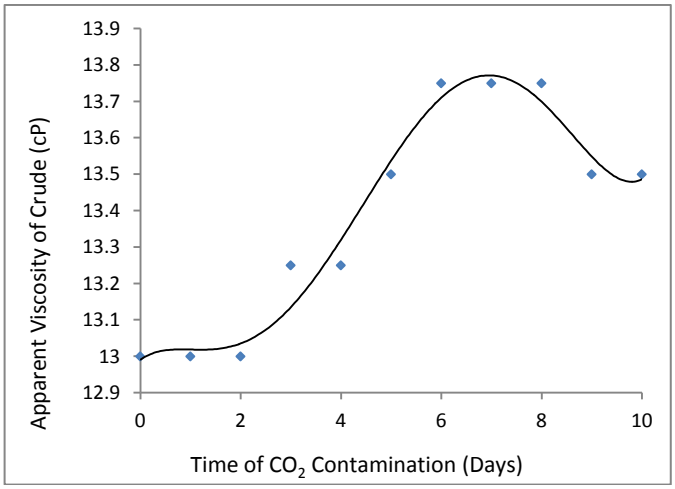

Figure 1: Change in Apparent Viscosity of Crude with CO_2 Contamination

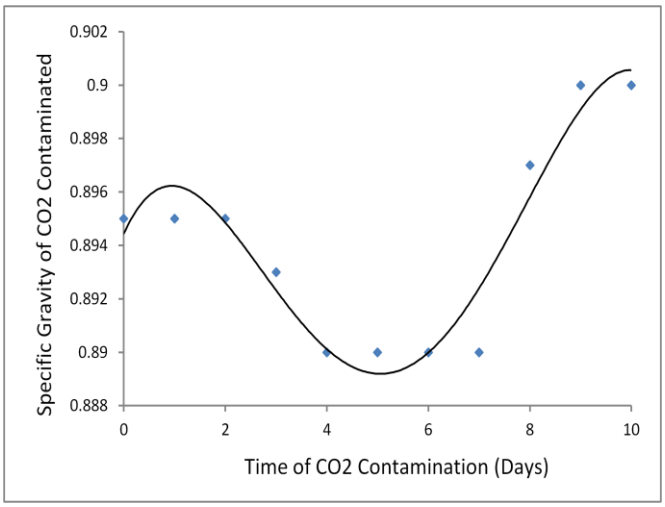

Figure 2: Change in Specific Gravity of Crude Oil with CO_2 Contamination

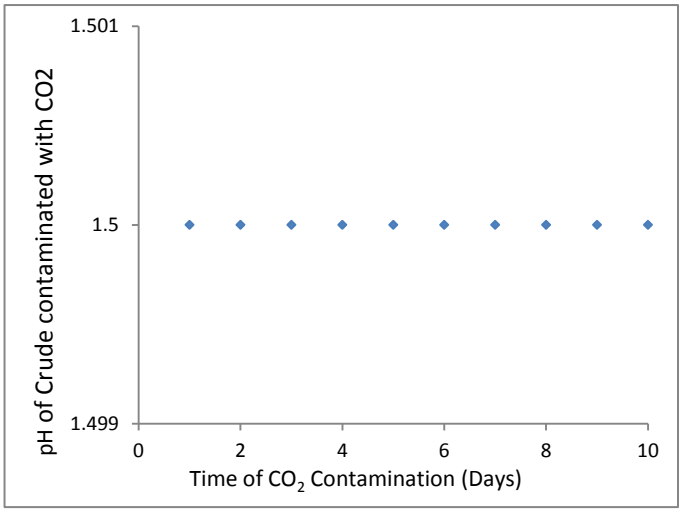

Figure 3: pH Variation with CO_2 Contamination

Table 1: Crude Oil Shear Stress with CO_2 Injection

TIME (Days)	600RPM READING (cP)	300RPM READING (cP)	AV(cp)
0	26	13	13
1	26	13	13
2	26	13	13
3	26.5	14	13.25
4	26.5	13.5	13.25
5	27	13.5	13.5
6	27.5	13.5	13.75
7	27.5	13.5	13.75
8	27.5	13.5	13.75
9	27	13	13.5
10	27	13	13.5

Table 2: Crude Oil pH Measurement with Increasing CO_2 Injection

TIME (DAYS)	pH of CO_2 Contaminated Crude
1	1.5
2	1.5
3	1.5
4	1.5
5	1.5
6	1.5
7	1.5
8	1.5
9	1.5
10	1.5

Table 3: Variation in Crude Density with CO_2 Injection

TIME (DAYS)	ρ (ppg)	ρ (sp.gr)
0	7.46	0.895
1	7.46	0.895
2	7.46	0.895
3	7.44	0.893
4	7.41	0.89
5	7.41	0.89
6	7.41	0.89
7	7.41	0.89
8	7.47	0.897
9	7.50	0.9
10	7.50	0.9

4. CONCLUSION

The result obtained indicated a constant in the apparent viscosity of the oil for the first two days followed by a 5.1% increase in the apparent viscosity over the next 5 days after which there was a reduction of 1.8%. The specific gravity was constant for first two days and followed later by 0.6% increase within the next 7 days. After the sixth day, further injection of the CO_2 made the crude denser an indication that there might be evaporation of lighter component of the crude that is expected to correspond to .increasing viscosity. The observed reduction in viscosity is an abnormality and could have resulted due to increase surface interactions between the CO_2 and the crude molecules in the mixture.

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