

Experimental Study of the Change in Porosity of Imeri Oilsand Rock Contaminated with CO_2

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Abstract

This research studies the effect of CO_2 on Imeri oilsand located in Ogun East, Nigeria. The experiment is to investigate the possibility of using the oilsand as a possible CO_2 storage reservoir and also to investigate the possible effect of CO_2 leakage from nearby stored reservoir on the oilsand reservoir. It was observed that there was gradual increase in porosity of the oilsand core up to 7.89% in the first 16days after intermittent injection of CO_2. After this maximum change in porosity there was a sudden gradual decrease in the measured porosity. The oilsand core outer surface was observed to have become hardened, with an increase of 30.94% in the fracture pressure, after 30 days of initial CO_2 injection and after exposure to air forming and the formation of a seal-like material at the exposed outer surface. This is suspected to be due to reaction of this oilsand with the injected CO_2 resulting into formation of cementing material or a type of CO_2 hydrates. The material formed is been investigated in the second part of this research as it may be a very good sealing material which could provide clue to the storage ability of oilsand as a CO_2 storage.

Keywords: Oilsand, CO_2 contamination, CSS, crude viscosity, Imeri oilsand, Nigeria oilsand

1. Introduction

Encyclopedia Britannica defines petroleum as a complex mixture of hydrocarbons that is located in the subsurface as liquid, gaseous, or solid forms. Oilsand is a combination of crude oil and sand. The crude is heavy and viscous or solid and best known as bitumen [1]. 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 [2].

The geological storage of CO_2 is a major concern now and this research investigates the possibility of using oilsand as a CO_2 storage by investigating the effect of CO_2 on the porosity of the oilsand reservoir. This alteration in the porosity, and hence the permeability, of the reservoir is expected to either favour or be detrimental to safe storage of the CO_2 in the reservoir [2].

A gas field off-shore Norway, the Statoil Hydro-operated Sleipner fields, is actually regarded as the world's first commercial CCS project. CO_2 used is captured from a gas processing facility using an amine process and storing it 1000m below the sea floor in a deep saline reservoir. Its operations began in 1996. Efforts were made so that the injection separated from the natural gas bearing zone some 2500metres below the injection zone [3].

Different media is being proposed as captured CO_2 storage; abandoned oil reservoir, coal seams, methane hydrates. No proposal has been made yet on oilsands deposit as a likely storage for captured CO_2 but the in-situ production of oilsand in deep underground formation may likely turn an oilsand reservoir to a water reservoir due to the fact that pressurized hot water flooding is used to produce this type of oilsand reservoir. The reservoir, which is now oilsand-water reservoir, may be a good candidate for captured CO_2 storage if the integrity of the reservoir is maintained when there is reaction between injected CO_2, injected water and oilsand.

Example of a necessary CO_2 capture and sequestration is found in Algeria. In order to produce natural gas acceptable for sale, BP and Statoil in In Salah, Algeria has to eliminate almost the whole CO_2 contaminants to acceptable level of about 0.3%. This amount to eliminating equivalent of about 4.7-8.7% of one million cubic feet of CO_2 gas in the natural gas and this huge CO_2 volume cannot be vented but must be re-injected back into the CO_2 storage reservoir. The operation was started in 2004 and designed to capture 1.2Mt/year of CO_2. "More than 3 million tonnes of CO2 have been securely stored and monitored in a deep saline formation which is characterized to oil and gas industry standards" [4].

Lots of thermal power generation and heavy pollutant companies are concentrated near the oilsand belt in western Nigeria and it would be cheaper to use the oilsand reservoir as CO_2 storage than to transport captured CO_2 over tens of kilometers to oil reservoir located at the south-south zone. This research therefore studies the integrity of the oilsand zone as a possible future CO_2 storage reservoir.

Limitation of this study is that the representative oilsand samples used were obtained at shallow depth. This might have been affected by leaching process due to rain and running water percolation and may therefore have composition that is a little bit different from deep subsurface oilsand.

2. Methodology

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

1. Sufficient oilsand sample was obtained at shallow depth at an outcrop at Imeri village, Ijebu east, Nigeria.
2. Core sample data of Length 6cm and radius of 4.55cm was made from the oilsand cutting.
3. CO_2 was injected into the core at pressure above 700psi.
4. The porosity of the sample was measured with porosimeter at interval of days to allow the intermittent injected CO_2 to react with the oilsand.
5. The mechanical strength of the core sample was measured before and after injection of the CO_2 to measure variation in the hardness, or compressive strength, of the oilsand.

3. Result

The measured porosity variation during the research is as stated in Table 1 and the graphical representation is as shown in Figure 1 below while the measured compressive strengths is as shown in Figure 2 below

Table 1: Porosity Variation With CO_2 Injection

Time (Days)	Porosity Variation (%)
0	0
2	0.218842126
4	2.495837914
6	4.879310345
8	5.711326604
10	6.74410664
12	7.089929269
14	7.813695773
16	7.887575091
18	7.136845649
20	8.004002001
22	6.356615463
24	4.401316929

The table above shows the variation in the porosity as CO_2 injection continues.

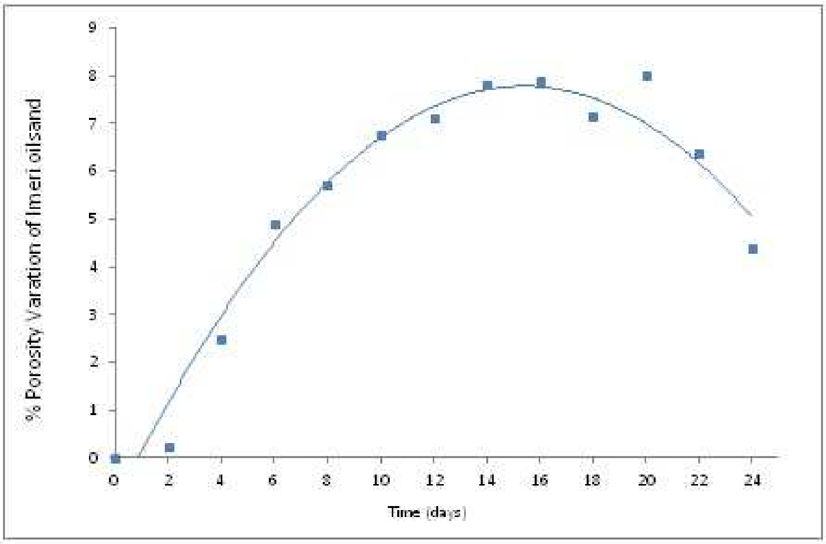

Figure 1. **% Porosity Variation of Imeri Oilsand With CO_2 Contamination**

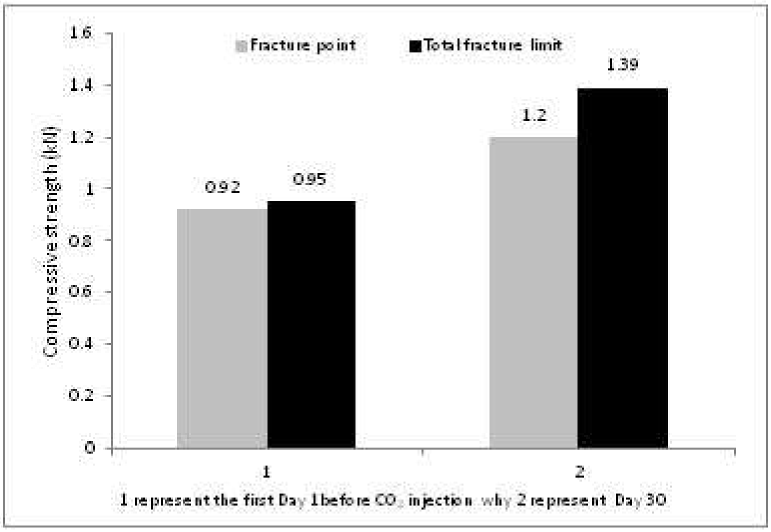

Figure 2. **Compressive Strength of Imeri Oilsand at first day before CO_2 injection and at the end of CO_2 injection**

4. Conclusion

It was observed that there was 7.888% increase in the porosity of the oilsand core in the first 16days after which there was rapid reduction to the 24th day.

The observed reduction in the measured porosity which is probably confirmed by observed hardening of the core sample after 30days of CO_2 injection as a result of increase in the measured compressive strength. Physical observation of the oilsand core shows a more slippery surface which is believed to have resulted into formation of seals of some grains within and outside the core that could have resulted into the reduction in measured porosity.

It was also observed that there was physical hardening of the oilsand core sample and a 30.43% increase in the measured compressive strength, i.e. fracture pressure, of the oilsand core after 30days of contamination with CO_2.

This is an indication that there might have been either a reduction in the porosity due to deposition of material in the pore space or that there is a change in the composition of the oilsand matrix due to formation of new and more abrasive mineral.

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