Analysis of Pressure Depletion Tests Using Methane Gas Saturated Crude oil from Argentina

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Abstract

The dataset in this article demonstrates the consequences of the important tests that were led with Argentinian crude oil saturated with methane gas. Four primary depletion tests were conducted with crude oil using depletion rates of 0.35psi/min, 0.23psi/min, 0.048psi/min, and 0.023psi/min. All tests started with the sand-pack fully saturated with live oil at irreducible water saturation. All the tests were conducted at a room temperature of 22 ±0.7 degree centigrade. What's more, the outcomes were dissected to surmise the impact of gas oil proportion and other foamy oil parameters on the depletion trend.

Keywords: Live oil, Methane gas, Crude oil, Argentina

Value of the Data

- During the initial segment of the depletion, the pressure at all locations decreases linearly in tandem with the pressure at the production port Figures 1-4.

- The pressure gradient remains too small to measure and there is very little oil production during the fast depletion, and this behavior is consistent with the liquid phase expansion under decreasing pressure. As the pressure declines, the dissolved gas super-saturation continues to increase and eventually leads to nucleation of gas bubbles Figure 1, Table 1.

- The gas production data is somewhat noisy due to the disturbance created when the collection vessel had to be emptied Figure 5.
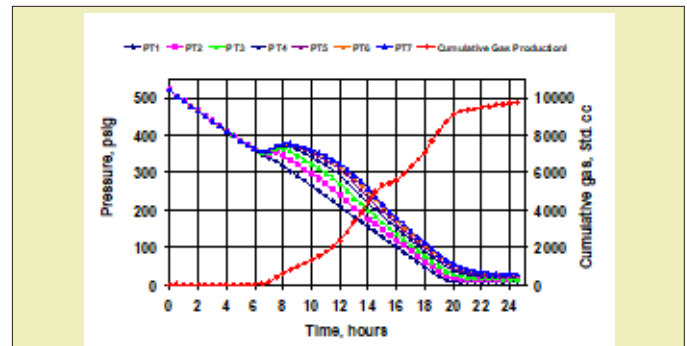

Figure 1: Pressure and oil production history of the fast depletion test.

- There was no oil production for the first four days of slow depletion test while the sand-pack pressure declined to about

420psig. That is where the gas nucleation started and oil production began. There is just a hint of pressure difference between the two ends of the sand-pack immediately after bubble nucleation.
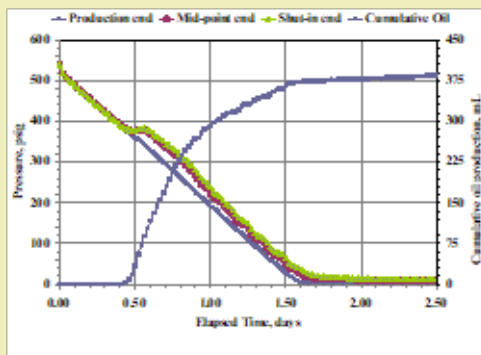

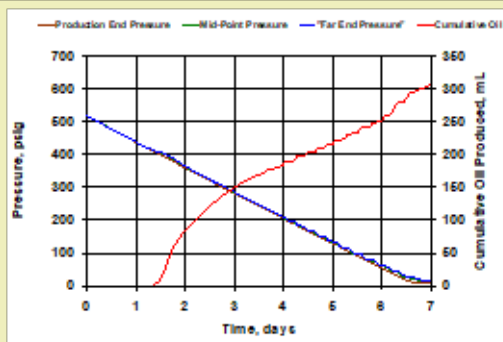**Figure 2:** Pressure and oil production history of the second fast depletion test.

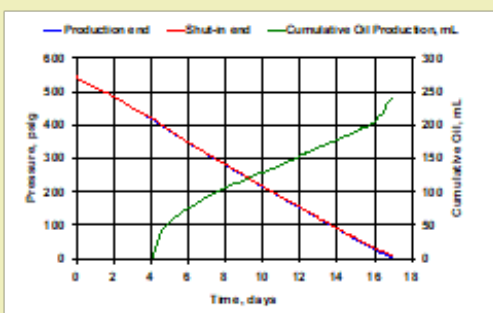**Figure 3:** Pressure and oil production history of an intermediate depletion test.

Figure 4: Pressure and oil production history of a slow depletion test.

- It appeared that the increase in oil recovery with increasing depletion rate reaches an asymptotic limit and the test @0.434psi/min is already close to this performance limit and it is likely that a lower limit of performance also exists when the rate is made progressively slower.

Data

The average pressure changes very slowly in the field but the production wells in cold heavy oil production are often kept pumped off; meaning the drawdown pressure is kept high, where different *depletion tests* were described in Busahmin BS,[1,2] Maini BB,[3] Abusahmin BS,[4] for the purpose of enhancing oil recovery. It was observed in many publications that the rate of pressure decline in the field is in orders of magnitude slower than in the laboratory experiments.[1-3] It has been proposed that perhaps the high-rate laboratory is more important. The average pressure changes depletions are irrelevant for the field situation. However, if it is the drawdown pressure rather than rate of pressure change that is more important, the picture changes completely. The drawdown pressure is often higher in the field than in the laboratory experiments,[4-8] so these high-rate tests are very relevant for the field situation.
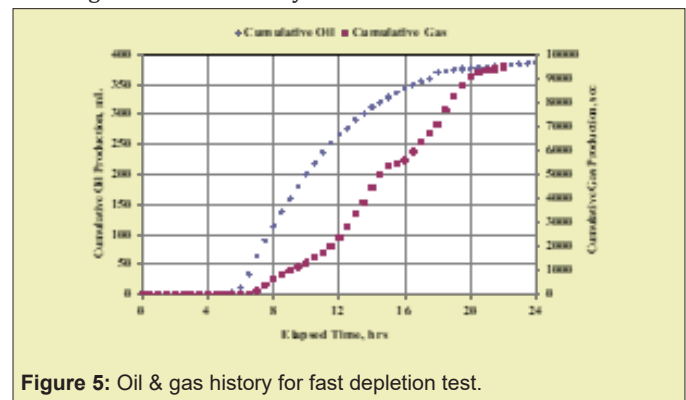

Figure 5: Oil & gas history for fast depletion test.

Experimental Design, Materials and Methods

Preparation of sand-pack

The water used in filling the pressure transducers was deionized water that was boiled to remove dissolved gases to minimize the formation of gas bubbles in the pressure transmitting lines and resulting artefacts in the pressure measurements.

Preparation of live oil

Live oil was prepared my mixing the desired gas with dead oil using a mixing cell. The mixer was then filled with dead oil, three quarters of its volume that is about six liters, and gas was introduced into the mixer at a pressure marginally higher than the desired bubble point pressure of the live oil. Once the pressure dropped below the desired bubble pressure more gas was added to the mixer to reach the desired pressure. Finally, the live oil was further agitated for another 24 hours to make sure the system was at equilibrium.

The primary depletion tests conducted with refined mineral oil saturated with methane, ethane, and carbon dioxide. The gas-oil systems characterized by measuring various parameters, for example, gas oil ratio and live oil viscosity as shown in Table 1.

Acknowledgements

Table 1: Comparison between Crude oil and mineral oil saturated Methane gas, depletion tests.

Parameter	Mineral oil	Crude oil	Saturated mineral oil	Saturated crude oil
Saturation Pressure (psi)	N/A	N/A	500	500
Density (kg/m^3) @ 23 ∘ C	896	936	891	928
Viscosity @ 23 ∘ C (m.Pa.s)	1583	2608	1080	1300
Liquid Phase Compressibility (psi^{-1})	6.8×10^{-6}	6.9×10^{-6}	4.52×10^{-6}	4.37×10^{-6}
Surface Tension (dyne/cm)	31	29	28	20
Solution Gas-Oil-Ratio (cm^3/cm^3)	N/A	N/A	10	11

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Conflict of interest

Authors declare that there is no conflict of interest.

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