Reservoir Characterization of Water Zone above Oil-Water Contact in a Carbonate Reservoir Offshore Abu Dhabi

Christophe Bassem Maalouf[1], Irina Baca Espinoza[1], Nusrat Afrin Afzal[1], Jorge Costa Gomes[1], and Salem Al-Jaberi[1]

[1]ADMA-OPCO

Abstract

In a green field offshore Abu Dhabi, a carbonate reservoir layer is water bearing across the entire field and is above the oil-water contact. This water zone is overlain by an oil bearing zone. The existence of such a zone poses a great risk of early water breakthrough for wells completed in the oil zone. Hence, it is essential to understand the dynamic behavior of the water zone and of the corresponding oil-water interface.
To characterize this zone and the oil-water interface, a pilot-hole was drilled and an extensive data gathering program was successfully executed. The well was logged (GR, Resistivity, Nuclear Magnetic Resonance (NMR), Density & Neutron) and cored across the zone of interest, Wireline Formation Testing (WFT) pressures were acquired, oil and water zones were sampled, and a Vertical Interference Test (VIT) was done between oil and water zones. Horizontal and vertical plugs were taken from the recovered cores every foot for Conventional Core Analysis (CCA). Thin sections were prepared for each plug to describe its texture, and Mercury Injection Capillary Pressure (MICP) was performed on trims taken from the plugs.

The core description showed the existence of a thin stylolitic interval between the water and oil zones. CCA results showed similar porosities in water and oil zones but a much higher permeability in the oil zone than in the water zone. This permeability contrast is also characterized with NMR log. Thin sections described the water zone reservoir texture as a wackstone and the oil zone reservoir texture as a vuggy packstone to grainstone. MICP showed that the water zone reservoir is mainly microporous. Finally, the Vertical Interference Test established that there is a dynamic communication between oil and water zones. Therefore, we conclude that the water zone is caused by microporosity and not by a dynamic barrier. Hence, it does not represent a risk of water breakthrough for development wells. After integration of all available data, we found that WFT, NMR and density/neutrons logs are sufficient for reservoir characterization of such water zones.

This paper showcases a special case where a water zone is present above the oil-water contact and presents extensive data gathering results that helped to characterize its behavior. The development of other fields with similar water zones can greatly profit from our study to optimize their development plans.