Expert Interpretation of Reservoir Saturation Data Boosts Reserves Estimation by 460%

Reevaluating oil saturation in low-resistivity carbonate substantially improves net pay for operator in Libya

**CHALLENGE**
Accurately and representatively measure oil saturation in low-resistivity carbonate pay, an environment where the traditional Archie equation overestimates water saturation.

**SOLUTION**
Interpreted reservoir saturation data from the RSTPro* reservoir saturation tool using GeoFrame* reservoir characterization software to enable more accurate and timely decisions.

**RESULTS**
Achieved more representative oil saturation values that better fit the production logging profile and increased net pay by 150% and oil reserves by 460%.

“Schlumberger petrotechnical interpretation provided an interesting approach that gave us more realistic values of oil and water saturation in this field.”

---

**Accurate saturations required for carbonate characterization**
Low-resistivity pay is a long-standing problem in formation evaluation; using the Archie equation in such environments underestimates oil saturation and overestimates water saturation. To overcome this challenge when drilling in a low-resistivity carbonate reservoir in Libya, an operator collaborated with Schlumberger petrotechnical experts to find a solution that would enable more accurate measurement of saturations.

**Water and oil saturation reevaluated**
First, Schlumberger worked with the operator to suggest a methodology to obtain more recent and reliable oil- and water-saturation measurements for reevaluation. For this, Schlumberger recommended using the RSTPro reservoir saturation tool, which determines reservoir saturation, lithology, porosity, and borehole fluid profiles with an accuracy comparable to that from core analysis. These petrophysical data were then input into GeoFrame software, which delivers advanced interpretation and actionable information to help operators make timely, better-informed decisions.

Then, the Schlumberger petrotechnical team reviewed previous approaches taken to measure reservoir saturation, including resistivity modeling using special core analysis (SCAL) data. SCAL interpretation variables include the cementation factor ($m$), saturation exponent ($n$), and formation water salinity. The team collaborated with the customer to test model resistivity in multiple scenarios using different $m$ and $n$ values. Then, they tested different salinity values until a good match was obtained between the modeled resistivity and true resistivity by using the modified parameters of 60,000-ppt salinity, an $m$ value of 1.67, and an $n$ value of 1.82.

Lastly, the Schlumberger team suggested reinterpreting the openhole logs using the Archie equation with the modified $m$ and $n$ parameters that led to good agreement between modeled resistivity and actual field resistivity. Reevaluation showed that the new openhole saturation is higher than that with default values of $m$ and $n$. The accuracy of this approach was validated by the good match of the data obtained using the RSTPro tool with that from laboratory core saturation studies as well as the modified Archie calculation.

**Net pay improved and oil recovery increased**
Interpretation results revealed that the carbonate pay’s oil saturation is actually higher than previously concluded from openhole log interpretation. Processing the data took only 24 hours, allowing the customer to confidently and quickly act upon the suggestions received.

Remediation based on these petrotechnical data and interpretation resulted in improved operations by a number of measures.

- Average water saturation decreased from 0.54 to 0.42, meaning more oil saturation in recovered resources.
- Net pay thickness increased from 54.5 to 139 ft, a 150% increase.
- Recovery factor increased from 0.22 to 0.37.
- Original oil in place increased from 1.9 million bbl to 6.32 million bbl, and oil reserves increased from 0.42 million bbl to 2.36 million bbl (based on nearby well drainage).
The customer was confident that the RSTPro tool’s saturation measurements were accurate after reviewing the results that the Schlumberger team presented. After the measurable success of this operation, the customer chose to run the methodology on future wells, including mature wells under production, to ensure the delivery of representative, reliable saturation results every time.