Accurate Water Saturation Estimation of the McMurray Formation: Wireline Log vs Core Data

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ABSTRACT

A traditional approach used to determine water saturation for oil sands reservoirs has been the Dean Stark analysis from core. However, a recent study done on core from the McMurray Formation revealed that drilling fluid readily penetrates to the center of the core during the recovery process. Consequently, previously determined values of water saturation have been overestimated and must be corrected.

Alternatively, deriving water saturation in these reservoirs from Archie's Equation have also yielded pessimistic results. Primarily this is caused by wrongly estimated or assumed values of the Archie variables used in this equation. The formation water resistivity, being the most important of these variables, has proved to be highly irregular and, therefore, the accuracy of both the m and n constants and water saturation are compromised.

Thus, comparing the core water saturation's adjusted for mud filtrate invasion to those calculated from Archie's Equation show a significant range of differences between data points. This inconsistency is further exaggerated due to the unequal sampling intervals between Dean Stark analysis and wireline data.

A methodology is used to reduce these errors. By using log calculated in-situ porosities from density measurements combined with core calculated mass fraction of oil to sand ratios, an accurate core water saturation is attained. Wireline measured resistivity and density values are resampled to ensure that Archie calculated water saturation's compare across a similar sample interval to that of the core corrected water saturation's. Finally, by applying a least squares regression method on the two data sets, new empirical Archie constants (m,n, and Rw) are derived. These new Archie parameters are then used to recalculate a more representative water saturation with much improved accuracy. A case study illustrates that when utilizing this method the field average water saturation for the McMurray Formation decreased in the order of 30%.