Petrophysical Approach and How to Calculate Kerogen Volume for Corrected Porosity in Unconventional Reservoir, a Case Study from Kuwait

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Abstract

The exploratory efforts are focused on evaluation the unconventional hydrocarbon resources in Kuwait, mainly tight formations, heavy oil and shale-gas/oil reservoirs. The target of this study is the organic-rich oxfordian upper jurassic najmah shale formation which is high priority shale gas resource systems in Kuwait.

Prospectivity analysis based on total organic content richness, good reservoir characters (porosity, hydrocarbon saturation and net thickness), natural fractures, maturity, depositional environments & facies, mineralogy and pore pressure data has led to upper jurassic najmah formation play for shale resource exploration.

Kerogen, the organic-rich shale, forms under low levels of oxygen in anoxic environments to accumulate high concentrations of organic matter, which are subjected to high pressure and temperature (maturation stages in hydrocarbon generation). With burial, temperatures and pressures convert organic rich matter into kerogen (solid, insoluble material). Depending on the type of kerogen produced, further increases in temperature, pressure and burial time, kerogen yields hydrocarbons (bitumen, oil liquid, wet gas, and dry gas) with other gases co^2, n^2 & h^2s. The major challenge for the organic rich shale reservoirs is the evaluation of actual porosity which by conventional analysis appears very high porosity due to the complex lithology and pore system that constrained by presence of the kerogen organic carbon. Other challenges are the accurate determination of the formation mineralogy and total organic carbon (toc).

The bulk density of organic-rich shale is low because of the presence of kerogen, which has low sp. gr. 1.05 g/cm^3. It adversely affects the true porosity estimations and gives high apparent porosity on the neutron-density log measurements, about 20%, which is over estimated but the core matrix porosity and nmr porosity between 3-6 pu.

An integrated workflow involving interpretation of different datasets has been evolved for identification and evaluation of shale gas reservoir. It is recommended to acquire complete suite of advanced logs. integration of basic open-hole well log data, core porosity, core grain density, core toc, xrd data, ecs and cmr logs, with obmi and ubi to properly evaluate the lithology, porosity, fractures and calculate toc using different methods to corrected porosity from kerogen effect in organic rich formation.