Liquid Permeability Correlation for Shuaiba Formation: "An experimental investigation for predicting liquid permeability from conventional core analysis results in Shuaiba formation".

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Abstract

Porosity and permeability are two important petrophysical parameters in formation evaluation. Both parameters can be measured from well logs. Logging tools can in principle measure hydrogen content, magnetic resonance, acoustic velocity, neutron density etc, but none of these parameters is a direct measurement for porosity and permeability and relies on models or conversion keys, with underlying assumptions, for determining porosity and permeability. This needs to be calibrated towards real and direct measurements, and this is the area where core analysis comes in.Absolute permeability, which is only present in water zone is important for static initialisation of dynamic simulation models. In a dynamic model for a hydrocarbon zone there will be both water and hydrocarbons presence. Permeability will, therefore be the product of K*Kr, where K is the absolute permeability, together with viscosities of involved fluids, that will determine mobility and transmissibility between grid blocks in the dynamic model and Kr is the relative permeability for the involved fluid phases. Standard industry practice for determining permeability is to perform single point gas permeability measurements and use assumptions or correlations to get Klinkenberg corrected gas permeability. Such measurements will always overestimate permeability compared with absolute liquid permeability, which is the desired parameter to be used in the dynamic model. In this study, a comprehensive experimental investigation was carried out with the objective of finding a correlation to convert Klinkenberg corrected gas permeability to liquid permeability. Values of Klinkenberg corrected gas permeability were taken from another study carried out on the same core samples used for measuring liquid permeability. Water permeability measurements were done on fully water saturated core samples. Results were compared with Klinkenberg corrected gas permeability. A correlation ($K_W = 0.864(K_L)^{1.039}$) with R^2 of 0.996 was developed for obtaining liquid permeability from Klinkenberg corrected gas permeability for Shuaiba formation.

Measurements on 10 new core samples by applying the same experimental procedure and data from a different study for 35 core samples from Shuaiba formation were used in the validation of the established correlation. Results showed 1.42 % error, which is considered negligible.

Principle Component Analysis Tool (PCA) was used to describe the data using fewer variables. Results of interpretation considering all variables showed two trends based on formation (Upper and Lower Shuaiba) and one trend, if permeability is the only variable. Reported cementation factors for the two formations are not unique and should be studied as a function of rock type. No conclusive results were found on the effect of overburden pressure on permeability.