Absolute and Relative Permeabilities from Well Logs in Tight Reservoirs

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Abstract

More than a hundred correlations have been proposed by several investigators, empirically relating permeability to porosity and estimate permeability from well log data. The major concern with those models is that they relate permeability to grain and pore volume surface areas, Sgv or Spv, which cannot be determined directly from well logs, but rather from special laboratory core analysis. Therefore, the well log derived permeability was obtained by relating surface area to irreducible water saturation, Swi. It should be noted that the application of most permeability models requires a formation that has an interval at irreducible water saturation somewhere in the well and that may not be available in most reservoirs.

Tixier (1949) and others proposed an empirical model that correlates formation permeability to the resistivity gradient in the transition zone. However, the model was developed for clean, non-shaly formation and did not account for variations in the cementation exponent, m, due to different pore-pore throat geometries.

Starting from Leverett J-function, a new technique is derived here to determine formation permeability over the whole range of formation water saturation (not only for zones at irreducible water saturation) from well log data. Three selected permeability correlations have to be generalized in terms of cementation exponent "m" and saturation exponent "n" or the single texture parameter "w". Cementation variable "m" is introduced as a porosity exponent in the technique to extend its applicability to formations with different pore-pore throat geometries particularly those with natural fractures. The graphical solution indicates that a crossplot of log porosity versus log resistivity group should result in a straight line with a negative slope function of "m".

The technique will best work for tight formations that exhibit a transition zone with relative variation in porosity. Permeability of formations with shaly contents can also be estimated through integration of various shaly models within the solution strategy. This study will also introduce new formulas for estimation of relative permeabilities from well logs. Application examples on real well log will be presented.