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Modelling approaches for the estimation of irreducible water saturation and heterogeneities of the commercial Ashtart reservoir from the Gulf of Gabès, Tunisia

Fatma Taktak[5], Adel Rigane[1], Taoufik Boufares[2], Samir Kharbachi[3] and Samir Bouaziz[4]
[1]King Saud University, Saudi Arabia
[2]Entreprise Tunisienne des Activités Pétrolières, Tunisia
[3]SEREPT, Tunisia
[4]Ecole Nationale d'Ingénieurs de Sfax, Tunisia
[5]UMS University, Dubai

Oil production based on reserves in place in the Ashtart oilfield required the precise knowledge of the main reservoir parameters including porosity, permeability and irreducible water saturation. The reservoir series is comprised of Nummulitid but heterogeneous limestones of the El Garia Formation, the petrofacies texture, geometry and petrophysical parameters of which were apprehended using seismic profiles; gamma-ray and sonic lateral logs, as well as cores and cuttings taken in drillwells. The evaluation of residual oil saturation, multiphase flow and oil production techniques from the Ashtart reservoir also depend on variations and zoning of the irreducible water saturation. Estimation of the initial water saturation and hence variations in the capillary pressure in the reservoir, required compilations of porosity data measured on cores, supplemented by additional but computed porosities based on acoustic log diagrams. Furthermore, Gamma-Ray, Sonic log, and well to well correlations tied to core results and well cuttings, help recognize the layered lithologies within the El Garia flat lying but stratified, Ypresian in origin reservoir rocks. Abundant permeability and porosity values compiled in the light of seismic sequence and Gamma Ray and Sonic log details, were integrated in an empirical approach using the Leverett J function, to model the irreducible water saturation depending on the capillary pressure distribution in the whole reservoir. Variations of this principal hydraulic parameter in a wide range (Swir: 12 to 40%) compared to the preceding lithostratigraphic, petrographical and petrophysical results help recognize four main rock pore types in the commercial Ashtart reservoir. These vary from (1) a zone with a rock pore type showing an irreducible water saturation as low as 12%, and a fairly good reservoir character in the lower third part of the lithologic column which is thought to channelize a multiphase fluid flow in the global oilfield, (2) to those zones built-up of rock pore types with higher initial water saturation amounts which in certain cases tend to indicate zones of degraded reservoir. Our study suggests that diagenesis prevalently controls porosity, due to operative dissolutions of the Nummulitid tests/bioclasts, and cementation; moreover, diagenesis exerts effects on permeability by interconnecting intergranular and intratest pore spaces. In contrast, microfracturing enhances permeability of the reservoir. This is notably the case in the fairly permeable central zone in the Ashtart reservoir with excellent petrophysical parameters, but which were found to degrade gradually towards its peripheries.

fatimtak@yahoo.fr