Norbert Péter Szabó et al., Int J Petrochem Res. 2018
http://dx.doi.org/10.18689/2638-1974.a2.002

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2nd International Conference on
Petrochemistry

April 25-27, 2018 Rome, Italy

Hydrocarbon Saturation Estimation Using an Adaptive Interval Inversion Method Applied to Borehole Geophysical Logs

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A soft computing approach is applied to estimate the vertical distribution of hydrocarbon saturation along the borehole. In the framework of the suggested interval inversion method, oilfield well logs measured at an arbitrary depth interval are jointly inverted, where the depth variation of hydrocarbon saturation and other important volumetric parameters are expanded into series using Legendre polynomials as basis functions. In the interval inversion procedure, the series expansion coefficients are estimated using an adaptive float-encoded genetic algorithm. From the inversion results, one can derive the movable and irreducible parts of hydrocarbon content. Since the solution of the inverse problem using linear optimization tools highly depends on the selection of the initial petrophysical model, a meta-heuristic search is made to reduce the initial model dependence of the interval inversion procedure. The optimization strategy used in interval inversion seeks the global extreme of the objective function and provide an estimate to the vertical distribution of petrophysical parameters even starting the inversion procedure from extremely high distances from the optimum. As a significance, the interval inversion method does not require prior knowledge (e.g. from core information) or strong restrictions on the values of petrophysical properties and gives quality-checked inversion results practically independent of the initial model, which serves a more reliable estimation of hydrocarbon reserves. The feasibility of the inversion method is demonstrated in a Hungarian unconsolidated gas-bearing shaly-sand formation. The interval inversion method can be further improved by estimating some petrophysical parameters outside the inversion procedure. For instance, factor analysis can be used to estimate the shale volume or other critical unknowns. In the future, well logs of unconventional reservoirs are inverted to interpret multi-mineral rock matrices, organic content, and complex pore-space and fluid saturation conditions.

Biography:

Norbert Peter Szabo graduated as a geophysical engineer in 1999, and gained his PhD in 2005 at the University of Miskolc (UM), Hungary. He is currently working as associate professor in the Department of Geophysics at the UM. In 2015, he obtained the “dr. habil” title. His main research interest is related to borehole geophysical logging methods. He participates in the development of joint inversion and geostatistical methods for an improved evaluation of hydrocarbon reservoirs. In recent years, he wrote several Q1 ranked articles about global optimization methods and exploratory multivariate statistical methods and their well-logging applications.