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Modeling of Asphaltene Grading in Oil Reservoirs

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ABSTRACT

Reservoir fluids frequently reveal complex phase behaviors in hydrocarbon columns owing to the effects of gravity, thermal diffusion, biodegradation, active charging, water washing, seals leaking, and so on. In addition, the formation compartmentalization often causing discontinuous distributions of fluid compositions and properties makes the proper fluid characterization and reservoir architecture even more challenging yet compelled. The recognition of compositional grading and flow barriers becomes a key to accurate formation evaluation in a cost effective manner. Downhole fluid analysis (DFA) of asphaltene gradients provides an excellent method to delineate the complexity of black oil columns. In this paper, a methodology was developed to estimate downhole asphaltene variations with depths using an equation-of-state (EOS) approach coupled with DFA measurements. DFA tools were used to determine fluid compositions of CO2, C1, C2, C3-C5, C6+, gas-oil ratio (GOR), density and the coloration (optical density) associated with asphaltene contents at downhole conditions. The delumping and characterization procedures proposed by Zuo et al. (2008) were employed to obtain the detailed compositions excluding asphaltenes. In addition, a molar mass distribution of asphaltenes was described by a three-parameter Gamma probability function. The Gaussian quadrature method was used to generate asphaltene pseudocomponents. Five pseudocomponents were employed to represent the normal asphaltene nanoaggregates. Asphaltene distributions in oil columns were computed by tuning the molar mass of asphaltene nanoaggregates against the DFA coloration logs at a reference depth. The methodology was successfully applied to investigate black oil reservoir connectivity (or flow barriers) for offshore field cases. The analysis results were consistent with the subsequent production data and analytical chemistry. Furthermore, for simplicity, it is reasonable to assume that asphaltenes have average properties such as molar mass in entire oil columns. The results obtained in this work demonstrate that the proposed method provides a useful tool to reduce the uncertainties related to reservoir compartmentalization and to optimize the DFA logging during acquisition.

KEYWORDS

Reservoir Connectivity, Asphaltene Gradients, Equations of State, Downhole Fluid Analysis

Cite this paper

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