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An Integrated Approach to the Carbonate Reservoir Modeling: Case Study of the Eastern Siberia Field

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Abstract : Carbonate reservoirs are known for their heterogeneity, resulting from various geological processes such as diagenesis and fracturing. These complexities may cause great challenges in understanding fluid flow behavior and predicting the production performance of naturally fractured reservoirs. The investigation of carbonate reservoirs is crucial, as many petroleum reservoirs are naturally fractured, which can be difficult due to the complexity of their fracture networks. This can lead to geological uncertainties, which are important for global petroleum reserves. The problem outlines the key challenges in carbonate reservoir modeling, including the accurate representation of fractures and their connectivity, as well as capturing the impact of fractures on fluid flow and production. Traditional reservoir modeling techniques often oversimplify fracture networks, leading to inaccurate predictions. Therefore, there is a need for a modern approach that can capture the complexities of carbonate reservoirs and provide reliable predictions for effective reservoir management and production optimization. The modern approach to carbonate reservoir modeling involves the utilization of the hybrid fracture modeling approach, including the discrete fracture network (DFN) method and implicit fracture network, which offer enhanced accuracy and reliability in characterizing complex fracture systems within these reservoirs. This study focuses on the application of the hybrid method in the Nepsko-Botuobinskaya anticline of the Eastern Siberia field, aiming to prove the appropriateness of this method in these geological conditions. The DFN method is adopted to model the fracture network within the carbonate reservoir. This method considers fractures as discrete entities, capturing their geometry, orientation, and connectivity. But the method has significant disadvantages since the number of fractures in the field can be very high. Due to limitations in the amount of main memory, it is very difficult to represent these fractures explicitly. By integrating data from image logs (formation micro imager), core data, and fracture density logs, a discrete fracture network (DFN) model can be constructed to represent fracture characteristics for hydraulically relevant fractures. The results obtained from the DFN modeling approaches provide valuable insights into the East Siberia field's carbonate reservoir behavior. The DFN model accurately captures the fracture system, allowing for a better understanding of fluid flow pathways, connectivity, and potential production zones. The analysis of simulation results enables the identification of zones of increased fracturing and optimization opportunities for reservoir development with the potential application of enhanced oil recovery techniques, which were considered in further simulations on the dual porosity and dual permeability models. This approach considers fractures as separate, interconnected flow paths within the reservoir matrix, allowing for the characterization of dual-porosity media. The case study of the East Siberia field demonstrates the effectiveness of the hybrid model method in accurately representing fracture systems and predicting reservoir behavior. The findings from this study contribute to improved reservoir management and production optimization in carbonate reservoirs with the use of enhanced and improved oil recovery methods.

Keywords : carbonate reservoir, discrete fracture network, fracture modeling, dual porosity, enhanced oil recovery, implicit fracture model, hybrid fracture model
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