Simulation of Khuff K3 Fractured Deep Gas Reservoir Using Single Porosity System

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ABSTRACT

This paper describes how the fracture model for K3 and faults were incorporated into the single porosity simulation model. It is an integrated study utilizing seismic, open hole logs, pressure transient analysis and production data with simulation to define and map fracture network patterns in enhancing the productivity from deep, thick, tight and fractured deep gas-bearing carbonate reservoir in the Bahrain field. The Lower Permian K3, the deepest unit of the Khuff formation zone, is a thick, tight, highly faulted and irregularly fractured Carbonate reservoir. The massive 800 ft thick reservoir with very low average permeabilities of the order of 1 mD, poses challenge in efficient recovery of hydrocarbons. The present production from this thick reservoir accounts for less than 10 % of the total gas production from the Khuff Formation of the field. This has prompted a detailed integrated study to help enhance the well productivity. A conceptual model has been developed by identification of Discrete Fracture Network (DFN) from seismic data and validating them with transient well testing, RFT and production data at and around well-bore. Detailed sector models have been built, and well test simulations in these models examined the fracture and fault geometries and properties. After the history matching of these sector discrete fracture network models to the well tests, a fracture model of the reservoir was used to derive and input fracture network and related data of the K3 zone into the simulation model to define and map the reservoir fracture patterns to aid in increasing productivity and recovery. It has been observed that the flow behavior from a well located in the central graben is different than from a well that is located on the flanks of the structure. This reflects variability in fracture orientation and hence directional anisotropy. The greater intensity of fracturing at the crest in comparison with the flanks is also likely to result in a well-connected network at the crest, with the degree of connectivity decreasing away from the crestal region. Furthermore, faults parameters were established during the well test matching of the fracture network for K3 have been used to derive the parameters used in the simulation model. Fractures distribution of parameters, calculated on a cell-by-cell basis, reveals that the permeability from the fracture model ranges from 0.01mD to 0.1mD and the area/volume ratio ranges from 0.001 to 0.01.