ABSTRACT

This research is an attempt in better understanding how flow simulation studies can be implemented in predicting fracture network properties. Fracture maps are modeled as permeability grids by considering the fracture continuum (FC) concept and flow simulation is performed using a streamline simulator, TRACE3D. Fracture network properties like clustering, connectivity, fracture aperture distribution and anisotropy are evaluated by implementing an array of techniques. Flow simulation results are correlated with network properties to find possible relationships between them. Chapter 1 introduces the network properties considered in this research, basic concepts of fracture modeling and flow simulation. It also contains a comprehensive literature review related to this research. In chapter 2, it is shown that in synthetic fractal-fracture networks, rather than fractal dimension, it is the lacunarity or scale-dependent clustering attribute that controls connectivity and hence, flow behavior. The concepts developed in chapter 2, is extended to the study of naturally fractured reservoir analogs in chapter 3 that seeks solutions to more practical problems faced by geo-modelers. Chapter 4, investigates the influence of variable aperture distribution on connectivity and flow in fractal-fracture models and natural maps. It is seen that smaller fractures with narrow apertures do not significantly contribute to the connectivity and flow behavior of the networks studied. Chapter 5, focuses on understanding whether anisotropy in flow through fracture networks can indicate the presence of fracture clustering along preferential directions. Here, two field development strategies are implemented in order to evaluate the flow behavior in x- and y-directions. It is found that such a "dynamic approach" can be applied for delineating anisotropy in "static" properties of networks like, fracture clustering. Overall, this research is geared towards an improved characterization of fracture network geometry that would ultimately help in reducing subsurface uncertainty thus yielding more accurate production forecasting in fractured reservoirs.

Keywords: Fracture Network; Fracture Aperture; Fractal; Lacunarity; Clustering; Connectivity; Anisotropy; Flow Simulation