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Natural Fracture Detection, Characterisation and Modeling using the Event Solution Synergy Approach

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SUMMARY

Abstract

The detection, characterization, modeling and impact of natural fractures in prolific producing reservoirs are major multidisciplinary challenges. The task, from fracture detection through modeling, is conducted conventionally through limited multidisciplinary integration resulting in poor fracture realizations and understanding. Currently, there is no industry standard workflow that encompasses the wide spectrum of multi-discipline natural fracture detection techniques and modeling approaches. Meanwhile, the availability and range of well performance and formation evaluation data combined with improved reservoir characterization (static and dynamic) techniques have raised the awareness of not only the extent of natural fractures characterization and modeling but also their impact on fluid flow, history match and prediction.

This paper presents a workflow that integrates and leverages different field data types (static and dynamic) to strengthen natural fracture detection, characterization and modeling. In this approach, different data sources are combined and contrasted to derive a most likely natural fracture distribution, understanding and characterization in simulation modeling, including uncertainty range. This industry unique naturally fractured modeling workflow has been developed, adapted and enhanced through the collective experience of applying the Saudi Aramco, synergy-based “Event Solution” (Elrafie et al. 2007) integrated reservoir study approach.

This paper is supported by sanitized projects of large and mature producing reservoirs that firmly illustrate the success of this industry leading workflow and the impact of natural fractures on field production performance. Examples include; pre-mature water breakthrough in reservoir regions and timescales that cannot be matched by matrix flow alone. Likewise, extreme oil rates that cannot be achieved through matrix permeability under measured pressure drawdown. These facts, coupled with static and geological insights are nested together to generate an integrated twenty-two components fracture detection and modeling workflow. Individually and in isolation, each data type component provides impractical and scattered fracture indications; however, the amalgamation of these varied data points narrows the uncertainty range of fracture realizations, yielding a robust and synergized fracture understanding and modeling.

This paper outlines best practices and critical factors of naturally fractured reservoir modeling and dynamic simulation. This includes a unique way of representing natural fractures in the numerical simulation model. Since there are many types of fractures, in this paper to simplify the illustration of the workflows we will target only the fracture corridors or the cluster of sub-vertical fractures that are normally extensive in their length and sometimes associated with shear faults.