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Analysis of fracture growth models for hydraulic fracturing of shale gas deposits in the karoo, South Africa

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Abstract

Prediction of fracture dimensions during propagation of a hydraulically induced fracture for well stimulation is essential for the design of a stimulation treatment. This study seeks to better understand the mechanisms of hydraulic fracturing through computational modelling of the fracture growth up to a specific time in MATLAB.

The computations were based on three existing theories of fracture propagation: the Khristianovitch, Geertsma and de Klerk (KGD) model, Perkins and Kern model (PKN) and Pseudo 3D model. Owing to the absence of raw data for the Whitehill formation in the Karoo, analogous shale rock from the United States of America was used as a basis for the study. The MATLAB computations were thus performed based on the following rock properties: Shear modulus = 1.466 x 10^5Psi; Drained Poisson's ratio = 0.2; Fluid Viscosity = 1cp; Pumping rate = 62.5bbl/min; In-situ stress = 3200Psi; Wellbore radius = 0.2ft; Passed time = 0.3min.

This report documents the differences in height, length, width, and pressure, predicted by the 2D and 3D models for the same set of input parameters. It is shown that the growth of the fracture for the 2D models yield much shorter lengths than the 3D model. It is also seen that the wellbore pressure predicted by the PKN model, in contrast to the KGD model, increases to 2.564 x 10^5 psi. as the fracture length increases. The pressure predicted by the P3D model increases to a peak of 1.411 x 10^6 psi at t = 0.24sec before declining to a final 7.709 x 10^5 psi.

Though the report proposed an understanding of the mechanisms of hydraulic fracturing in the Karoo, and even obtained solutions, it is limited to simulation models without application to field data.