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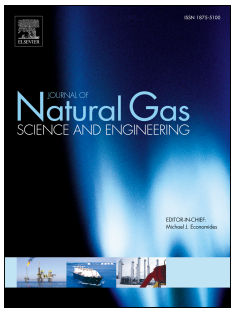

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Three-dimensional hydro-mechanical model of borehole in fractured rock mass using discrete element method

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Abstract

Borehole stability, in heavily fractured rock mass has been a significant issue in deep earth resources exploration and extraction. In this study, a three-dimensional model using 3DEC is developed to simulate a borehole drilled in fractured rock mass. A model with overbalanced drilling conditions is simulated in this study. In doing so, different depths of a borehole, MB-1 borehole, in Northern Perth basin was simulated. The developed model was validated against log measurements of Caliper log and strength of rock is found as a governing factor in controlling the stability. Then, hydro mechanical modelling was carried out and it was observed that high mud flow rates and high pore pressure increased the instability around borehole. Furthermore, a parametric study was performed to investigate the influence of viscosity and fluid flow on the stability. Shear displacement linearly increase with an increase in flow rate while fluid pressure decreases due to increase in fractures aperture with an increase in flow rate. Similarly, increase in viscosity caused increase in fracture shearing and therefore instability around borehole.

1- Introduction

Borehole stability is a major issue faced in petroleum and mining industry as it can result in significant expenditures. Thus, having a substantial impact on reservoir production, operation and exploration. Stability of circular boreholes have been considered and studied in multiple disciplines. New challenges have emerged and it has become important to study borehole stability in unconsolidated formations (Hashemi et al., 2014, 2015), heavily naturally fractured rock mass (Karatela et al., 2016) and deep-seated formations (Camac and Hunt, 2004).

A number of experimental (Santarelli et al., 1992; Ohoka et al., 1997), analytical (Moos et al., 2003; Fjar et al., 2008; Zoback, 2007) and numerical methods (Zhang et al., 1999; Xu et al., 2004; Zhang and Roegiers, 2005; Karatela et al., 2016) have been used for borehole stability analyses. However,