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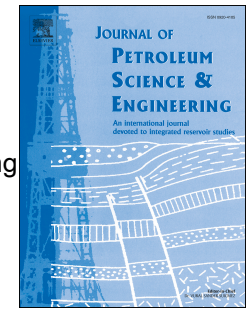

Modeling and simulation of gas-liquid-solid three-phase flow in under-balanced drilling operation

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Modeling and simulation of gas-liquid-solid three-phase flow in under-balanced drilling operation

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Abstract

In this study, gas-liquid-solid three-phase flow in the annulus of a well with actual dimensions is simulated numerically considering under-balanced drilling (UBD) operations. The multi-fluid approach which is the most accurate and sophisticated method is used for the simulation. For this purpose, one-dimensional form of steady-state three-fluid model in the Eulerian frame of reference is used to simulate the three-phase flow in the UBD operation. The results have been validated with actual field data and also with the result of gas-liquid two-phase flow model. The comparisons show that three-phase numerical simulation gives better accuracy compared to two-phase numerical simulation and most of other models which are using mechanistic approach. Given the importance of the prediction and control of the bottom-hole pressure (BHP) during drilling operations, the effects of controlling parameters such as liquid and gas flow rate, drilling velocity, size of cuttings and choke pressure on the BHP are investigated. Also, due to the importance of the hole-cleaning during drilling operations, the effects of different controlling parameters on the solid volume fraction distribution during annulus are discussed. Results show that the increasing of the gas flow rate and decreasing of the cutting size can be used as a tool for improved hole-cleaning in the UBD operation.

Keywords: under-balanced drilling; three-phase flow; bottom-hole pressure; hoe-cleaning

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