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A Dynamic Model for Gas Percolating in a Well Filled with Water

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Extended Abstract: In this paper, the distribution of gas percolating in a vertical well that filled with water is modeled by ordinary differential equations and algebraic relations. The examined model is a gas kick that we considered a triangular distribution function for it along the well. Bottom hole pressure is considered constant as the gas is circulated out of the well through slow flow of water. Pressure measurement at different points of drill string pipe is used to estimate the liquid-holdup profile in the well. Because the relation between slip and holdup is not considered, and some time varying parameters are considered constant, we cannot achieve high accuracy by using this model. However since most of the important dynamic parameters are included, it can be used to estimate overall well conditions. By using this model some parameters such as the length of gas structure, the time required for gas front to reach the choke, pressure upstream the choke, pressure in the bubble structure and also at the bottom of the well, volumetric flow-rate of water through the choke, and the gas content in the well can be calculated.

Keywords: Gas Percolating, Liquid Hold-up, Modeling, Kick

Summary: A simple model is developed for predicting well conditions during a methane gas kick percolating in a vertical well filled with water. The model that is described is based on tracking of the gas front during its rise through the well. Although the model lacks the relation between slip velocity and liquid hold up, it is suited for estimation purpose as the other important parameters are considered in the problem solving process. So we can simulate gas kick percolation in the well and estimate some parameters like pressure of different points, gas structure length and its location along the well.

Introduction: In drilling engineering, kick is undesirable flow of formation fluid into the wellbore and it happens when formation pressure is more than hydrostatic pressure in wellbore. If the kick is not controlled properly it will cause more gas to enter the well, which might ultimately lead to a blowout or even a fire. The purpose of this paper is to model a gas kick percolation inside a vertical well in a simple way and without using partial differential equations.

Methodology and Approaches: First, without considering a certain assumption on gas distribution function, a generalized model for gas percolation is expressed in term of gas rise velocity and mud flow rate. Next, a triangular gas distribution is used for model validation and estimation of the liquid hold-up profile. Then, using existing relations for choke flow rate, Chen's friction coefficient, ideal gas equation of state and etc. liquid hold-up profile is estimated. This model is valid until gas front reaches surface. The simulation results are presented for a methane gas kick in a vertical well filled with water.

Results and Conclusions: Parameters such as the length of gas structure, the time required for gas front to reach surface, pressure upstream the choke, pressure in the bubble structure and also at the bottom of the well, volumetric flow-rate of water through the choke and the gas content in the well is calculated.

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