Prediction of Stand Pipe Pressure Using a Technical Drilling Simulator: A Case Study in South of Iran

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Abstract
Stand pipe prediction is a most important aspect of hydraulic design in drilling engineering. It is crucial to predict stand pipe pressure and pressure losses to be encountered in well planning.

A drilling well in south of Iran consider as a case study to determine the accuracy of stand pipe pressure prediction, rheological parameters affecting the pressure losses and impact of each of the parameters was studied with commercial drilling simulator**.**

the results obtained using the four widely used rheological models namely the Newtonian model, the Bingham plastic model, the Power law model and the Herschel-Bulkley model are presented.

Four rheological models are used to find out their ability of predicting SPP with sufficient accuracy. The power law model is found to produce SPP estimates considerably close to the measured values for the drilling data considered (oil base mud).

Keywords: SPP, rheological models, frictional pressure drop

Introduction

Hydraulic modelling is an integral part of drilling operations, thus its importance for the efficient delivery of a wellbore cannot be over emphasized. The standard API methods for drilling fluid hydraulics assume either Power law or Bingham Plastic, these models provide a simple way of estimating required parameters for efficient drilling operations, but for conventional wells. These models are sometimes not accurate when used to model the hydraulics of more difficult wells.

When drilling fluid is circulated, pressure drop takes place due to friction between the fluid and the surface of the stand-pipe, rotary hose, swivel, Kelly, drill-pipe, drill-collar, drill-bit, and the annulus between the drill-string and the open hole or casing. This generates a total frictional pressure drop in the hydraulic circuit called the Stand Pipe Pressure (SPP). The Equivalent Circulating density (ECD), which is generated from annular pressure losses, needs to be predicted correctly to ensure that the fracture gradient of the formation to be drilled is not exceeded, as there will be losses of the drilling fluid into the formation and potential wellbore instability problems [1].

During drilling operations it is very important to know exactly the pressure drop along the hydraulic circuit for many reasons. The most important are the following [2]:

- Optimize the pressure drop at the drilling bit in order to get the maximum impact force or maximum HSI on the formation and, as consequence, increase the rate of penetration.
- Optimize the flow rate in the annular space, between the drill pipe and the wellbore wall, in order to have a better transport of the drilling cuttings to the surface an optimize the hole cleaning.
- Avoid to fracture the crossed formation due to the underestimation of the annular pressure drop.
- Detect any unexpected changes of the stand pipe pressure, due to a change of the hydraulic drilling circuit (i. e. wash out, plugged nozzles and fluid kick) and take the opportune decisions to restore the original conditions in the well.
- Better design the mud pumps available on the drilling rig.

The Rheological Models

Rheological models (Figure 1) are mathematical equations used to predict fluid behavior across a wide range of shear rates and provide practical means of calculating pumping (pressure) requirements for a given fluid. Most drilling fluids are non-Newtonian and pseudoplastic and, therefore, hydraulic models use a number of approximations to arrive at practical equations [3].

Newtonian model

A fluid that has a constant viscosity at all shear rates at a constant temperature and pressure is called a Newtonian fluid. An equation describing a Newtonian fluid is given below [4]:

$$\tau = \mu\gamma \qquad (1)$$