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General Computerized Well Control Kill Sheet for Drilling Operations With Graphical Display Capabilities

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ABSTRACT

A rigorous method of pressure calculations was used in a general well control procedure for drilling operations with the drillbit on bottom. A computer program was developed to handle the calculations and graphics interactively to allow speed and flexibility of choices throughout a kick situation. A well control procedure was developed to handle from vertical to horizontal wells for many drilling situations. All pertinent equations are presented and unlike other publications the computer source code is given in the Appendix.

INTRODUCTION

Although the vast majority of kicks are controlled, much research is still to be done to investigate the different scenarios of kick occurrence and the flow behavior while pumping it out, considering the different fluids in the well (while taking the kick) and its spatial configuration.

In particular, for drilling, two are the commonly accepted methods for well control operations: the Driller's Method and the Wait and Weight Method [1].

The Driller's Method consists in circulating out the kick before weighting up the drilling fluid while the Wait and Weight Method consists in circulating out the kick after weighting it up. Simultaneous circulating and weighting up the drilling fluid have also been studied but it is not of common use due to the additional accounting required. A qualitative example for the drillpipe pressure schedules for all three methods are shown in Fig. 1.

To aid the rig personnel, several kill sheets have been developed [2, 3], most of which consider a vertical well, a uniform distribution of pressure loss within the drillstring (from

the bit, throughout the drillstring to the pump) and that the pressure loss changes, after weighting up the drilling fluid, are solely dependent upon its final density. Furthermore, it is a common practice in the industry today to periodically train the rig personal on well control practices (this is particularly true for offshore operations) that include among other training, to fill out correctly the kill sheets to avoid incorrect calculations during actual well control operations. This training to fill out the kill sheets could take a day or two depending on the different scenarios investigated (land rigs, floating vessels, etc).

The objective of this work was to develop a general and rigorous method of well control that can be easily used for any kind of rig during drilling operations with the bit on bottom, and to automate the calculations through the use of a computer program that also handles interactive graphics with all necessary information for circulating out the kick.

RIGOROUS METHOD

This method considers all the information for usual well control operations (reduced circulating pressures, borehole and pipe geometries, mud properties, etc.) and also makes use of the rheological properties of the new drilling fluid, and the directional survey data to determine the true vertical depths (see tables 1 through 3 for details).

The method is based on the following procedure:

First the mud properties (rheology and density), borehole and pipe geometry, and flow rates are used to calculate the pressure loss through the surface equipment [4] (that lies after the surface pressure gage), the drillstring (drillpipe, heavy weight, collars, etc.), the bit, and throughout the different annular sections for the old mud in the well (Fig. 2).

Then the circulating pressure at the kill rate (P_r)_m mea-

References and illustrations at end of paper