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Computerized Kill Sheet for Most Drilling Operations

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ABSTRACT

This paper addresses a portion of what is actually needed for deep water operations involving well control procedures for directional and horizontal drilling.

Drillpipe pressure schedules were investigated together with the analysis of surface pressure gauge limit to avoid further gas influx and predict the onset of casing shoe fracture.

Examples are run mainly using directional and horizontal well data illustrating the procedure and operation.

INTRODUCTION

Standard kill sheets are limited in their use to vertical wells, and pressure drop calculations are simplified mainly to facilitate filling out the forms. A computer kill sheet by Leitão et. alli.[1] was developed to handle common well control drilling problems from land to deep waters with and without deviation control. The method made use of more accurate pressure drop calculations using the drilling fluid rheological data throughout a wide span of shear rates (basically the 6 FANN35 readings). Several kill muds could be used throughout the control sequence and a computer program was written to handle the calculations on a personal computer with interactive graphic capabilities to provide the user with an operational procedure update after every actual operation.

As a continuation to what has already been developed, the theory in this paper will address a practical problem that is normally shown on the conventional kill sheets through one or at most two numbers - the maximum casing pressure (or kill line pressure for offshore floating vessels) at which the casing shoe fracture or casing burst will occur Fig 1.

References and figures at end of paper.

WELL CONTROL PROCEDURE

The basic task in well control is to circulate out the kick maintaining the bottom hole pressure constant and sightly higher than the pore pressures within the exposed formation. Several methods have been developed for such purposes [2] including one rigorous one [1].

This paper also deals with a second constraint, the casing shoe pressure, at which formation fracture will occur (an example of these pressure values is given in the Appendix). Once the fracture is initiated, the circulation losses could lower the bottom hole pressure and therefore promote further formation fluid influx that could quickly lead to an underground blowout. It is important to quickly recognize when this situation has occurred.

Casing wear can sometimes require an unexpected reduction in the maximum allowable casing pressure. The procedure in a critical well control situation, where casing rupture pressure is being approached, is to operate the choke such that the casing shoe pressure remains sightly below the fracture pressure until these pressures drop as the gas phase (or intrusion fluid phase) passes by that point. Of course this procedure will incur in an additional influx of fluids from the higher pressure formation since bottom hole pressure was necessarily lowered during this operation. Fortunately the computer program can handle all these situations since this problem is an accounting one to keep track of the fluid boundaries (interfaces) and therefore can calculate the new drillpipe schedule to be followed, assuming that the new gas or fluid influx was smaller than the first one, otherwise there is no solution to the problem and the ability to safely shut-in the well will be lost.

Assuming an offshore situation with the wellhead placed at the mudline, the measurement of the shoe pressure is done by reading the surface kill line gauge pressure corrected by the fluid densities within the kill line and casing.

The kill line fluid density is assumed here to be known and constant. Unfortunately such an assumption isn't appro-