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FEASIBILITY EVALUATION OF ALTERNATIVE WELL CONTROL METHODS FOR A RISER GAS-LIFT APPROACH FOR DUAL DENSITY DRILLING

TASK #3 REPORT

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13. ABSTRACT (Maximum 200 words)
Several dual gradient drilling methods have been proposed for reducing deepwater drilling costs. This report investigates the well control considerations for achieving a dual gradient system by gas-lifting the riser with nitrogen.

The specific concerns addressed were kick detection, cessation of formation feed-in, and removal of kick fluids with a constant bottom hole pressure method. These concerns were studied using a transient, multiphase simulator. The validity of using the simulator to study this system was previously confirmed by comparison to transient, multiphase flow tests in a test well.

Conventional kick detection methods relying on the pit gain and return flow rate were concluded to be effective. BOP closure was reliable for stopping flow and minimizing kick volume. Further, a relatively conventional approach of circulating up a gas-lifted choke line against a surface choke was compared to a dynamic approach based on reducing the nitrogen rate and to the use of a seafloor choke. It was concluded that methods using a choke were much simpler and more effective for controlling pressure than controlling nitrogen rate was and that control was simplified when using a subsea choke.

14. SUBJECT TERMS
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SUMMARY

The recent push into deepwater is currently limited by high drilling costs resulting from conventional well designs. These high costs restrict development and utilization of deepwater reserves. As a result, dual gradient drilling methods have been proposed in order to provide simpler, safer and more economic well designs. This report investigates riser gas-lift as a potential means to implement a dual gradient system. The primary concern addressed herein is the feasibility of well control in a riser gas-lift system containing so many different density fluids and different flow paths.

The specific concerns addressed in this study were kick detection, cessation of formation feed-in, and removal of kick fluids with a constant bottom hole pressure method. These concerns were studied using a transient, multiphase simulator. The validity of using the simulator to study this system was confirmed with comparison to transient, multiphase flow tests in a test well.

Conventional kick detection methods relying on the pit gain and return flow rate were concluded to be effective. Two alternatives for stopping formation flow were considered, a "load-up" method of reducing the nitrogen rate versus closing a subsea blowout preventer, BOP. BOP closure was shown to be more reliable for stopping flow and minimizing kick volume. Further, a relatively conventional approach of circulating up a gas-lifted choke line against a surface choke was compared to a dynamic approach based on reducing the nitrogen rate and to the use of a seafloor choke. It was concluded that methods using a choke were much simpler and more effective for controlling pressure than controlling nitrogen rate was. The subsea choke has an advantage over the surface choke due to faster pressure responsiveness, smaller pressure variation, and needing fewer and smaller choke adjustments.

INTRODUCTION

The overall objective of this project is to establish whether more comprehensive research concerning dual density drilling systems based on the use of low density fluids, either liquid or gas, is justified. The project is intended to continue the research initiated by LSU and Petrobras, and described by Lopes (1997-b) and Lopes and Bourgoyne (1997-a,-c), on the riser gas-lift method and to begin assessing injection of unweighted liquid into the riser as another alternative. These methods are intended to offer alternative methods of achieving a dual gradient deepwater drilling system that utilizes more standard equipment than the separate industry projects focused on the use of seafloor pumps to achieve the advantages of a dual gradient method.

The focus of this report is to address the question whether an effective well control method can be defined for a system containing the many different density fluids and different flow paths inherent with a riser gas-lift system. Consequently, it is intended to answer the second of the four critical questions about the practical feasibility and commerciality to be addressed in this project.

Three critical phases of a well control operation were addressed: kick detection, stoppage of formation inflow, and circulation to remove kick fluids. Each of these phases was simulated using a transient, multi-phase numerical simulator. The results of these simulations are presented and analyzed in order to evaluate the effectiveness and practicality of alternative approaches for achieving control of gas and salt water kicks.

RESULTS AND DISCUSSION

WORK PLAN

The plan for this task, Task 3, was to perform an engineering analysis to evaluate alternative approaches for controlling a gas kick and a saltwater kick. The purpose was to evaluate whether the best well control method is more likely to be conventional circulation against a surface choke, a more dynamic approach of using the dense fluids already in the well to regain an overbalance, use of a subsea choke, or some combination. The emphasis is on controlling kicks taken while drilling with a riser gas-lift system.

The report addresses the three major well control concerns: kick detection, stopping inflow, and kick removal. These are presented and analyzed in a sequential order. The results presented for each question are based on simulations with the OLGA 2000TM transient multiphase simulator. Lopes (1997-a, -b, -c), Maus (2001), and Herrmann (2001) all discussed some aspects of well control with a riser gas-lift system. In addition, a number of well control studies have been done for a mudlift pump system, especially those by Choe (1998) and Schubert (2003-a, -b). However, no tests, simulations, or comprehensive study have been conducted for a riser gas-lift system. Therefore, the simulations described herein are the first serious study of well control for a riser gas-lift system.