Deepwater Reverse-Circulation Primary Cementing

Project Fact Sheet

Program
2010 Ultra-Deepwater

Project Number
10121-4502-01

Start Date
June 2012

Duration
27 Months

RPSEA Share
$861,623

Cost Share
$293,067

Prime Contractor
CSI Technologies

Participants
Weatherford; University of Houston

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Reports and Publications

RPSEA
www.rpsea.org

04.20.17

Research Objectives

The primary objective of this project is to assess the Deepwater well applicability of reverse-circulation primary cementing (RCPC) techniques. Whereas conventional primary cementing fluids are pumped down the casing and then up into the annulus, RCPC allows fluids to be pumped down through the annulus and up into the casing shoe. The scope of work comprises analyzing the RCPC placement method, preparing a development path for technology required to apply RCPC to Deepwater wells, and creating preliminary operational procedures with associated contingency plans. The application of RCPC to Deepwater wells is expected to reduce bottomhole circulating pressures and prevent lost circulation during cementing as well as increase safety, enhance environmental sustainability, provide zonal isolation, and improve cement seals.

Approach

Anticipated challenges to the application of RCPC to Deepwater wells included modeling and simulations, mechanical placement controls, and cementing fluid design. Subsequent tasks of this project included University of Houston's development of a series of numerical model simulations applicable to RCPC operations in Deepwater. In addition, Weatherford investigated and analyzed the mechanical tool components required to implement RCPC in Deepwater wells, which included an analysis of cement flow and placement controls required to direct fluid down the annulus of a Deepwater well casing or liner as well as a means to separate fluids during placement. Also, CSI Technologies studied cementing materials and operational considerations to identify potential design and performance benefits/issues based on cement performance under Deepwater conditions when placed by RCPC.

Accomplishments

A finite-element software package has been used to develop a robust model capable of handling Deepwater RCPC. Also, a method was developed to be able to use workarounds within commercial cementing simulation software to perform Deepwater RCPC simulations. The resulting temperature and pressure profiles provided basic estimates of placement. Laboratory intermixing studies have shown that rheology is a key parameter in fluid design and placement while use of a conventional fluid hierarchy can result in interface instability and fluid swapping. Key mechanical components required to perform Deepwater RCPC were analyzed to determine the current state-of-the-art, as well as future, performance requirements.

Future Plans

Overall, the applicability and benefits of RCPC to Deepwater should be evaluated on a case-by-case basis. Existing gravel pack and sting-in float technology can be modified for use in the near future. However, technology needed for future development includes the modification of float equipment and a switchable crossover that will divert fluids on demand. The next step in tool development should add capabilities that allow for nonmechanical operation of tools from the surface by incorporating technologies such as RFID, chemical-activated triggers, or mud-pressure pulses. Mud removal and fluid separation will remain a major challenge for Deepwater RCPC since physical separation will need to be maintained through the use of viscous plugs instead of traditional plugs, darts, or balls. The design methodology of cementing fluids is affected by this change in placement method since the leading edge of cement will become the critical shoe slurry. A close review of simulations of various wells and casing strings reveals that cement slurry is often exposed to a higher downhole circulating temperature, and that placement time can be shortened significantly in some cases. Hydraulic analysis of these Deepwater strings has confirmed the critical depths at which placement by RCPC results in a lower equivalent circulating density (ECD).

Acknowledgements

CSI Technologies wishes to acknowledge the support of RPSEA, Weatherford, and the University of Houston, as well as the Working Project Group, for their invaluable expertise.