Oil & Natural Gas Projects
Exploration & Production Technologies

Ultra-deepwater Gulf of Mexico Field Development Enabling Technologies and Demonstrations

DE-FC26-00NT40964

Goal:
The goal of this project is to reduce the costs, improve the efficiency, lower the risks and improve the safety of drilling and producing in ultra-deepwater offshore locations.

Background:
The purpose of this project is to develop and demonstrate three enabling technologies that will help to reduce the field size required for economic development in ultra-deep water. The three technologies include: subsea processing, composite production risers, and the application of a “casing drilling” approach to deepwater subsea wells using a Close Tolerance Liner Drilling (CTLD) system.

Performers:
ConocoPhillips Inc. – Project management and all research products
AkerKvaerner ASA – technology development partner for subsea processing effort
Kvaerner Oilfield Products, Inc. – JIP partner for composite riser demonstration effort
ChevronTexaco Inc. – JIP partner for composite riser demonstration effort
Tesco Corp. – technology development partner for CTLD effort
Baker Hughes Inc. – technology development partner for CTLD effort

Potential Impact:
In deepwater developments, approximately one-half of the costs are associated with the surface facilities necessary to produce and transport the hydrocarbons. Floating production platforms cost from several hundred million to well over one billion dollars, with the vast majority of the investment in the structures necessary to support the production equipment. The subsea processing (SSP) technology has the ability to reduce facility costs by up to 80% or more. This could lead to the exploitation of some smaller reservoirs which were considered uneconomic.

Close Tolerance Liner Drilling provides numerous benefits, the primary benefit being that all trips to run and cement casing are eliminated, along with the exposure to hole problems while tripping the pipe. A secondary benefit is that the casing is always near the bottom of the wellbore, enabling an operator to case off a section rather than fight a potential wellbore problem. Other wellbore problems are also avoided. Significantly fewer wellbore problems means significantly reduced costs.

A composite production riser has several attractive properties, such as high specific strength and stiffness, lighter weight, improved corrosion resistance, high thermal insulation and damping characteristics, and excellent fatigue performance. These properties make composite risers good candidates for deepwater applications. In addition, the use of composites permits tailoring of properties to meet specific design requirements, promoting better system-oriented solutions. Capitalizing on these advantages for composite riser applications could result in lower system cost and higher reliability for deepwater developments.

Results:

- Designed a SSP system for specific locations in the Gulf of Mexico and showed that no technology gaps remain to deter its application,
- Designed composite riser joints for installation on the Magnolia TLP and performed risk assessments to confirm that they will place no additional risk on the structure,
- Fabricated composite liner samples for testing,
- Manufactured five composite production risers for installation,
- Designed a CTLD system capable of performing under subsea drilling conditions,
- Built and successfully lab tested individual system components needed for a CTLD system,
- Assembled components and successfully tested a full-scale CTLD system prototype in a cased test well onshore,
- Successfully employed a full-scale CTLD system prototype to drill an openhole section onshore.

Subsea Processing – The design objectives were to prove technical feasibility for an SSP system in water depths to 10,000 feet, and at a distance of up to 50 miles from a host facility. In order to ensure competitiveness with conventional technology in any deepwater development opportunity, the first step was to ensure technology gaps for SSP were identified and resolved and that specific deepwater location data sets were used for credible comparisons to conventional solutions.

Subsea processing modules

Multiple locations in the Gulf of Mexico were evaluated and a SSP system designed for the requirements. In one case, the design called for a 33,000 barrels of oil per day (BOPD) SSP system with separate liquid export and gas export to a nearby facility. The second system was similar in design but rated for 20,000 BOPD. The design was shown to be economically viable with unrisked reserves ranging from 50 to 200 million barrels of oil recoverable. Unfortunately, none of the prospects within ConocoPhillips' current portfolio met economic hurdles once geologic risks and unique accommodating costs were accounted for. Despite the negative economic evaluations, there was sufficient technical work done to confirm that no technology gaps remain for the SSP system.

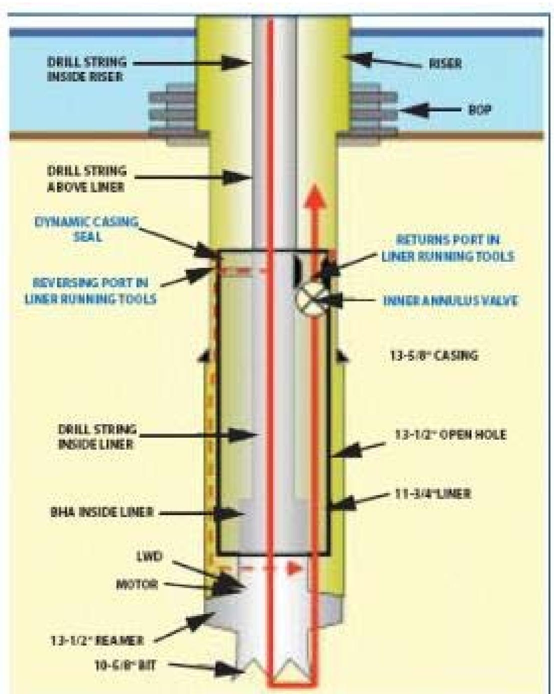
Composite Riser – A field demonstration in the Gulf of Mexico was considered key for both industry and regulatory acceptance and as part of this project the DOE, Kvaerner Oilfield Products, ChevronTexaco and ConocoPhillips initiated a Joint Industry Project to design, qualify and fabricate five to ten composite production riser joints for installation on the Magnolia Tension Leg Platform (TLP) in the Gulf of Mexico.

The Magnolia field is in the facilities construction stage. Riser installation was expected to take place in the first quarter of 2005. The lead contractor for the design, testing and fabrication of the composite joints was DeepWater Composites AS. In addition to the qualification of the proposed design and fabrication/installation of several field joints, the project involved a study to assess the benefits of the composite joints on the vortex induced vibration (VIV) response of the riser string. Also included in the project was an evaluation of in-service inspection methods that have the potential of being monitored remotely or by an remotely operated vehicle (ROV). The result will be to prove the technology in the Gulf of Mexico deep water and obtain actual performance data for application to future developments.

Four of the five composite risers failed testing. Therefore, the decision was made not to install the remaining riser and to wrap up the project. ConocoPhillips was confident that the failure problems could be corrected, but the Magnolia riser installation schedule did not allow sufficient time to implement the solution. Steel risers were to be installed as a result. It should be noted however, that the failure of the composite risers was not due to the composite material, but to the steel liners inside the composite and their welds. ConocoPhillips still considers this technology highly promising.

CTLD – With Casing Drilling, a well is drilled with standard oilfield casing in place of drill pipe, allowing an operator to simultaneously drill, case, and evaluate a well. Drill bits and other tools are lowered inside the casing to the bottom of the hole via wireline, where they are latched to the last joint of casing. Specially designed underreamers extend out from the bottom hole assembly (BHA) to create a hole sufficient for the casing and cement. For directional and horizontal wells, the BHA can be fitted with conventional mud motors and measurement-while-drilling (MWD) tools. A top drive system is used to rotate the casing, which remains in the hole at all times and is eventually cemented in place when the appropriate depth is reached. It is estimated that the efficiency of the drilling process can be improved by 20 to 30 percent with casing-while-drilling.

The onshore application of Casing Drilling has been successful, but the actual cost savings are relatively small as the daily spread costs in South Texas are relatively small. However, if the approach could be modified so that similar time-related savings and problem avoidance could be achieved in the deepwater areas of the Gulf of Mexico, cost savings could approach several million dollars per well. This opportunity was the impetus behind this Close Tolerance Liner Drilling (CTLD) research and demonstration effort designed for floating drilling operations in the deeper water Gulf of Mexico. Because the wells are subsea, drilling is never done with casing in the rotary table. Instead, a casing liner is run on the drill string (hence the term “liner drilling”). Because deepwater wells can require eight or nine casing strings, there is a need to minimize the space between consecutive strings (hence the “close tolerance” aspect). ConocoPhillips, Tesco and Baker Hughes are cooperatively developing this technology.



Schematic showing key elements of the CTLD system

After successfully passing all laboratory and shop testing, the full-scale drilling completion and stimulation (DCS) and liner hanger and running tool were assembled and delivered to Tesco’s test well in Houston. Testing was carried out to better understand surge and swab pressures associated with the reverse circulating port and two downward flow paths; to determine whether rotational dynamics between the liner and casing are an issue; and to subject the system to about 10,000 feet of tripping and to the equivalent of about 3,000 feet of drilling rotational wear. After performing these tests, the liner hanger still had to set, and the liner packer still needed to be able to be set and seal. The four objectives were successfully completed in mid-February 2004.After a full teardown of the DCS it was learned that minor damage had been sustained by the leading edge of the pilot seal, but the seal was still functioning. The main seal displayed acceptable wear and functioned as designed. The rotational components of the seal showed minimal wear in the 100,000 revolutions, and there was no evidence of plugging in any of the internal passages.

During April – May 2004 the CTLD system was tested in an open hole at the Tesco test well site. Approximately 300 feet of hole was drilled through shale an sandstone, ending at a total depth of 2,595 feet. No problems were observed with vibrations, slip/stick, or hole cleaning, however at a depth of 2,595 feet, plugging problems were observed and the tool was pulled.

The work done so far indicates that the DCS element is robust and fully meets the design requirements. The liner hanger has been demonstrated to be robust and the liner connections are not limiting. Also, well control and safety are fully addressed with the design and operation of the system.

Current Status and Remaining Tasks:
Work related to the SSP technology, the composite riser joints, and the CTLD system equipment has been completed. ConocoPhillips is continuing to search for an opportunity to demonstrate the CTLD technology on a deepwater drilling rig. The draft final report was submitted and ConocoPhillips is incorporating the comment into the final version.

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Performer Contribution: $5,477,213

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