The time has come to develop Riserless Mud Recovery technology's deepwater capabilities

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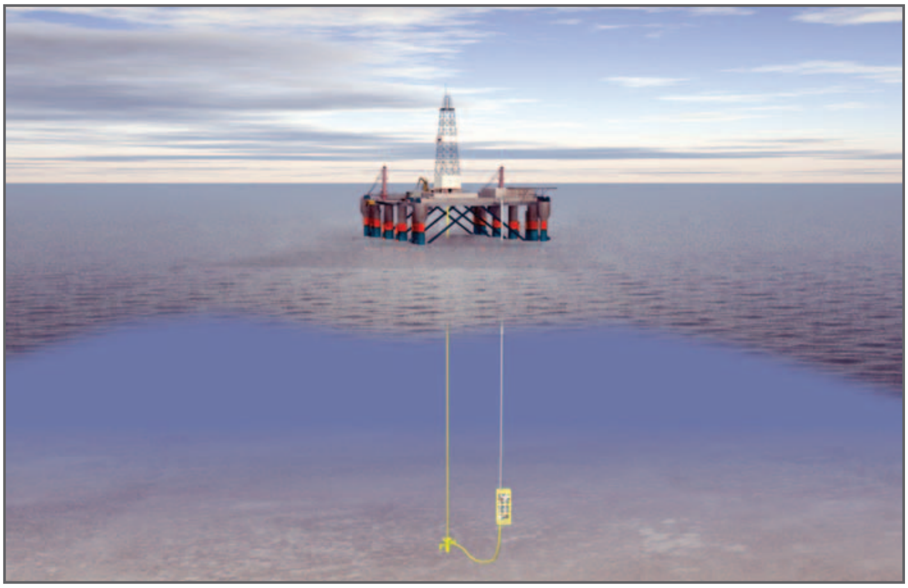

Above: A Riserless Mud Recovery (RMR) joint industry project is being organized to field-trial an updated look at the riserless dual gradient drilling technology. Below: A two-stage RMR pump is deployed through the moon pool.

OVERALL AND OVER a number of years, the industry has spent significant research and development funds for the initial determinations of the capability and development of dual gradient drilling technology (DGD). It has been estimated that total R&D dollars in excess of $100 million, excluding internal salaries, have been spent on industry's DGD technology development.

This would include work done in the second half of the past decade up to around 2002 by the Subsea Mudlift Drilling JIP, the DeepVision Joint Industry Project (JIP) and Shell DGD approach.

Costs previous to these initiatives, such as those incurred by the **Conoco/Union Oil of California/Superior/Shell** Joint Industry Project (1948-58) that had an offshore California focus involving both with marine riser and without marine riser applications of dual gradient technology, the "Riserless Drilling JIP" (22 member companies in 1996) and the **Chevron**/Conoco/**BP Amoco** "Shallow Water Flow Diverter" efforts (1998) are unknown by the authors.

One perhaps may say that in these and other past initiatives involving what the industry now refers to as DGD technology, "the operation perhaps was a technical success, but the patient did not survive."

Although encouraging from probabilistic model results, the high initial investment cost, inflexibility for rig-to-rig transfers, perceived reliability issues and a downturn in drilling activity in 2002 dealt serious blows to the most recent commercialization efforts that focused primarily on DGD with marine risers.

The calculated value of true DGD with a marine riser as an enhancement technology on explorations wells, appraisal wells, and risk-weighted future development wells from exploration successes, did not provide the basis for an overwhelming or compelling business case.

Emphasis is currently being placed on finding and developing technologies that provide some of the benefits of DGD but with lower investment costs, increased flexibility to move among rigs, and per-

mitting the operator to pay on an "as used" basis versus a long-term commitment.

Riserless dual gradient drilling, e.g., Riserless Mud Recovery (RMR), appears to match these criteria and current challenges to the economics of a growing number of deepwater prospects.

A RMR joint industry project is in the organizational phase to field-trial an updated look at the technology. Labeled the Demo 2000 RMR Deepwater JIP, participants are committed to develop and prove the tools and technology to a point of being available as a user-friendly, safe and cost-effective alternative to the conventional practice of riserless pumping and dumping in up to 5,000-ft water depths.

The basic "kit" required incorporates a subsea mud collection module, subsea pumps, and a mud and cuttings returns line back to the floating rig.

In applications where enhanced control of the well is required based on potential shallow water/gas flow risks or to enable drilling riserless with drilling fluids deemed incompatible with the seawater environment or cost-prohibitive for discharge, a subsea Rotating Control Device provided by **Weatherford** is being considered for integration into the system.

The current participants of the JIP are **Demo 2000**, BP, Shell, and **AGR Subsea Inc**. Demo 2000 is a Norwegian funding entity providing funds for supporting piloting and bringing new Norwegian technology to the market.

Field trials of this deepwater RMR technology development are currently planned for post hurricane season 2007 in the Gulf of Mexico.

RDG DRILLING

Alan Gault, a consultant for **Pioneer/Dallas** who has been involved in several

DGD initiatives over the years, has made an interesting observation: "Industry interest in DGD began in the late '40s with the project in California and appeared at the time destined to ebb and flow in a 20-year cycle. Today, however, the peaks in interest are occurring much more frequently as the hydraulics of offshore drilling, particularly in deepwater, are becoming more challenging."

It has been established that both riserless and below BOP versions of dual gradient drilling has been a topic of interest by some of the industry's best and brightest for a long time. Riserless DGD has been identified as a technique with potential to deal with shallow geohazards (i.e., shallow water flows/gas flows) when establishing the top-hole sections of subsea locations. Compared with the conventional "pumping and dumping" method of riserless drilling, the potential to apply greater overbalance than the mud in the hole at the time would impart via a mechanical means as opposed to mud weight hydrostatic alone shows great promise. The ability to drill riserless with drilling fluids incompatible with the sea environment or too expensive to discharge to the seafloor is attractive for both environmental and economic reasons. The potential to drill deepwater pilot holes for exploratory purposes with rigs perhaps not designed to drill in waters so deep is also recognized as a potential benefit.

The Integrated Offshore Drilling Program (Texas A&M) several years ago envisioned the ability to collect scientific core samples without having to set casing strings, but the program was abandoned after the sample was collected. Looking to the future, such an integrated top hole-drilling package may have unique application drilling for commercial quantities of methane hydrates as well.

For these purposes and others, the JIP participants are considering now as the time to take the next step and prove the technical and commercial merits of such a riserless top-hole drilling package and normalizing the practice of riserless dual gradient drilling with RMR when deemed cost-effective.

The method to be practiced in the field trials has had a number of labels attached to it over the years it has spiked interest. Today, the method has been defined as one of the several varia-

A Weatherford subsea rotating control head was shop-tested to a simulated water depth of 7,500 ft for a period of 1 week, or 168 hours, and to a differential pressure maximum of 2,000 psi.

tions of managed pressure drilling by the IADC Underbalanced Operations & Managed Pressure Drilling Committee and will be taught in the MPD section of SPE's new textbook, "Advanced Drilling Technology & Well Construction."

FIELD TRIALS

Under the auspices of the JIP, proving the technology offers a number of potential benefits and applications:

• Mechanically overbalancing shallow geohazards with additional backpressure;

• Alternative to deploying a marine riser in some applications;

• Drill riserless with drilling fluids environmentally incompatible for direct discharge to ambient seawater;

• Recover expensive riserless drilling fluids;

• Extend surface casing setting depths and possibly eliminate additional shallow liner or liners;

• Provide improved hole quality and predictable setting of casings at desired depths;

A basic RMR "kit" incorporates a subsea mud collection module, such the AGR Suction Module (Mud Collection Module) shown above.

• Volume control while drilling top-hole sections;

• Drill pilot holes in deep and ultra-deep water with older-generation rigs.

The benefits of RMR over "pump and dump" are thought to be substantial. First, there will be considerable savings in both the mud costs and the logistics support costs to get the large fluid volumes to the rig site. In addition, use of an engineered fluid system will lead to better hole quality, which in turn will give rise to additional benefits such as improved top hole cement jobs, lowering potential re-spud requirements due to behind pipe shallow flows.

On older MODUs with limited tank space where the time taken to change out fluid systems from a water-based mud system to a synthetic SBM is substantial, it has been suggested that a synthetic system could possibly be used for the total well construction below the jet string provided the Weatherford RCD is used.

Obviously, the "zero discharge" characteristics of the RMR system, in keeping with the vision of the previous DGD initiatives, offers environmental benefits compared with current riserless drilling practices.

With the subsea RCD integrated into the system, drilling decision-makers are enabled to view the circulating fluids system somewhat akin to that of a pressure vessel, certainly low pressure in the top-hole sections with fragile fracture gradients, but as a pressure vessel, nevertheless.

RMR TRACK RECORD

AGR's Riserless Mud Recovery component of the system has been used successfully on a number of shallow water riserless drilling applications over the past 3 years.

The first commercial application was for BP on the Azeri Field in the Caspian Sea in 2003. On this field, a total of 15 wells have been successfully completed using the RMR technology. Since then, 3 additional wells have been drilled on the deepwater Gunashli field and 1 well on Shah Deniz (1,280 ft water depth), also for BP in the Caspian Sea.

In 2004, a North Sea field trial was carried out, funded by Demo 2000, **Hydro**, Statoil and AGR to qualify the RMR technology for the North Sea/NCS environment in water depths up to 1,500 ft.

Recently the system has been applied on 1 well for **Total UK**, and another is planned this autumn.

More and more focus is being seen on discharge to the marine environment. Russian authorities have been among the first to totally ban discharges from everything below the initial conductor. This has resulted in BP selecting RMR

The first commercial application of AGR's Riserless Mud Recovery component was for BP on the Azeri Field in the Caspian Sea in 2003. Fifteen wells have been completed using the RMR technology.

for 2 wells outside Sakhalin this summer in the Kaigansky-Vasukansky license area. At the time of this writing, 1 of these wells has been completed.

Hydro/Gazprom have also selected RMR for an exploration well on Shtokman in the Barents Sea in order to meet discharge-to-environment requirements, and this operation was successfully completed late July 2006.

Recently, AGR was awarded a contract for Shell for 12 wells on the Western Australia Drilling Project. These operations are expected to begin in November 2006.

SUBSEA RCD SHOP TESTING

The subsea RCD was developed and extensively shop-tested several years ago as an integral component of the DeepVision and DeltaVision version of this DGD initiative. The design was ultimately deemed "technically qualified for both DeepVison and Shell DGD initiatives.

However, unlike the AGR components, the subsea RCD has no field trials experience to date.

Shop tests results of a Weatherford Model 7875 self lubricated subsea RCD Bearing & Dual Stripper Rubber Assembly to a simulated water depth of 7,500 ft:

- Weatherford Model 7875 self lubricated Bearing Assembly;
- Stripped 28,000-ft of 6 $^5/_8$-in. drill pipe with tool joints;
- Pressure differential, 0 to 2,000 psi;
- 168 hours (one week with no intervention);

- 140 RPM;
- Stripper Rubber performance – Excellent (pipe wet & cold).

CONCLUSION

Riserless mud recovery technology is a technology whose time has come to continue development of its deepwater capability and to conduct deepwater field trials in earnest. Once this step is successfully taken in the evolution of deepwater drilling technology, several next steps that may now seem insurmountable will be enabled. Much of the key equipment required has already been either field-proven or extensively shop-tested, and its design and configuration into a deepwater system will be completed.

At the IADC Drilling Gulf of Mexico Conference & Exhibition, 5-6 December, a joint presentation by representatives of several of the participant member companies of the Demo 2000 Deepwater RMR JIP is scheduled.

A single-stage RMR pump is deployed over the side of a rig.

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