

Progress continues in underbalanced well systems

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UNDERBALANCED technology (UB) is becoming more widely accepted as industry awareness of its advantages grows. UB increases the value of the well and enhances productivity. Often, it reduces well fluid costs and can eliminate the need for remedial operations such as fracing and acid stimulation.

Experts predict that UB activity will more than double in the next 3-5 years as additional benefits become evident. Weatherford has assembled a fully integrated underbalanced system with products and services that are proving themselves around the world. The next step will be to refine the system with strategic enhancements and speed acceptance of UB.

This goal can be accomplished by our approach in key areas:

- Investment in people and a global infrastructure already in place;
- Refinement of the engineering system and delivery process for consistent, reliable, safe service;

- Integration of services across Weatherford's product lines and divisions, including pull through of many other oilfield services to work in conjunction with UB.

WELL CONTROL

Weatherford engineers are developing more sophisticated ways to manage UB operations at the wellsite. One such technology is the rotating control head and flow control separation system.

Weatherford developed and successfully tested the RiserCap™ External Riser Rotating Control Head System in field trials with the Petrobras Joint Industry Project (JIP).

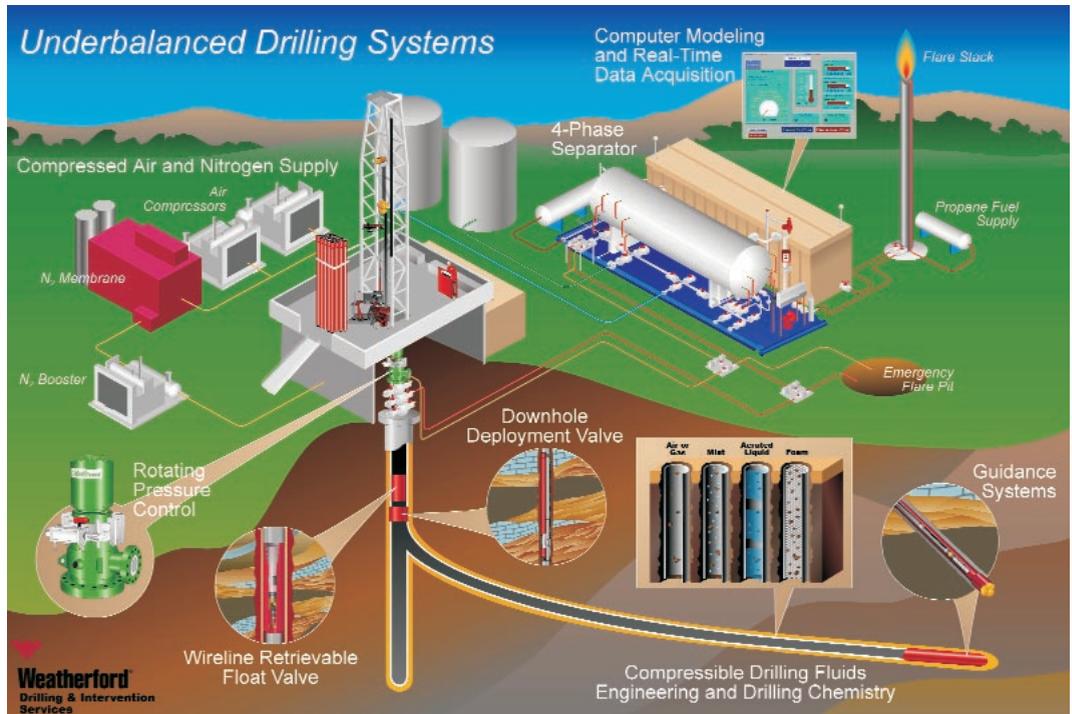
Weatherford Underbalanced Systems

(UBS) proprietary RiserCap is a rotating control head system specifically designed for deepwater floating drilling rig applications. It replaces the conventional slip-joint system with a specialized Rotating Control Head (RCH) based system in order to control the pressure created in the marine drilling riser if a lightweight drilling fluid system is used on a deepwater drilling rig.

The RiserCap has been successfully proven in a field trial to drill in deepwa-

redundant hoses after being installed on top of a closed riser slip joint. The RiserCap Bowl, Bearing Assembly and stripper rubbers sealed the annulus of the well at the top of the riser and held the required pressure while drilling ahead.

And its flexible flowlines handled the diverted annulus returns to the choke manifold while accommodating heave movements of the floating rig.



An integrated underbalanced drilling system includes products and services now being proved around the world. The next step is to refine the system with several strategic enhancements and speed the acceptance of UB technology.

ter with lightweight fluids. The trial, conducted in a 10,000-ft well in approximately 1,000 ft of water, took place on the Petrobras XVII semisubmersible in the Albacora Field of the Campos Basin, Offshore Brazil, as part of the Petrobras Joint Industry Project (JIP).

The JIP's objective is to adopt lightweight drilling fluid equipment and techniques for use in deepwater floating drilling and in addition to Weatherford, involves several other operating and service companies.

During the field trails, the RiserCap was connected to the drilling choke and surface separation system with flexible

SMALL FOOTPRINT EQUIPMENT

UB techniques allow drilling with minimal environmental impact.

Weatherford's ability to provide stackable offshore nitrogen compression units combining air compression, a booster and a nitrogen generation unit in a single, small footprint machine has created a significant opportunity for taking UB offshore.

Addressing the limitations of space, the SeaWolf™ Nitrogen Generation System features the latest design in Weatherford's worldwide fleet. The system separates nitrogen from the air, offering a



This Downhole Deployment Valve is used to isolate underbalanced reservoir section.

low-cost method to create high-pressure nitrogen. This direct drive system offers high performance using high-pressure membrane nitrogen separation.

First used over 10 years ago, this system's design continues to evolve based on field operation results. With total package output of 650 scfm of 95% nitrogen and a proprietary "thru-shaft" design, the Sea-Wolf System offers the industry's highest volume output (relative to size). The "thru-shaft" design allows for reduced maintenance, fewer moving parts and a less complicated filtration system.

NEXT LEVEL

Weatherford Underbalanced Systems is advancing from the addition of sophisticated UB technology toward engineering more complex UB solutions to answer customer needs.

We have had numerous early successes with UBS and several companies have adopted the technology early in the game. Among these are **Pertamina** in Indonesia and **Petrobras** in Brazil.

Earlier this year, Weatherford was chosen by **BP Colombia** to supply complete UB services for an initial 12-month program in the Cusiana and Cupiagua fields.

The award was made based upon peer group technical evaluation and focuses on reservoir protection. The UB solution is expected to enhance productivity for existing and new wells through the delivery of underbalanced lateral wells. The approach was the result of an extensive joint planning and engineering study.

Based on initial results, and the growing attention UB has received, Weatherford has moved to the forefront with not only the hardware and systems approach already in place, but with the well supervision and evaluation skills to successfully engineer projects.

To build on the growth that has occurred since 2000, we have developed and enhanced several key technologies,

including the Downhole Deployment Valve and the MacDrill™ Thru Tubing Motor.

DDV OFFERS BENEFITS

Weatherford's new Downhole Deployment Valve isolates the Underbalanced Reservoir section from the rest of the hole during tripping operations and makes it possible to complete the well in

an underbalanced condition. This can save rig time, eliminate the need for snubbing and limit exposure of the reservoir to an overbalanced condition.

On top of these added benefits, the DDV greatly enhances the safety of an underbalanced operation by minimizing exposure time to hydrocarbons. It also eliminates pipe light conditions and allows the rig crews to trip pipe in a natural

environment without the assistance of expensive rig-assisted snubbing units.

The valve is surface controllable, run as an integral part of the casing string and opens to the full bore of the casing.

The DDV has undergone an extensive HAZOP chaired by an independent third party with the participation of skilled individuals from within the industry.



SeaWolf generation system separates nitrogen from the air, providing a low-cost supply.

It is about to be field-tested in a harsh environment where it will be deep set and operated via a control line run back to surface.

The DDV improves upon current industry technology and will have a significant impact in the design of future underbalanced wells.

MACDRILL

The MacDrill is a high temperature hydraulic motor for drilling and well cleaning that features a stainless steel stator rather than the elastomers of conventional motors.

This allows operation at temperatures over 500 degrees Fahrenheit.

The MacDrill can be powered by hydrocarbon-based solvents, acids, and gases. It is 50% shorter than conventional motors, allowing faster rig up times and easier transportation.

MacDrill motors have been run successfully on dry nitrogen gas, natural gas with a high distillate content, naptha, brine and fresh water.

The ability to operate in high temperature wells for extended periods—and to change from liquid to gas or spot acid drive fluid—in a single drill motor in a single trip offers operational flexibility as well as time and cost savings.

The MacDrill is ideally suited for underbalanced drilling because it will not over-rev or suffer decompression problems.

It has a proven track record even when driven with 100% nitrogen. ■