

# World's first Level 6 intelligent completion drilled

**CHINA NATIONAL OFFSHORE** Operating Company (CNOOC) and Schlumberger recently designed, drilled and performed the world's first TAML Level 6 intelligent completion. The two-leg multilateral well was drilled and completed from the NE Intan "A" platform in the South Java Sea, Indonesia, in approximately 75 ft of water, during the fall of 2002.

The NE Intan A-24 well, in addition to being the world's first intelligent completion in a Level 6 multilateral well, is the first TAML Level 6 multilateral well drilled in Indonesia. The TAML Level 6 is the highest rating given in the TAML multilateral rating system.

The A-24 well provides an example of how multilateral completions can bring on new production at lower capital investment expense and reduce ongoing operating costs.

Adoption of this technology is enabling CNOOC to contact more of the reservoir by drilling dual drainholes through a single primary wellbore. Benefits include greater production efficiency and optimized use of limited well slots on the NE Intan platform.

In addition, the use of the Schlumberger RapidSeal\* multilateral completion system was instrumental in CNOOC achieving an approximately \$1 million reduction in well construction costs compared with a similar Level 3 multilateral well previously drilled by the company.

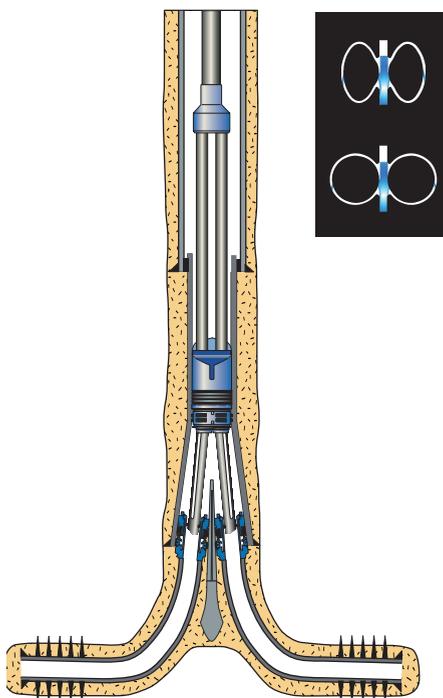
Furthermore, CNOOC anticipates that the multilateral and intelligent completion technologies incorporated in the A-24 well will work in synergy to improve life-of-the-field oil production and reserves recovery, helping to maximize the asset value of the reservoir.

## MULTILATERAL COMPLETIONS

Multilateral completions increase productivity by penetrating more reservoir than a single-bore vertical or horizontal well. Multilateral wells allow higher flow rates at lower pressure drops than single-bore wells.

In certain situations, producing through shorter lateral branches may prove more cost-efficient than producing the same reservoir section through a single,

longer horizontal borehole, as spreading the production inflow across two or more laterals reduces frictional pressure losses during production.



**The world's first TAML Level 6 intelligent multilateral completion was recently drilled and completed by CNOOC in the NE Intan A-24 well in the Java Sea off Indonesia. The inset shows a cross-section of the junction before and after expansion. Hydraulic flow-control valves and sensors measure pressure, temperature and flow rate for each well branch.**

Drilling dual opposed laterals, the pattern chosen on the NE Intan A-24 well, can reduce flowing friction pressure compared with a single-bore horizontal well with the same reservoir exposure and production rate.

Multilateral wells require additional initial investment in equipment but potentially reduce total capital expenditures and development costs, as well as operational expenses, by decreasing the number of required wells.

This technology reduces wellhead, platform-riser and subsea completion requirements, which decreases cost and

optimizes slot utilization on offshore platforms or subsea templates. Fewer main wellbores reduce repeated exposure to shallow drilling risks. Multilateral wells also minimize the size, or footprint, of surface locations and mitigate environmental impact onshore.

## LATERAL JUNCTIONS

Lateral junctions are critical to the effectiveness of multilateral completions. These completion components can fail when subjected to high formation stress, temperature-induced forces and differential pressures during production.

Junctions are divided into two broad groups: those that do not provide pressure integrity (Levels 1-4); and those that do (Levels 5 and 6). Success depends on junction durability, versatility and accessibility.

Level 3 and Level 6 systems have emerged as preferred multilateral junctions. Level 3 junctions incorporate a liner tieback and mechanical connection to the primary casing that permit selective access and reentry of lateral branches. Level 6 junctions are an integral part of the primary casing string that provides pressure integrity and lateral access.

Intelligent well completions provide the ability to monitor and control one or more zones of a producing reservoir.

This is accomplished through the installation of permanent downhole sensors and gauges, integrated with surface data collection and metering facilities, and the incorporation of remote control technology.

The latter allows interactive response to real-time downhole changes disclosed by the sensor and gauge data.

In multilateral completion designs, zones are isolated through specialized valves and related technology to enable separate flow control of multiple zones for more efficient reservoir management.

## RAPIDSEAL MULTILATERAL SYSTEM

Schlumberger RAPID\* products include the RapidSeal multilateral system,

which uses standard drilling and completion techniques in a low-risk well construction process. It utilizes proven well technologies to achieve pressure integrity with the casing at the multilateral junction.

The RapidSeal junction is formed by integrating either two sections of 7-in casing below the 9 5/8-in parent casing or two sections of 9 5/8-in casing below the 13 3/8-in parent casing to provide two identical outlets placed symmetrically.

In the RapidSeal junction manufacturing process, the two outlet sections are plastically preformed to yield a reduced effective outside diameter so that the junction can be installed through the upper casing.

This unique design features strong but highly ductile components. When the junction is placed in the wellbore, the junction is reformed to the original geometry to provide full API drift in both outlet sections.

The system allows dual laterals to drain the same reservoir, as was done in the NE Intan A-24 well.

With RapidSeal, it is possible to control the separation distance and prevent communication between the laterals, providing increased production efficiency.

The ability to influence near-wellbore flow patterns can improve control of water coning and gas migration.

This system also provides the flexibility to produce from either isolated tubing strings with different pressure regimes or an injector/producer application.

## NE INTAN A-24 COMPLETION

After the 9 5/8-in RapidSeal junction was oriented, expanded and cemented in place at 2,770 ft, both lateral branches were drilled with M-I Drilling Fluids synthetic OBM.

The first lateral extended 1,655 ft and was drilled with a 6 1/8-in PDC bit. The second lateral, extending 2,335 ft, was drilled with a 6-in by 7-in bicenter bit using a PowerPak PDM that had a 1.83° bent housing.

CNOOC completed the first and second laterals with 3 1/2-in and 4 1/2-in premium sand control screens, respectively. Each

branch included an ECP for zonal isolation.

Advanced well-completion equipment installed above the junction included:

- Downhole hydraulic valves to minimize water influx and selectively control the flow from either leg;
- Sensors providing real-time pressure, temperature and flow rate measurements for each well branch;
- A Schlumberger (REDA) electrical submersible pump to optimize oil flow from the wellbore. (The pump system lifts hydrocarbons to the surface through 4 1/2-in tubing and includes a downhole MultiSensor\* well-monitoring unit for submersible pump completions and a variable-speed drive at the surface.);
- A SCADA system and multiphase flow meters on the surface to monitor pump parameters and well performance, and transmit real-time data to CNOOC via the Web.

The well was drilled in 25 days. Cost savings for the well project as a whole amounted to about \$1 million, compared with the earlier AC-06 well, a Level 3 multilateral completion of similar depth and lateral lengths by CNOOC in the East Rama field.

## LESSONS LEARNED

The CNOOC A-24 well, the world's first TAML Level 6 multilateral intelligent completion, demonstrates the effectiveness of today's rapidly evolving multilateral well technology.

It reduces project capital expenditures through contacting more reservoir via dual lateral branches and optimizing limited well slots on the NE Intan plat-

form. It also reduces operating costs through achieving greater production efficiency.

Further, major project savings in well construction costs, on a comparative basis, resulted from use of the Schlumberger RapidSeal multilateral completion system.

Incorporating an intelligent completion in both branches of this multilateral well, with its full mechanical and pressure integrity, will enable real-time data gathering and remote, selective flow control for each branch.

This makes it possible to optimize reservoir management and increase production and reserves recovery over the life of the well.

Taken together, the benefits of the TAML Level 6 intelligent completion in the A-24 well are helping CNOOC to maximize the return on its investment in the NE Intan field and the value of field reserves.

\* Mark of Schlumberger

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