Wells yield direct OBD, UBD comparisons

DRILLING EXPERIENCE IN the Gargdazi Region of Western Lithuania utilizing conventional drilling techniques resulted in formation invasion damage and poor productivity in the Middle Cambrian Sandstone reservoir. Eight to ten wells were drilled between 1966 and 1994 with uniformly disappointing results.

Production rates ranged only up to 130 b/d. Production from the license peaked in 1996 and has declined since then due to the absence of natural water drive.

In 2000, UAB Minijos Nafta (MN), a Lithuanian/Danish joint venture that is operator of five fields in the region, began a new drilling campaign with the aim of using underbalanced drilling methods in an attempt to minimize formation invasion damage.

Beginning with the Pietu Siuparaiai #2 (PS-2) three wells were drilled with underbalanced techniques and safety measures continually being refined by constant consultation between the operator and Weatherford UBS, the underbalanced drilling contractor.

Each of the three wells, PS-2 through PS-4, showed encouraging results with initial production rates up to 30 times greater than those achieved with conventional overbalanced drilling.

Oil produced while drilling contributed positively to the overall economics of the programs with two of the three wells paying for themselves within 4-6 weeks of completion.

In 2001 the Aisenai-1 (A-1) exploration well was drilled in a unique fashion. The well was drilled through the reservoir at a 45° angle using a low solids designer fluid as a low invasion mud in an overbalanced technique.

An open hole drill stem test was performed, indicating a production rate of approximately 55 bopd from the hole section. The well was plugged back with cement and a second leg kicked off at 180° to the overbalanced leg azimuth and drilled underbalanced with dead crude as the drilling fluid.

This leg was drilled horizontally into the reservoir to TD and 2 7/8-in. tubing was run "pseudo-underbalanced" to the surface from a packer at the casing shoe. The well was completed open hole at an initial open flow rate of 2,000 b/d.

PLANNING UNDERBALANCED CAMPAIGN

The Pietu Siupariai field is typical of the history of the six fields in the Gargdazi concession. The discovery well was drilled in 1996 and tested at 289 b/d but was suspended with heavy mud across the formation. Eight more wells were drilled, three of them cased, then tested and suspended in a similar manner to the discovery well.

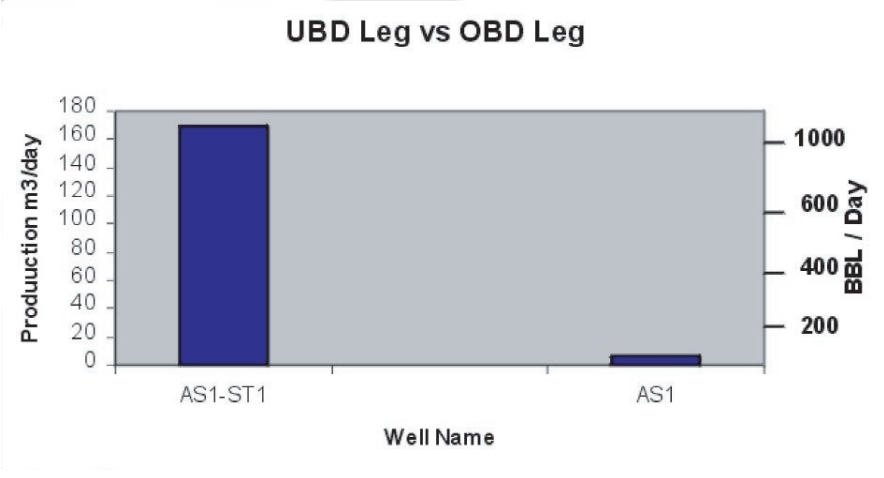
In each case, the wells exhibited skin factors in the range of 70-100 with low productivity, indicating that the formation is extremely sensitive to formation damage by invasion of the suspended mud solids utilized in conventional drilling methods.

The reservoir is now in a highly depleted condition and any significant overbalance pressure that occurs during drilling could be highly detrimental to the near-wellbore matrix area.

MN believed the fields had better potential than had been demonstrated and the operator began a study in 1998 to review the performance of the concession area to investigate the feasibility of using UBD techniques to prevent or minimize formation damage.

As a result of the study MN planned a new drilling campaign with UBD for drilling through the reservoir. The first three UBD wells were drilled as close offsets to well G-7, which was drilled with conventional overbalanced methods in the 1970s. Initially the G-7 produced at rates up to approximately 400 b/d but has since declined to 130 b/d.

The main objective in designing the three wells was to minimize or eliminate formation invasion damage and create increased production rates through reduced skin factors. The three wells effectively doubled the daily production from all five fields in the Gargdazi concession area. Additional benefits were higher penetration rates through the sandstone reservoir and extended bit life.



The results of underbalanced drilling in the PS-2, PS-3 and PS- wells were significant. The PS-2 well, drilled in July 2000, was drilled overbalanced to the 7-in. casing point, casing was set and the well displaced to dead crude oil from the G-7 tank battery.

A 6-in. hole was drilled underbalanced into the upper reservoir section, which was not expected to produce. However, drilling had to be suspended due to a large influx of oil. MN decided to run a completion and the well was tested at an initial rate of 4,000 b/d, a 30-fold increase compared with the G-7 well. As of June 1, 2001, production was being maintained at 2,800 b/d with ESP lift.

The upper section of the reservoir had typically been drilled overbalanced and had remained undetected during conventional drilling operations due to the

high mud weights utilized. Historically, this upper section was not perforated. This well highlights the added value of UBD operations in identifying zones with production potential that are masked and cased of during overbalanced drilling. As a result of this well, MN is considering a well intervention program to perforate and test this upper reservoir section in other wells.

In November 2000 well PS-3 was drilled in a similar manner to PS-2. The well tested at an initial rate of 2,500 b/d of oil, a 17-fold improvement compared with G-7. As of June 1, 2001, the well was maintaining production of 540 b/d with beam pump lift.

PS-4 was drilled in December 2000 with initial production of 928 b/d, a seven-fold increase compared with G-7. At June 2001, the well was maintaining production at 1,312 b/d with jet pump lift.

OBD AND UBD COMPARISONS

Following the success of the three wells in the Pietu Siupariai field, MN evaluated the operation and made changes to the procedure and equipment for UBD These changes were implemented on the next underbalanced well the operator drilled, the Aisenai-1, an in-fill development well in the Degliai field.

Until this well there had been little opportunity to make direct comparisons between overbalanced and underbalanced drilling results.

This well provided the unique opportunity to make a direct comparison between the productivity results of OBD and UBD techniques in the same well and reservoir.

Higher reservoir pressure risk was anticipated in the field due to the relatively unknown bottom hole pressure conditions. As a result, the well was initially drilled overbalanced using a "Blockator" type of designer drilling fluid as a low invasion carbonate drilling fluid to minimize invasion and consequent formation damage.

This overbalanced section was drilled through the reservoir at a 45° inclination and an open hole drill stem test was run across the entire reservoir section. Summation of the test suggested that the interval was "starting to produce" hydrocarbons at a calculated flowrate of 38-52 b/d in the first and second flow periods.

The well was then plugged back with cement to the 7-in. casing shoe at 2,339 m and a second leg was drilled underbalanced.

This leg was oriented 180° to the overbalanced leg and drilled horizontally into the reservoir section. The top of the reservoir was tracked using basic MWD and fluid inflow monitoring and measurement.

The process of production steering can enable the drilling process to locate the sweet spot, or the most productive zone in the reservoir. The production steering process has been pioneered by Weatherford Underbalanced Services and will be further developed in future project wells.

The technique requires only basic MWD, for example directional/gamma and underbalanced drilling separation system.

The MWD gamma is used to locate formation tops while productivity and derived PI results from the ability to measure production in real time, the only true inflow measurement technique.

During the underbalanced drilling process, the well produced 11,000 b/d while one round-trip was made. During drilling the inflow rates varied between 51 and 145 barrels per hour.

The AS-1 well was terminated due to reduction to zero increment in production observed while drilling at a depth of 1,987 m in April 2001. A 2 7/8-in. tubing string was run "pseudo underbalanced".

The initial flow rate on the choke was 3,000 b/d with an estimated open flow potential of 3,500 b/d. The well was the most prolific initial oil well producer in Lithuanian oilfield history until subsequent underbalanced wells were drilled.

No major problems were encountered during the drilling and completions operations as a result of the high level of preplanning. There was no environmental impact and no accidents occurred.

Well AS-1 was engineered to North Sea standards in terms of Q/HSE and well engineering and the operator and Weatherford suggest that this should be a minimum standard for all future underbalanced operations globally.

CONCLUSIONS

Several conclusions were realized from the AS-1 results and the underbalanced drilling operations:

UBD techniques are viable even in a tight low permeability reservoir.

The concept of production steering is viable when little or no bottom hole pressure prediction techniques are available. Some of the more expensive techniques available and sophisticated MWD may not be needed it this approach is further developed.

The technique of a "pseudo underbalanced" completion is a safe and efficient method of completion that can obviate the risks inherent in creating overbalanced conditions.

The importance of safety considerations, well defined procedures, rig crew and service personnel interface, particularly where language differences exist, and direct interface between operations and reservoir engineering functions for production optimization cannot be overemphasized.

As a result of the successful UBD operations, the operator plans to continue using UBD for the next wells in their fields.

REFERENCE

This article is based upon a paper presented at IADC's UBO Technology Conference & Exhibition held in Aberdeen in Nov 2001. The paper is titled *Underbalanced and Overbalanced Well Legs Afford Direct Comparison in the Same Reservoir Section Yielding Record Well Productivity in Lithuania*.It is authored by **Thomas M Haselton** and **Ringys Kirvelis**, UAB Minijos Nafta; **Giancarlo Pia**, Weatherford International; and **Tom Fuller**, Weatherford (UK) Ltd.