**Case study:** East Malaysia

# EQUALIZER LIFT autonomous inflow control device (AICD) improves oil production in a mature field

The EQUALIZER LIFT™ autonomous inflow control device (AICD) from Baker Hughes is an effective reservoir management solution that enhances oil recovery and reduces water and gas production in long, horizontal wells in heterogeneous reservoirs.

The proprietary AICD design was developed to address the shortcoming of conventional inflow control device (ICD). The AICD functions like a passive ICD for single-phase production, preventing water/gas breakthrough and promoting oil recovery from lower-permeability sections of the reservoir.

the EQUALIZER LIFT AICD features a floating disc that autonomously responds to changing flow rates and fluid properties, restricting flow of low viscosity fluids like water and gas. If either break through, the floating disc immediately restricts the valve inlet, creating additional pressure drops in these zones.

Installing AICDs along the wellbore in heterogeneous formations equalizes the inflow pattern to promote uniform formation drainage, improves productivity, and reduces the costs associated with surface handling of unwanted fluids.

Combining EQUALIZER LIFT AICDs with specific sand screens or Baker Hughes' GeoFORM™ conformable sand management technology can further enhance oil recovery.

## East Malaysia Brownfield conditions

An operator in Eastern Malaysia had attempted to address falling oil production and increasing gas and water influx with an infill drilling campaign in a reservoir that was overlain by a sizable gas cap (M size = 2.0).

The original development consisted of a central processing platform, with three pilot holes three water injectors, and 14 oil producers.

When the production wells were drilled, each of them was placed in the middle of the oil column in the horizontal section and completed with a single string horizontal open-hole standalone screen and an ICD to balance reservoir influx.

The horizontal sections were placed at the same depth of 1,487 m, between initial gas-oil contact (GOC) at 1,468 m and the initial free water level at 1,506 m. As a result of this placement, water breakthrough occurred at about the same time for all the production wells. After only eight years of production, most of the wells were producing at high water cut or had already watered out. The field reached a production plateau of 13,000 bbl/d after only two years.

The first infill drilling campaign for the field included seven new horizontal producers to increase production for maximum recovery, the infill wells had to be placed shallower, some of them

## Challenges

- Control excessive gas production by restricting flow based on fluid types in a brownfield development offshore East Malaysia
- Balance reservoir influx through downhole choke orifice and segmentation of horizontal section

## Results

- AICD technology was successfully implemented in seven infill wells, with six of the wells delivering targeted oil production rate with no excessive gas production, despite being completed in a high gas-saturation zone
- Demonstrated that horizontal well placement can be achieved effectively using real-time LWD interpretation, pilot hole or geosteering
- Post-job production modelling shows that the AICD completion improved oil production more effectively than could be achieved by alternative means

only 5 m below GOC. This was done to position the horizontal section as far as possible from the oil-water contact to delay water breakthrough. Unfortunately, shallow placement exposed the wells to the risk of excessive gas production from the gas cap.

In addition, the horizontal sections intersected sands of varying qualities separated by shale. As the wells completed these various sands, it was necessary to address differences in reservoir influx using downhole chokes to prevent certain intervals from dominating the flow, which could lead to faster water and/or gas breakthrough.

## Improving production with AICDs

The decision was made to use EQUALIZER LIFT AICDs to control excessive gas production by restricting flow based on fluid types and properties and balancing reservoir influx through the downhole choke orifice, segmenting horizontal sections into compartments using blank pipes and swell packers for zonal isolation.

AICD valves were installed in the lower completion as part of the downhole sand screen and swell packer assembly across producing intervals.

The seven infill wells targeted two separate areas in the north and south of the field. Three of the infill wells targeted an undrained area, where there was no existing well—and hence, no well control. The other four infill wells were placed in established area where there were several existing wells with production data.

In examining the well conditions, it became apparent that the overly simplistic well placement design would have to be reworked to account for potential shrinkage or expansion of the gas cap. In addition, placing the horizontal section in the middle of the oil column 9.5 m below the GOC introduced the risk of leaving recoverable oil behind when the water contact reached the horizontal section.

To ensure maximum oil recovery, the well placement design was optimized to land the horizontal section approximately 5 m below the GOC and away from the aquifer. Because no pilot wells were planned, LWD data was used to build angle and land the horizontal section. This approach required the development of an operational decision tree before drilling each well to effectively land the horizontal section at the designed depth.

Despite the shallow landing of the infill wells, no excessive gas production was recorded.

## Producing better results

Implementing AICD technology successfully reduced gas and water breakthrough and improved oil recovery.

This installation demonstrates that LWD data can be used to optimally place horizontal wells and AICDs for improved production.

Results from monitoring water cut and GOR show the efficacy of the AICD installation in restricting gas production and improving well performance.

Baker Hughes