White Paper

Utilising Sand and Inflow Control with Zonal Isolation to Increase Oil Recovery

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Introduction

A multi-faceted approach to sand management and enhancing oil recovery is becoming increasingly common, particularly with the increase in number of long horizontal wells. Utilising inflow technologies is proving to effectively reduce water production, increase oil recovery and reduce potential problems associated with sand breakthrough. Combining this with zonal isolation tools effectively compartmentalises the reservoir, providing operators with the flexibility to select zones to produce, closing off any potential troublesome zones and reducing annular flow, preventing the risk of hot spot corrosion on the completion equipment. Creating smaller compartments leads to the increase of oil production by being able to control water breakthrough more efficiently. Modelling can identify the recommended number of compartments and number of ICD/AICD required to maximise the potential from the reservoir based on the reservoir characteristics.

Technologies

Inflow Control Devices (ICDs) have been utilised in the industry over numerous years, to effectively manage inflow along the horizontal wellbore, increasing oil production by restricting unwanted production of oil and gas. Although effective, these devices are unable to be adjusted after installation and are a completely passive device, resulting in a limited operating window. A recent development in this area comes from the development of an autonomous inflow control device (AICD) which regulates flow based on the velocity of the fluid, whereby effectively shutting off water/gas production and delaying the breakthrough of water/gas for the life of the well. The device, which Tendeka are leaders in the market, is based on the Bernoulli principle – sum of static pressure, dynamic pressure and friction loss along a streamline is constant. Utilising AICDs in compartments along a horizontal well can prevent high flow rate conditions which can destabilise the surrounding formation leading to sand production.

ICDs and AICDs are more commonly used in conjunction with Tendeka’s portfolio of sand screens to prevent any unwanted sand breakthrough into the production string whilst controlling flow. This has resulted in over 700,000ft of sand screens being successfully installed with over 2000 ICDs and 14,000 AICDs. The reservoir fluids enter through the sand screen and along the annulus between the base pipe and filter to the AICD sat within a housing. The fluids flow through the device into the production string. The device does not protrude from the OD of the screen so no restrictions are seen.

Fluid flow through the screen

Utilising AICD technology and zonal isolation along an evenly distributed well increases the recovery of oil after a breakthrough is seen compared with conventional inflow control.

Using premium mesh technology the screen is comprised of a number of mesh layers, to enable appropriate drainage and solids retention, the screens can be sized and designed to provide retention of sands ranging from 150-350 Micron. The mesh layers incorporate a Dutch twill weave with a high dirt holding capacity, surrounded by jackets for protection and swaged together. Tendeka’s premium screens are qualified to ISO 17824 and as per Statoil specific requirements TR 2385.

Tendeka’s Wire Wrap screens are directly wrapped onto the required base pipe and can be configured with gauge from 0.008”-0.024”Ga, effectively retaining homogenous sands and providing maximum open area for unrestricted...
flow. This technology is qualified to ISO 17824. The screens are selected to ensure maximum solids retention without impairing the passage of the production fluids. Historically compartmentalisation was conducted using mechanical packers, due to cost, this resulted in fewer compartments than can be achieved using a cost-effective alternative. Increasing the number of compartments enables water/sand control to be managed more efficiently in a uniform manner, therefore increasing the oil productivity.

Effect of compartmentalisation on production

Tendeka’s swellable technology resulted in the first swellable installation in 2002. The portfolio has since grown and includes bonded packers and various slip on sleeve versions. The benefit of the slip on sleeve allows flexibility to enable installation onto any joint. This is becoming increasingly popular to install a sleeve on a screen joint, it is then therefore provided as one tool, comprising of an ICD/AICD, sand screen and a swellable sleeve for zonal isolation.

The Swellables are designed to withstand up to 1000psi per foot of rubber and swell performance is highly dependent on the temperature of the reservoir. The SwellRight Ultra sleeve is a slip on sleeve specifically designed for horizontal applications. The supporting end-rings are welded to an inner core and the insertion of inner seals prevent any pressure leak under the end-ring between the ID of the core and the pipe OD. This has successfully been tested in multi-lateral window tests with Tendeka’s premium mesh screens.

Tendeka Screen being run through multi-later window

Tendeka Swellable Sleeve being run through multi-later window

Significant testing was conducted on all components of the solution. The AICD was tested and modelled on various different Troll conditions, incorporating multiphase testing in Statoil’s flow loop to look at the volume flow of oil, gas and water as a function of differential pressure. Tendeka’s AICD has been rigorously tested for plugging and erosion testing alongside specific customer testing.

Trendeka’s premium screen has been qualified to Statoil TR 2385 alongside numerous other tests, including integrity tests and the operational test of being handled on a hydraulic yoke to ensure no damage occurred to the screen whilst being installed.

The chosen swellable sleeve option was designed to ensure swelling occurred in line with Statoil’s operational plan. The sleeve was tested in the crude oil at the reservoir temperature and pressure tested to ensure the sleeve could withstand the differential pressures seen within the well. The sleeve design was specifically designed for Statoil requirements for a long horizontal multi-lateral well. The rubber compound was also designed to meet the swell times required, to prevent any premature swelling and to enable the completion to be retrieved if any difficulty occurs whilst running to depth.

Results

It was seen that cumulative oil production on the Troll field had increased by 20%, with the volumes able to be produced quicker. Gas breakthrough occurred later than expected due to this technology improving the oil recovery. No sand has been reported at surface showing full isolation and screen retention.

Troll Case Study

An example of this practice is on the Troll Field in Norway which consists of long horizontal multilateral wells that have a high chance of early gas breakthrough. Numerous wells have been completed with Tendeka’s AICD technology incorporated in premium mesh screens and completed with a swellable slip on sleeve installed on the screen joint. Sand has been shown to be successfully managed with no reports of sand at surface.

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TDK-WP-IOR-0917