BiSN Applications in BP
ICorr / IOM³ Meeting November 2019

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BiSN Technology Applications

Introduction
• BP has worked in collaboration with BiSN Oil Tools Inc. for a number of years to develop solutions for:
  – Water Shut Off (WSO) in Sand Control Completions
  – Restoring Well Integrity
  – Alternative Barrier Material to Cement for Well Plug and Abandonment
• To date, BP has installed ~10 BiSN Plugs across a number of Regions
• The main application within BP so far has been for WSO in sand control completions
Pre-Deployment Testing

• BiSN plugs are currently custom designed for each application.

• Key input parameters include:
  – Well Geometry (Sizes and Weights)
  – Setting depth conditions (Temperature, Inclination, Fluids, etc.)
  – Minimum restriction / drift
  – Conveyance method
  – Maximum pressure differential across plug

• These parameters impact the selection of:
  – Heater material
  – Type & melting point of alloy
  – Thermite mix used for the heater

• Typically up to three workshop tests are then carried out to replicate the setting of the plug under the proposed wellbore conditions to confirm performance prior to installation in the field.
Water Shut Off - Gravel Pack Completions

Objective
• Shut off water & gas to increase hydrocarbon production

Challenge
• Provide zonal isolation in Gravel Pack completions

Solution
• Combination of bridge plugs (internal) and a BiSN plug
• Setting BiSN Alloy on a bridge plug base help to direct the melted alloy out into the gravel pack
• Bridge plugs also increase pressure to pack off shunt tubes
• Plugs set in a range of 45-72deg inclinations

Deployments

<table>
<thead>
<tr>
<th>Date</th>
<th>Region</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Q4-2016</td>
<td>Angola</td>
<td>Successfully deployed water reduction from 73% to 46%.</td>
</tr>
<tr>
<td>Q1-2017</td>
<td>Angola</td>
<td>Successfully deployed with water reduction from 69% to 35%</td>
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<tr>
<td>Q1-2019</td>
<td>Angola</td>
<td>Successfully deployed, water reduction ~70%-50, Well still cleaning up</td>
</tr>
<tr>
<td>Q1-2019</td>
<td>Angola</td>
<td>Successfully deployed, Water reduction from ~75%-45%, Well still cleaning up</td>
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Note:
Further information can be found in the SPE paper - SPE-191449-MS
Objective
• Provide zonal isolation in an open annulus to shut off unwanted water production

Challenge
• Isolate lower watered out zone through 4.5” slotted liner set in a 6” open hole
• Plug set at around 3deg inclination and 150degC

Solution
• Similar to the gravel pack solution where the BiSN plug is set on a bridge plug to direct the melted alloy to flow through the screens / slotted liner and set in the open annulus to provide a restriction to flow below the plug

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| Q2-2018 | Algeria | • First application of an open annulus isolation BISN WSO plug,  
• Plug successfully installed as planned  
• Still awaiting results of the plug installation due to unrelated issues preventing the well being brought online. |
Objective
• Extend well life through cost effective intervention to access a marginal upper production zone

Challenge
• Through tubing isolation of a lower watered out zone in order to re-complete across an upper production zone

Solution
• Placement of BiSN alloy in the tubing and A anulus in order to isolate the lower zone through 5.5” x 5” completion Tubing and re-complete an upper production zone

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| Q2-2018 | ACG    | • First Coiled Tubing (Teli-coil) deployment of BiSN
• Installed using a high temperature alloy through 5.5” x 5” completion tubing.
• 75deg Inclination at setting Depth
• 1st tool set in 5” failed pressure test - 2nd tool set across 5.5”x5” passed 2,800 psi pressure test
• Well successfully brought on production following re-completion (i.e. perforating) the upper zone. |

Picture shows the cut out of the final test for the BiSN M2M Bridge Plug formed in the 5” OD tubular

Note:
Further information can be found in the SPE paper - SPE-194275-MS
### Objective
- Restore Well Integrity

### Challenge
- Ability to seal a leaking production packer without having to recover the completion tubing

### Solution
- Placed alloy beads into the A annulus
- Beads melted using a heater deployed through the tubing
- Melted alloy flows into any voids spaces and provide a seal on setting to restore the well integrity.

### Deployments

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| Q2-2016 | Alaska | Proof of concept testing:  
  - 4 ¼” x 9 5/8” “A” Annulus; ~3,500 psi dP  
  - 10ft. of beads placed in “A” annulus; ~991kg beads, formed a plug of ~75” due to ~17kg un-melted volume (Theoretical plug length 76.8”)  
  - Pressure test was successfully completed holding 6,000 psi (target 3500psi) |
Alternative Barrier Material Qualification for P&A

Objective
- Provide a Step Change in Well P&A Performance

Challenge
- Qualifying an alternative barrier material to cement for the permanent abandonment of wells which can be:
  - Installed riglessly (Using wireline, tractor or CT)
  - Reduce plug lengths from min 30m (usually double) down to ~3m

Solution
- Qualification of BiSN’s Wel-Lok technology for permanent abandonment applications as per the Oil & Gas UK Guidelines on the Qualification of Materials for the Abandonment of Wells (Issue 2, 2015)

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<tr>
<td>2020</td>
<td>N. Sea</td>
<td>Looking for potential deployment opportunities to install BiSN plug and monitor the its performance under downhole conditions over an extended period of time.</td>
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