An innovative approach of revival for damaged wells in high erosive environment using ceramic sand screens

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• Application in Oil and Gas
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Why ceramics?

Why ceramics? Benefits include:

- **Mechanical**
  - Hardness, density, strength

- **Tribological**
  - Wear resistance

- **Chemical**
  - Corrosion resistance, acid resistance

- **Thermal**
  - Thermal expansion

- **Electrical**
  - Conductivity

*Courtesy of ESK Ceramics*
Ceramic sand screen - Background

2008
• Idea generation – Proppant flowback Maersk oil
• Erosion resistance SSD protector

2009
• Final concept
• Testing
• Patent registered

2010
• First successful SSD protector implementation: North Sea Denmark (SPE146721)

2011
• Entry into intervention market
• Activation of wells shut-in due to unmanageable sand production
• Oil and gas wells in Austria (SPE 160327)

2012
• Standard dimension for TT and SAS
• Application for BG, Maersk, Interwell, Talisman etc

2013
• Sand control through tubing application

2014 onwards: Subsea application, New completions, Revival of wells closed due to bottom hole sand erosion, production rate improvement in wells flowing below erosional limits, High angle wells

BG Through tubing installation Offshore well, slightly deviated

ESK
Ceradyne
3M (2012)
BG Bolivia - Background

Well re-completion

- Abandoning current completion and re-complete in above virgin zone installing ceramic screens
- 2 zones targeted
- Multi-zone allows selective shut-off
  - SSD in case of water production can shut off and produce from lower zone
- Completion designed with two alternative screens sizes to account for uncertainty in sand grain size
  - Surface sand analysis from nearby operator used for ceramic screen slot sizing
- Work-over was performed and new completion installed with ceramic sand control screens
- A detailed bean-up procedure was executed to allow a natural sand pack to form behind the screens
BG Bolivia – Success!

- Completion was installed in September 2012 with expectation of 4 - 6 mmscf/d
- **Well initially produced between 7 - 8 mmscf/d and continues sand free**
- A well test performed in February 2013 confirmed low skin for the completion
- Payback for recompletion <1 year
- Payback for screens alone <4 months

Gas rate maintained above expected rate from well
BG Trinidad and Tobago

- Current shut-in well since 2005 due to severe sand erosion
- Failed OHGP 800ft completion with up to 1000 ft of sand (above casing section)
  - Several points of ingress
- Coiled Tubing application
- Uncertainty
  - sand sample for PSD analysis (slot size)
  - Well clean out (screen lengths)
  - Screen diameters (well restrictions)
- Aim of 15-20 MMscfd flow rate
Simulation and modelling

- Assess uncertainties in mechanical and reservoir properties
- NeTool software

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Well</th>
<th>Base Case</th>
<th>Sensitivity</th>
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<tbody>
<tr>
<td>-Grid</td>
<td>-Deviation</td>
<td>-BHA</td>
<td>-No of joints</td>
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<tr>
<td>-Data</td>
<td>-Depth</td>
<td>-Near well bore</td>
<td>-Skin</td>
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<tr>
<td>-INIT</td>
<td>-Vertical Lift</td>
<td>-Nodes</td>
<td>-Expected gas rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Screen details</td>
<td>-Gas velocity across screens</td>
</tr>
</tbody>
</table>

- Base Case
  - Skin
  - Expected gas rate
  - Gas velocity across screens

- Sensitivity
  - No of joints
  - Skin
  - Expected gas rate
  - Gas velocity across screens
Screen mesh size selection

- Particle size distribution
  - Sieve Analysis
  - Laser
- Retention tests
  - Slurry test
  - Prepack test
  - Combination
- Modification for ceramic coupons
  - Reduced in-flow area but gas rates and sand retention similar
Installation techniques

- Rig Based
- Rig-less
  - Coil Tubing
  - E-line, slickline
- Installation sequence
  - Stacked installation
  - Multi-run
- Supporting tools
  - Straddle packers
  - Centralisers
  - Subs
- Operations
  - Beam-up procedure critical
  - Surface sand detector
Economics

• Key essentials
  – Ceramic screens are currently more expensive than metallic counterparts
  – Overall intervention cost to be considered
  – Longevity – increased well life without interventions
  – Optimum length and location
  – Flexible dimensions as no standards currently in place
    • Tapered to individual requirements

• Comparison with other options
  – Stand alone metallic screen
  – Side-track
  – Rig-less / Rig based
  – Compare on well by well basis
Conclusions

• Ceramics have advantageous properties compared to metallic based equipment:
  – including being ten times harder than metals and exceptionally erosion resistant
• Ceramic sand screens can potentially be used as inserts in existing failed completions, or in new wells where severe sand erosion is predicted
  – Restoring well productivity / allowing wells to produce would add value through increasing production
• Thorough understanding of strengths and limitations are required for technical justification
• A complete economic evaluation with other techniques will ensure it to be most suitable solution for a specific well
• A solution for deep water or HPHT projects where interventions are very expensive

For BG-Group, ceramics will not replace conventional sand control

Another option that should be considered when evaluating completions!
Thank you for listening

Any questions?