Shearwater Well, Reservoir and Facilities Management Optimisation

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Shearwater WRFM Team
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Agenda

- Introduction to Shearwater
- Topside Facilities
- Well Reservoir Management Plan
- Surveillance
- WRFM Activities
- WRFM Production Optimisation Delivery
**Condensate via FPS to Kinneil**

**Process includes:**
- 3 phase separation
- Gas sweetening & dehydration
- NGL extraction & stabilisation

**Gas export via SEAL to Bacton**
Shearwater

- Located in block 22/30b in the UK Central Graben of the North Sea.
- Discovered 1991, first production 2000
- HPHT: High Pressure & High Temperature
- Gas /Condensate field, 90m water depth
- Initial pressure 15,500psi, 185degC at 16900ft
- Depleted reservoir pressure 6,000-10,000psi
- Slot recovery executed 2011-2013
- New well drilled in 2014-2017
Satellite Field (Scoter, Merganser, Starling)

- Subsea wells
  - Scoter 12km to North SW Platform
  - Merganser – Subsea daisy chain tied to Scoter
  - Scoter 4km to SW platform
  - Starling - 33KM South West of SW
- Normal Pressure Normal Temperature
- Depleted, reservoir pressure 1,000-1,500psi
Shearwater WRFM Plan

Focus on
- “Make it safe” (e.g. Integrity scope)
- “Make it Work” (e.g. restoration scope)
- “Make it Grow” (e.g. optimisation scope)
- Ensure safe production
- Safeguard current production
- Maximise production incremental to Business Plan using Production System Optimisation (PSO) and the WRFM E2E process to identify, assess and execute well and facilities optimisations.
**Surveillance**

- Integrated team
- Surveillance hub
- Real time Interaction with offshore
- Real time data - PI Process Book
- Exception Based Surveillance - EBS
- Operating envelopes
- Well testing
- Sampling
- Sand sensor
Shearwater Limit Diagram

Q1 2017 - Locked in Potential shown in Green

Q4 2017 - Optimised Production
Well Activities

- Revived a closed in well
  - Well start up strategy
  - Unload to lower back pressure

- Unblocked SSSV control line
  - Impermeable blockage in the control line
  - Involved temporarily installing a “hold open sleeve” across the SSSV
  - Instantaneous gain of 3.0 kboepd

Slick line Rig Up
Production System Optimisation

- IPSM for Surveillance
  - Multiple cases run
  - Opportunities to optimize identified and implemented
    - Managing dew point
    - Choke optimization
    - Compression optimization
    - Flash gas optimization
Sand Issues in Separators

- Reduction in separation residence time and separation efficiency due to sand accumulation in separators.
- Thermographs below show cold spots (blue) indicating sand deposition in the Separator.
Accelerated Cleaning of Separator

- Separator was soaked with chemical to help Separator with significant sand. (Photo below taken post initial chemical soak)
- Significant fouling of internals impacting separator performance. Multiple online sand removal attempts did not prove effective due to high viscous and clay based nature of solids.
Accelerated Cleaning of Separator

- Localised cleaning with tubes was used to avoid entry into separator and expedite cleaning process.
First Stage Separator Weir Height increase

- First Stage Separator weir height increased from 0.6m to 1.3m
- Handling capacity increased from 5,000 bbl/d to 15,000 bbl/d
Produced Water Capacity Increased

<table>
<thead>
<tr>
<th>System</th>
<th>Bottleneck</th>
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<tbody>
<tr>
<td>1st Stage Separator V-1010</td>
<td>Water residence time / water axial velocity limit</td>
</tr>
<tr>
<td>2nd Stage Separator V-1210</td>
<td>Water axial velocity limit</td>
</tr>
<tr>
<td>HP Hydrocyclone V-4015</td>
<td>Number of liners (13)</td>
</tr>
<tr>
<td>LP Hydrocyclones V-4016/17</td>
<td>Number of liners (6)</td>
</tr>
<tr>
<td>Degasser V-4030</td>
<td>Inlet liquid distributor / vane pack</td>
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<tr>
<td>(Membrane Package – parallel with Degasser)</td>
<td>(Membrane modules)</td>
</tr>
</tbody>
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HP hydrocyclone changeout

- HP hydrocyclone processing capacity increased by 80%
- OIPW improvement
Shearwater WRFM Production Optimisation Delivery
Shearwater WRFM Production Optimisation Delivery 2017

WRFM Gain

- 7% of Business Plan Production (TQ)
- Stretch Target
- Business Plan Submission

Jan, Feb, March, April, May, June, July, August, September, October, November, December

- Closed in well review
- Optimised choke setting
- Bean up
- ClampOn Sand sensor repair
- LPC optimisation
- Water handling capacity
- Flash gas optimisation
Questions and Answers