Subsea Liquid Sampling Using Flow-through Technique

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Sales Director
Agenda

Introduction to MARS
MARS projects & applications
Liquid sampling
Conclusions
Introduction to MARS Technology

- MARS Insert is located in the subsea tree choke system.
- Can be installed at FAT / SIT or retrofitted subsea.
- Creates access to the production flow which enables the addition of production technology without the need to modify the tree or carry out modifications to the subsea architecture.

- Two configurations:
  - Concentric dual bore which enables process applications such as:
    - Boosting technology - Metering technology – Solids handling
  - Single bore
    - Fluids / Chemical injection – Well Kill – Well abandonment

- Retains the OEM choke supplier qualification.
- Retains the flow characteristics of the original choke.
- Uses existing installation tooling where practical.
- Diverless solution.
MARS (Multiple Application Re-injection System)

**MARS** (via the treecap)

**MARS** (via the choke)
Concentric flowpath MARS

Where the MARS insert is located in the choke body and the choke functionality is re-positioned into a UWP (Universal Work Platform) that houses the production technology.

Applications:

- Metering and Sampling systems
- Boosting and Injection systems
- Multi-function systems
Single flowpath MARS

When the choke system is upgraded to incorporate an injection flowpath.

Applications:
- Scale Squeeze
- Downhole Chemical/Fluid Injection
- Pipeline Flushing
- Hydrate management
- Well Kill

Additional flow path

Retaining Choke Functionality
<table>
<thead>
<tr>
<th>System</th>
<th>Customer</th>
<th>Project/Location</th>
<th>Details</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 off Subsea MARS insert &amp; UWP c/w Water Injection Boosting System.</td>
<td>Shell</td>
<td>North Sea</td>
<td>1,000m max water depth, Full ROV installation sequence verified, 22,000bbls/day flow rate.</td>
<td>Feb 2005 FAT/SIT completed and witnessed by Lloyds Register.</td>
</tr>
<tr>
<td>2 off Subsea MARS insert &amp; UWP c/w replacement choke, suction and</td>
<td>BP</td>
<td>King Field - GOM</td>
<td>1,600m water depth, Full ROV deployment, Full suite of running tools, test equipment etc included. Integrated into PMT.</td>
<td>FAT completed Aug 2006, SIT completed Sept 2006, Installed and in Production Q4 2007.</td>
</tr>
<tr>
<td>discharge hubs for fluid displacement to/from external pump skid.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 off Subsea MARS insert &amp; UWP c/w Well Stimulation / Injection</td>
<td>Shell</td>
<td>Bittern Field - North</td>
<td>1,000m max water depth, Full ROV deployment, Scope includes running tools and test equipment.</td>
<td>Complete, Installed Q4 2008; wells squeezed Q3 2010.</td>
</tr>
<tr>
<td>system.</td>
<td></td>
<td>Sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>system.</td>
<td></td>
<td>Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 off Manifold mounted metering systems.</td>
<td>TOTAL</td>
<td>Usan - West Africa</td>
<td>850m water depth, including insulation, Scope includes running tools and test equipment.</td>
<td>In build stage, Installation due Q2/Q3 2010.</td>
</tr>
<tr>
<td>4 off Subsea MARS insert &amp; UWP c/w Well Stimulation / Injection</td>
<td>Shell</td>
<td>Pierce Field - North</td>
<td>1,000m max water depth, Full ROV deployment, Scope includes running tools and test equipment.</td>
<td>SIT Complete, Installation due Q2 2010</td>
</tr>
<tr>
<td>system.</td>
<td></td>
<td>Sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 off Subsea MARS insert &amp; UWP c/w Repositioned choke, valve and</td>
<td>BP</td>
<td>Schiehallion - West of</td>
<td>500m water depth, Scope includes running tools and test equipment.</td>
<td>PO placed Q4 2008, SIT complete, Installed Q2 2010 and in service.</td>
</tr>
<tr>
<td>sensor package.</td>
<td></td>
<td>Shetland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 off Topside MARS Insert to enable multiphase metering.</td>
<td>Statoil</td>
<td>Oseberg – North Sea</td>
<td>Scope includes running and test equipment.</td>
<td>Complete, delivered Q4 2009</td>
</tr>
<tr>
<td>18 off Manifold mounted metering systems.</td>
<td>Chevron</td>
<td>Jack &amp; St Malo - GOM</td>
<td>15,000psi MWP, 2100m Water Depth, Scope includes running tooling and test equipment</td>
<td>PO Placed Q4 2009, Currently in detailed engineering phase.</td>
</tr>
<tr>
<td>2 off MARS Insert &amp; Retrievable Metering Packages.</td>
<td>BP</td>
<td>Isabela - GOM</td>
<td>15,000psi MWP, 1700m max water depth, Scope includes Insulation, running tooling and test equipment</td>
<td>PO Placed Q4 2009, currently in detailed engineering phase.</td>
</tr>
<tr>
<td>1 off MARS Gas Lift By-pass Insert</td>
<td>EnQuest</td>
<td>Broom Field, North Sea</td>
<td>100m Water Depth, Scope includes Retrievable Cameron CC30SR Choke insert.</td>
<td>PO Placed Q1 2010, Installed.</td>
</tr>
</tbody>
</table>
MARS enabled Fluid Intervention - Shell Bittern

- 3 off MARS modified Kent Introl Series 74 choke
- Deployment Q2, 2008
- Scale Squeeze completed Q4, 2008, Q3 2010
- “Safer, Faster, Cheaper” than existing methods i.e:
  - Eliminates Divers in hazardous operations
  - Reduced well risk

- Enables multiple well concurrent campaigns
- Estimated 60% reduction in operation costs
- Lower cost vessel
- Less vessel time
- Less shutdown time
- Increase weather window
- Installed on existing and new trees
MARS enabled Fluid Intervention – West Africa

Chevron Lobito Tomboco
Lobito Tomboco MARS Subsea Equipment

- 16 off MARS Modified Chokes
- 2 off Short Term Injection Inserts
- 2 off Injection Skids
Fluid injection - summary

• Traditional approach
  Via rig
  Via light well intervention vessel
  Via flowline

  Time consuming
  Expensive
  Loss of production on adjacent wells

• Cameron MARS approach
  Via ROV support vessel
  Use vessel of opportunity
  Can incorporate pumping capability

  Fast
  Cost effective
  No Loss of production
BP Schiehallion - MARS Sensor and Valve Package

• Solution for retrofitting pressure sensors and isolation valves on an existing horizontal tree
• Utilises existing subsea control system
• Retains full choke functionality
• Rapid installation & re-deployment from ROV support vessel
BP King – Gulf of Mexico

- BP King installation is first Multiphase pump in GOM
- 2 off MARS Inserts & 2 off Universal Work Platforms
- GOM Deep Water, 1600m
- Deployed Q4, 2007
- In Production
- Projected to increase production from mature asset by 20% and extend field life by five years
Total Usan - MARS Enabled Manifold Mounted Metering

- Total USAN (x32)
- Deployed / Retrieved using existing MPRT tooling
- 5,000psi, -18C to +102C
- 900M water depth - Nigeria
- 1st batch complete Q3 2009
BP Isabela – Retrievable Metering Package

• 15,000psi MWP system
• Solution to retrofit 2-off multiphase meters in 1700m water depth in Gulf of Mexico
• Designed to retrofit onto Cameron deepwater tree and CC40SR choke
• Incorporates Framo Multiphase Flowmeter
• “Over the Side” Design eliminates requirement to remove system prior to BOP installation.
• Includes all running and test tooling
Chevron Jack & St. Malo

- 15,000psi MWP Manifold mounted metering System
- System comprises of two main components, a fixed MARS Flowbase and a retrievable MARS meter module.
- Dummy modules are to be provided which can later be easily upgraded to production modules.
Subsea Liquid Sampling:

Method of capturing a physical sample of produced fluid from Tree / Manifold and recovering for laboratory analysis.

Value To Field Operator: Production Optimization

- Flow-meter calibration (affected by water cut / salinity).
- Tracer detection (understanding the reservoir)
- Need for Scale squeeze (barium content)
- Well fluid composition (per well)
MARS-PS Sampling System

Simplified Sampling Circuit Piping and Instrumentation Diagram
Simplified Sampling Circuit Piping and Instrumentation Diagram
National Engineering Laboratory, Test Facility: Multiphase Flow-loop
National Engineering Laboratory Testing - Conclusions

• The testing validated the theoretical calculations and gives confidence in being able to design project specific configurations with an optimized sampling window.

• The testing showed that the liquid sample was very close to the production flow’s water cut.

• The sampling performance was consistent across the flow regimes encountered.

• Testing was witnessed by independent certifying authority – Lloyds Register
Sample Preference

- Testing has shown that the Sampling System has a preference for liquids. It returns gases and excess liquids to production flow.

- It has no preference for oil or water.

- Provided there is sufficient mixing before the fluid enters the pipe work, the captured liquid is of a similar oil / water ratio to that of the produced fluid.
Cameron MARS Sampling Solution - Advantages

- Pressure driven, flow through technique at ambient wellhead pressure (isobaric)

- ROV operated valves (hydrocarbon flow path independent of ROV)

- Lift line run / retrieved (ROV assist)

- Self flushing – contamination free sampling

- Simultaneous production & sampling

- No active heating required

- No slops tank – (return to flowline)

- Well intervention is not required

- Dual barrier metal sealing & hard piped
Conclusion

• MARS is a field proven technology for new installations and retrofit

• Proven cost effective enabler of
  • Processing system
  • Fluid injection
  • Multiphase metering
  • Sampling

• Various set-up possible
  • Platform- subsea
  • 5kpsi to 15 kpsi
  • Interface with every subsea vendor architecture
THANK YOU