Subsea Chemical Storage and Injection collaboration project

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Agenda

1. SCS&I – What is it?
2. Project justification
3. Scope of work and project schedule
4. Examples of key challenges
5. Conclusion
1. Subsea Chemical Storage & Injection

**Background**
Separately studied by TOTAL and TechnipFMC prior to entering the development contract

**Main project objective**
To develop and qualify an SCS&I station to be ready for industrial piloting in 2020-2021

**What is it?**
Complete system for seabed storing and pumping all required injection chemicals
- Retrievable and refillable storage tanks
- Retrievable pump modules
- Distribution system for chemicals
- Power transmission and distribution
- Control system
Application areas

**GREEN FIELD**

**All-Electric**
- All-electric field developments where the functionality of the umbilical is reduced as much as possible with respects to fluids

**Long tie-backs**
- Field developments with long tie-backs to land, platform, or FPSO
- In fields where local content is excessively driving cost, especially for umbilical

**New tie-backs to existing HOSTs**
- New field developments with tie-backs to existing host with capacity constrains or other owners

**BROWN FIELD**

**Mature Field Developments**
- Field extensions and add-ons
- Marginal pockets and satellite well developments

**IOR**
- Existing Fields which needs additional chemicals due to change in production premises
- Testing of production chemicals

**Troubleshooting**
- Operational premises have changed over time
- Testing of new inhibitors
- Hydrate remediation

**SCS&I Technology**
2. Project justification – value proposition

Improved HSE at the topside facility – eliminate storage of chemicals and high pressure pumps

Project economics – increased production

All-electric and all-subsea – enabler

LoF benefit – change or add new chemicals

Less elements in the umbilical – reduced size and weight

Smaller topside facility – space and weight savings

Less maintenance work at offshore facility – moved to shore base
3. Scope of work

Complete system approach required to reach a cost effective solution

**Tanks**
Technology and materials
Manufacturing
Transport and handling

**Pumps**
Technology
Sizing

**Power system**
Transmission
Motor operation

**Control system**
System integrity
Component integrity

**Structures**
Light and robust

**Installation**
Suitable for all WDs
Chemical density
Retrievability

**LoF operations**
Tank re-filling
Pump maintenance

**HSE**
Water ingress
Chemical release
Project design premises

Water depth: 3000m
Design pressure: 690bar
Wells: 4 oil producers
Storage: 6 months consumption

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Volumes (m³)</th>
<th>Type of injection</th>
<th>Injection location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion Inhibitor</td>
<td>58</td>
<td>Continuous</td>
<td>Christmas Tree</td>
</tr>
<tr>
<td>Demulsifier</td>
<td>18</td>
<td>Continuous</td>
<td>Manifold</td>
</tr>
<tr>
<td>Scale Inhibitor</td>
<td>23</td>
<td>Continuous</td>
<td>Christmas Tree</td>
</tr>
<tr>
<td>Biocide</td>
<td>27</td>
<td>Batch</td>
<td>Manifold</td>
</tr>
<tr>
<td>LDHI (low dosage inhibitor)</td>
<td>32</td>
<td>Intermittent (Start-up)</td>
<td>Manifold</td>
</tr>
<tr>
<td>Methanol</td>
<td>56</td>
<td>Intermittent (Start-up and Shutdown)</td>
<td>Christmas Tree</td>
</tr>
<tr>
<td>Total volume</td>
<td>214</td>
<td></td>
<td></td>
</tr>
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Project schedule

Hardware and Integration 2019 - 2020

Critical components
Bench tests
Integration test

Pilot 2021

Pilot design
Manufacturing Testing

SCSI Station Definition 2018 - Q1 2019

Concept definition
Aging and compatibility tests
Operability, safety and environmental philosophies

Hardware and Integration
2019 - 2020
4. Technical challenges

1. HSE
   Safety barriers

2. Operations
   Tank re-filling

3. Power System
   Motor operation

Each topic can’t be addressed alone - A complete system approach is required
Safety barriers

Potential for both burst and collapse
Tank volumes are prohibitive for a high pressure design – wall thickness and weight!
Pressure compensated to ambient pressure
Design the system to manage;
- Potential over-pressure caused by backflow of hydrocarbons
- Potential under-pressure caused by pump suction

A full HIPPS per chemical would be a show-stopper

Need;
- Pressure monitoring and control
- Highly reliable barriers
- Precise monitoring of;
  - Chemical consumption
  - Seawater content in the chemicals
Operations

**Tanks are refilled onshore**
Module weight within vessel capacity
Target weight <70 tons

**Safe handling of tank modules**
Chemical dependent
Filling
Transport
Installation
Retrieval

**Frequently operated connection points**
Wear of coupler seals - replaceable
Motor operation

High volume batch injected chemicals – several volumetric pumps in parallel
Scaleable concept
Same design for multiple chemicals

3-phase motor – 15kW and 55kW pumps
Several concepts for motor operation evaluated;
Hardware requirements (switches, penetrators etc)
TRL - general
TRL – subsea

Alternatives
Direct online start
Y-D start
Soft starter
Auto-transfer
Variable Speed Drive - selected for pump qualification

Simulation of sequential direct online start
5. Conclusion

New technology - still safe and reliable

Designed for subsea application to ensure a cost effective solution

No show-stoppers

Next step: Qualifications

Collaboration with the operator
1. Establishes ownership and commitment
2. Enables bolder, disruptive thinking
3. Complimentary competencies ensures a technical solution which is robust, reliable, and cost effective