Subsea Processing

- Why?
- What?
- Where in the world?
- What risk?
Why Consider Subsea Processing?

- Life of Field
- Reservoir Characteristics
- Flow Assurance
- Project Economics
Why Consider Subsea Processing?

• Life of Field
  – Increase Hydrocarbon Recovery
    • Integrated production modelling
    • Maximise hydrocarbon recovery

With Subsea Pumps

With Subsea Processing
Why Consider Subsea Processing?

- Reservoir Characteristics
  - Deep Water
  - Low Reservoir Pressure
  - Deep Reservoir
  - High Well Productivity Index (PI) (barrel of oil per psi drawdown)

![Impact of Subsea Processing Graph](image)

Source Data from BHP Billiton, Source: Sulzer
Subsea Technology

- Subsea Pumping: Boost production from the seafloor to the host platform.

Image Source: Sulzer
# Subsea Boosting Technology

<table>
<thead>
<tr>
<th>Type</th>
<th>Applicability for Subsea Boosting</th>
</tr>
</thead>
</table>
| Single Phase (Centrifugal) | Highest differential pressure capability  
Only handles low Gas Volume Fraction (<15%)                                                |
| Hybrid                | Combination of helico-axial and centrifugal impeller stages.  
Generally used down stream of the separator, GVF, 38%                                        |
| Mudline ESP           | Widely deployed technology  
GVF < 50%                                                                                      |
| HSP                   | Compact hydraulic drive pumps  
GVF < 75%                                                                                      |
| Multiphase            | GVF tolerance 30-95%                                                                           |
| Twin Screw            | Good handling on high GVF – up to 95%                                                           |

Image Courtesy of Sulzer
Subsea Compression

- Shell Ormen Lange Subsea Compression Pilot
- Statoil Asgard Subsea Compression

Image Source: Offshore Energy Today
Åsgard compression train (2 + 1) – modules

Separator module
Compressor module
Outlet cooler module
Inlet / antisurge cooler module
Pump module

Image Source: AkerSolution
OneSubsea Helico-Axial Pump.

OneSubsea’s multiphase pump stages in a vertical configuration. Recent testing and successful qualification work, in the HiBoost MPP Joint Industry Project, have greatly increased differential head capability.

Image Source: OneSubsea

Aker Solutions  Aasgard Subsea Compressor Train with 11.5 MW Compressor Module, Separator, Cooler and Pump Module

Image Source: Aker Solutions
Considerations

• Current technology uptake is low
• Reasons:
  – Cost
  – Uncertainty regarding reliability (proven on boosting and separation)
  – General conservatism in industry
  – Low cost sensitive environment where low risk solutions seems to be preferred.
Obstacles to overcome

• The subsea components run on high voltage alternated currents which has limits on transmission distance relative to power.
• This means high DC may be needed. Companies like ABB and Siemens are working on this. (Design 101)
• Power distribution: large subsea field with high power inputs, many components and long step-out distances means subsea variable speed drives will be needed to convert, distribute and control electricity.
Obstacles to overcome

• Control Systems
  – Putting all the equipment subsea also increases the requirements for the control systems. There will be a need for increased bandwidth, real-time information on system performance, in addition to increase demands on safety functionality and regularity.
Monitoring

• Knowing the state of the well stream is crucial in terms of production monitoring and flow assurance.

• Improved reliability for subsea and multi-phase sensors is the key for success.
Subsea Intervention

• Intervention and maintenance operations from ships in high waves, particularly the handling of large and heavy processing modules.

• The reduced accessibility of seabed installation, brings additional requirements to the system uptime, maintenance on demand and general optimization of intervention frequencies.
Obstacles to overcome

Integration, reliability and cost. Enabling and qualifying the integration is a key challenge with standardisation being a topic.
Thank You