Subsea Compression – Now and the Future

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Advanced Subsea Production

Typical Subsea Process Block Diagram - Building Blocks

1) Gas Processing
   - Gas Treatment
   - Gas Liquid Separation
   - Production

2) Oil-Water Processing
   - Oil Water Separation
   - Oil Treatment
   - Water Treatment

3) Boosting
   - Compressor
   - Pump
   - Injection

Host Facilities
Subsea Gas Compression: Drivers

- Gas fields require boosting of the reservoir flow as reservoir pressure depletes
- Subsea gas compression replaces the need for an offshore platform or onshore compression facility
  - Cost-effective development solution (CAPEX)
  - Reduced operational costs (OPEX)
- HSE advantage due to unmanned operation
- Advantageous to place the compressor close to the well
  - Increased and accelerated production
  - Reducing CO₂ emissions through lower energy consumption
  - No emissions or disposals to sea
Subsea Compression Adds Recovery - Principle

\[ \Delta p = k \cdot \rho \cdot \frac{Q^2}{t} \]

- Pressure drop in the flowline / riser depend on the density and the square of the volume
- Placing the compressor upstream the flowline/riser will give the lowest wellhead pressure
Åsgard Subsea Compression Project
Subsea Compression Development Timeline

Concept

1985

1989-1993
Kværner Booster Station

Conceptual development

Qualification

2001-2003
Demo 2000 GasBooster™ Qualification

2004-2013
Ormen Lange Compression Pilot
System Testing at Nyhamna

Project

2010-2015
Åsgard Subsea Compression system EPC

Operating since Sept 2015
Åsgard Subsea Compression Project – Scope

- Compression station
- Manifold station
- Topside power & control module
Åsgard Subsea Compression Project – Details

Project details
- Water depth: 260 m
- Tie-back distance: 40 km
- Flow rate: 21 MSm3/d
- Power: 2 x 11.5 MW
- Shut in pressure: 220 bar
- IOR: 306 million barrels of oil equivalent

Project schedule
- 2006 - 2010: studies, Pre-FEED, FEED
- 2010: EPC contract (1st December)
- 2013: Fabrication
- 2014: SIT and FUT
- 2015: Delivery and Start-up (17th of September)
Åsgard Subsea Compression Project – Process System
Åsgard Subsea Compression Project – PFD
Excellent Operational Performance

- Accumulated running hours: $12,000 \, (T1) + 8,800 \, (T2) = 20,800$ in total
- Producing more condensate than expected
- Very low vibrations
- No trips / shutdown caused by the subsea compression system
- 100% availability for the subsea system (Statoil quote "the system has been running like a Swiss clock with practically no stops or interruptions")
Åsgard Subsea Compression Project – Recovery Details

- Increased recovery of 306 Mmboe through the life of field
- Field life extended up to 2032
- Recovery rate from the Midgard and Mikkel reservoirs has been raised from 67% to 87% and from 59% to 84% respectively
- During the first year of operation the production has been raised by an excess of 16 million boe, equivalent to more than 5 billion NOK today’s price market (around to 600 MUSD, with a conversion rate of 0.12)
Next Generation – Subsea Compression System
**Subsea Compression – Now and the Future**

**Today (Asgard Copy)**
- Asgard-like SSC
- 13 subsea modules
- Similar modularisation and layout philosophy
- Over-trawlable structure
- Proven technology & setup

**Tomorrow (SCS 2.0)**
- Optimisation with Asgard technology, core components & functionality
- Up to 50% reduction in total size and weight
- 13 → 7 module subsea
- Lighter compressor module
- Able to be fitted in to a 4-slot subsea template

**Future (Wellstream Compression)**
- Further optimisation of the SCS 2.0 system
- Utilises liquid tolerance properties of MAN HOFIM compressor
- Eliminate the need of scrubber and pump
- Able to handle up to 30wt% liquid (95% GVF)

*Less than half size, weight and cost*
Subsea Well Stream Compression (WSC) System Vision

- A robust, high capacity compression system that can handle wellstream conditions without scrubber and pump
- Design and operation philosophy
  - Liquid tolerant compressor handles normal liquid production
  - System design w/FCU handle upset conditions and transients

**Control and automation**
- Monitoring and control system designed to handle normal and upset conditions

**Flow conditioning unit**
- Smoothen GVF variations
- Slug accommodation
- Important to handle upsets

**Compressor**
- Handle continuous liquid load in wellstream
- Long term tested up to 30% LMF / 5% GVF
- Even distribution of flow at suction
Thank You / Questions
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