Subsea compression technology

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Aker Solutions
Who we are and what we do
This is Aker Solutions

- Provides oilfield products, systems and services for customers in the oil and gas industry world-wide
- Built on more than 170 years of industrial tradition
- Employs approximately 27 500 people in more than 30 countries

Employees: 21 000
Contract staff: 6 500
Revenues: 44.9 bn
EBITDA: 4.7 bn
Market Cap: 22.7 bn

Revenues and profits are in NOK and for 2012. Market capitalisation as of 13 May 2013.
Introduction
Subsea gas compression: a technological leap

- 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)
- 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
- Safer due to unmanned operation
Åsgard subsea compression increasing recovery

- 29.7 BSm3 gas
- 3.5 MSm3 condensate

Total gain: 278 mill boe
Aker Solutions’ Gasbooster™ system road-map

**Technology**

1989-1993 Kvaerner Booster Station

2001-2003 Demo 2000 GasBooster™ qualification

2004-2011 Ormen Lange Subsea Compression Pilot - Qualification, delivery, testing 1 x 12.5 MW 120 km

2011-2013 Ormen Lange Subsea Compression Station - EPC 1 x 12.5 MW 120 km

2010-2015 Åsgard Subsea Compression Station - FEED, EPC 2 (+1) x 11.5 MW 40 km

2012-2019 Ormen Lange Subsea Compression System - Testing at Nyhamna 2 x 12.5 MW 120 km

**Specifications**

1 x 6 MW > 350 km

2013-2020 CGB™ Compact Gas Booster for deep waters and long step-out

**People**

**Facilities**

**Methodology**

**Supply chain**

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Why Aker Solutions?

1. 25 years of technology development to industrialise a subsea compression system

2. More than 450 people working with subsea compression in Aker Solutions today
Why Aker Solutions?

3. State of the art in-house facilities/sites

Aker Solutions Egersund – Unique experience from topside and subsea making success for subsea compression
Ormen Lange subsea compression pilot
Ormen Lange licence partners

Statoil
DONG energy
ExxonMobil
Shell
petoro
Ormen Lange subsea compression pilot

- Objective: Mature and qualify a viable subsea compression alternative to the base case platform

**2006 – 2011 Subsea Compression Pilot**

- Identical to one of the 4 trains for OL subsea compression station
- 12,5 MW compressor unit
- 400 kW pump unit
- SIT Complete
- Installed at Test Site (Nyhamna)
- Testing ongoing (2013)

**Base case TLP Option: Subsea Compression**

- 2 compression trains (2 compression trains onshore)
- Tie-back 120 km
- Design water depth 900 m
- 70 MSm$^3$/d of gas production – 2012
- 30 MSm$^3$/d of gas production – 2023
- 2 x 12,5 MW compression trains
World’s first subsea compression system delivered!
Control and condition / performance monitoring

- Compressor performance
  - Polytropic head
  - Polytropic efficiency
- Antisurge valve performance
- VSD efficiency
- Heatloss out of VSD
- VSD output quality (THD out of VSDs)
- HV equipment internals supervision
- Harmonic vibration analysis compr.
- Pump performance
- Harmonic vibration analysis pump
- Runtime counters for pump and compressor
- Runtime counters for compressor
Åsgard subsea gas compression project
Åsgard licence partners

- Statoil
- Eni Norge
- ExxonMobil
- Total
- Petoro
Åsgard field layout
Asgard subsea compression system – project data

Project details
- Shut in pressure: 220 bar
- High power: 2 x 11.5 MW
- Flow rate: 21 MSm3/d
- Compressors: 2+1
- Step-out: 40 km
- Water depth: 250 m
- Topside frequency converter

Project schedule
- 2006 - 2010: studies, pre-FEED, FEED
- 2010: EPC contract
- 2013: equipment testing
- 2015: delivery and start-up
Compression system – scope of supply

- All electrical control systems
  - Low voltage distribution system
- High voltage electrical power transmission

Compression station
- Weight: 5063 tonnes
- Size: 75x45x20m

Manifold station
- Weight: 911 tonnes
- Size: 34x28x9m
Åsgard compression train (2 + 1) – modules

- Seperator module
- Inlet / antisurge cooler module
- Compressor module
- Outlet cooler module
- Pump module
Åsgard compression train – process equipment

Inlet and antisurge cooler

Compressor

Separator

Pump

Discharge cooler
Templates fabrication at the Egersund yard

Compression station template

Manifold station
Overall view of the compression station
Future trends – new system concepts
Extreme step-out distance

Combined HV power supply and Integrated Heating System

RotoConverter™ – Advantages

1. Enables more power (MW) @ longer distances
   - No need for subsea VSD
   - Reduced subsea CAPEX
   - Also makes it possible to stretch subsea control system supply (full range from 5kW to 50MW and beyond)

2. Reduced transmission frequency
   - Smaller cables → less copper
   - Increased transmission cable robustness/lifetime
   - Reduced CAPEX

3. Better power system stability
   - Less charging currents
   - Less voltage variations
   - Works as phase compensation and harmonic filter
Real-time monitoring, interactive troubleshooting and advanced optimisation in a distributed setting

Remote Support Services

Information management
- Validation, reconciliation
- Archival, transmission
- Linked to ERP system

Condition monitoring
- Advanced interactive troubleshooting
- Predictive maintenance
- Key performance indicators (KPI's)

Production efficiency
- Flow assurance
- Process optimisation
- Key performance indicators (KPI's)

Decision support
- On demand and ad-hoc support
- Production optimisation, debottlenecking,
Subsea compact GasBooster™ (CGB™) JIP

1. Compressor system in the range of 3-6 MW
   - To address a wider range of fields

2. Leverage Ormen Lange & Åsgard experience
   - Qualified components
   - Qualified system

3. Benefit from liquid tolerant compressor
   - Simpler and smaller scrubber

4. Simplified functionality
   - Reducing critical items

5. Enabling long power step-out
   - RotoConverter™ - patent pending

6. Enabling ultra-deep water
   - Small diameter separator, press. balanc. RotoConverter™

Size (6 MW unit): 5 x 11 x 7 m
Weight (6 MW unit): <250 tonnes
Summary
Summary

- Subsea compression will provide a good business case for many subsea gas fields
- Feasibility of subsea compression now proven through Ormen Lange pilot testing and in 2015 through the Åsgard station operation
- Still some technology challenges before subsea compression can be used for all applications
  - Even longer step-out distance
  - Even deeper and higher shut-in pressure
  - Injection compression
- Aker Solutions believes that the market for large and medium size subsea compressions systems will grow and we want to be the preferred partner for this high technology projects
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