Design, Operation and Learning from the World’s First Compression System Operating Subsea

Perth, 23rd February, 2017
Salvatore Micali, Regional Concept Line Manager
Content

■ Introduction

■ Åsgard subsea compressor project
  ■ Design and project execution
  ■ Operation
  ■ Learnings

■ Next generation of subsea compression systems

■ Summary
Aker Solutions creates solutions to unlock energy safely and sustainably for future generations

14,000
EMPLOYEES

20
COUNTRIES

46
LOCATIONS

175
YEARS OF EXPERIENCE
Introduction
Subsea gas compression – the benefits

Relocating topside compression on the seabed, close to the reservoir, provides for a number of benefits:

- Reduces **CAPEX** and **OPEX**
- Provides for **increased total recovery**
- Enables for **accelerated production** and greater up-front return
- Enables **longer tie-back**
- Enables the use of **smaller pipeline**
- Replaces the need for topside manning
- Provides **flexibility** in flow assurance philosophies
- Reduces **carbon footprint**
Subsea gas compression – long term commitment

- 1985
- 1989-1993 Kværner Booster Station
- 2001-2003 Demo 2000 GasBooster™ Qualification
- 2004-2011 Ormen Lange Compression Pilot Qualifications and EPC
- 2011-2013 Ormen Lange Compression System Testing at Nyhamna
- 2010-2015 Åsgard Subsea Compression System EPC
- 2015 -> Well Stream Compression (WSC) Conventional Compression System
Åsgard subsea compression project
Åsgard field layout and scope of supply

- Topside power & control module
- Manifold station
- Compression station
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: equipment and modules testing
- 2014: SIT and FUT
- 2015: delivery and start-up (16th of September)
Åsgard subsea compression system – subsea modules
Excellent operational performance

- Accumulated running hours to date: 12,000 (T1) + 8,800 (T2) = 20,800 in total
- Increased production during the first year of operation = 16 million barrels of oil equivalent
- Producing more condensate than expected
- Very low vibrations
- No trips / shutdown caused by the subsea compression system
- 100% availability for the subsea system
Lessons learnt

- Total system responsibility
  - Managing technology qualifications
  - Integrating core technologies in the system
  - Designing, manufacturing and testing
- Early cooperation with installation contractor
- Core team retention and development

Going forward

- Optimization by challenging requirements
- Rationalization of the capital spare parts
- Simplification of the testing philosophy
Next generation subsea compression systems
Next generation subsea compression systems
Reduce cost, size, weight, complexity and delivery time and remove need for heavy lift operations

- Simplified Conventional «SCS 2.0»
- Åsgard Subsea Compression «SCS 1.0»
- Wellstream Compression «WSC»

SCS 2.0 Program:
- Ormen Pilot EPC
- ASC EPC “SCS 1.0”
- Åsgard Lessons Learned
- AKSO & MDT Alliance PA1

Field specific applications
Cost & Schedule & Execution
Completed
Ongoing
Planned

- Overall system design
- All disciplines / work packages
- Engineering methodology/tools
- Execution and test philosophy
- Installation / intervention
- Alliances / cooperation models
Result – More than 50% reduction in size, weight and cost

- Core functionality un-changed
- More than 50% reduction in size and weight and cost
- From 13 to 7 modules per train
- Simplified LV distribution using own SIS 2/DCFO compliant electrical actuators

- Simplified piping resulting in less pressure drop
- Optimized orientation of connection systems
- Single train fit inside 4-slot template
- No heavy lift, resulting in large installation savings

Today

Tomorrow (SCS 2.0)

Future (Wellstream Compression)

March 3, 2017 | Slide 15
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
Summary
Summary

- The subsea compression system installed at Åsgard is approaching 1.5 years of successful operation.
- This is not only a technology leap, but it represents also a strong business case.
- The learnings from the first project will allow to improve the next generation of subsea compression.
- Australia could be one of the next offshore gas region to benefit from this technology.
Copyright and Disclaimer

Copyright
Copyright of all published material including photographs, drawings and images in this document remains vested in Aker Solutions and third party contributors as appropriate. Accordingly, neither the whole nor any part of this document shall be reproduced in any form nor used in any manner without express prior permission and applicable acknowledgements. No trademark, copyright or other notice shall be altered or removed from any reproduction.

Disclaimer
This Presentation includes and is based, inter alia, on forward-looking information and statements that are subject to risks and uncertainties that could cause actual results to differ. These statements and this Presentation are based on current expectations, estimates and projections about global economic conditions, the economic conditions of the regions and industries that are major markets for Aker Solutions ASA and Aker Solutions ASA’s (including subsidiaries and affiliates) lines of business. These expectations, estimates and projections are generally identifiable by statements containing words such as “expects”, “believes”, “estimates” or similar expressions. Important factors that could cause actual results to differ materially from those expectations include, among others, economic and market conditions in the geographic areas and industries that are or will be major markets for Aker Solutions’ businesses, oil prices, market acceptance of new products and services, changes in governmental regulations, interest rates, fluctuations in currency exchange rates and such other factors as may be discussed from time to time in the Presentation. Although Aker Solutions ASA believes that its expectations and the Presentation are based upon reasonable assumptions, it can give no assurance that those expectations will be achieved or that the actual results will be as set out in the Presentation. Aker Solutions ASA is making no representation or warranty, expressed or implied, as to the accuracy, reliability or completeness of the Presentation, and neither Aker Solutions ASA nor any of its directors, officers or employees will have any liability to you or any other persons resulting from your use.

Aker Solutions consists of many legally independent entities, constituting their own separate identities. Aker Solutions is used as the common brand or trade mark for most of these entities. In this presentation we may sometimes use “Aker Solutions”, “we” or “us” when we refer to Aker Solutions companies in general or where no useful purpose is served by identifying any particular Aker Solutions company.