



Subsea Processing – Status Report and Research / Testing Needs

RPSEA Seafloor Technologies Forum

Lars Farestvedt – March 09, 2007

Agenda

- Subsea Processing – Status Report
 - What is Subsea Processing?
 - Subsea Technology – Past, Present and Future
 - General overview of technology status
 - Subsea Gas Compression
- Research / Testing Needs
 - Technology Gaps
 - Research Needs
 - Testing Needs



Subsea Processing

- Is any active treatment of fluid(s) performed at or below the seabed

Subsea Processing includes:

Separation	Pumping
Mixing	Raw seawater Injection
Cooling	Compression
Heating	De-hydration
Filtering	Chemical Injection

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Tordis IOR Project

Profitable Increased Oil Recovery from Tordis

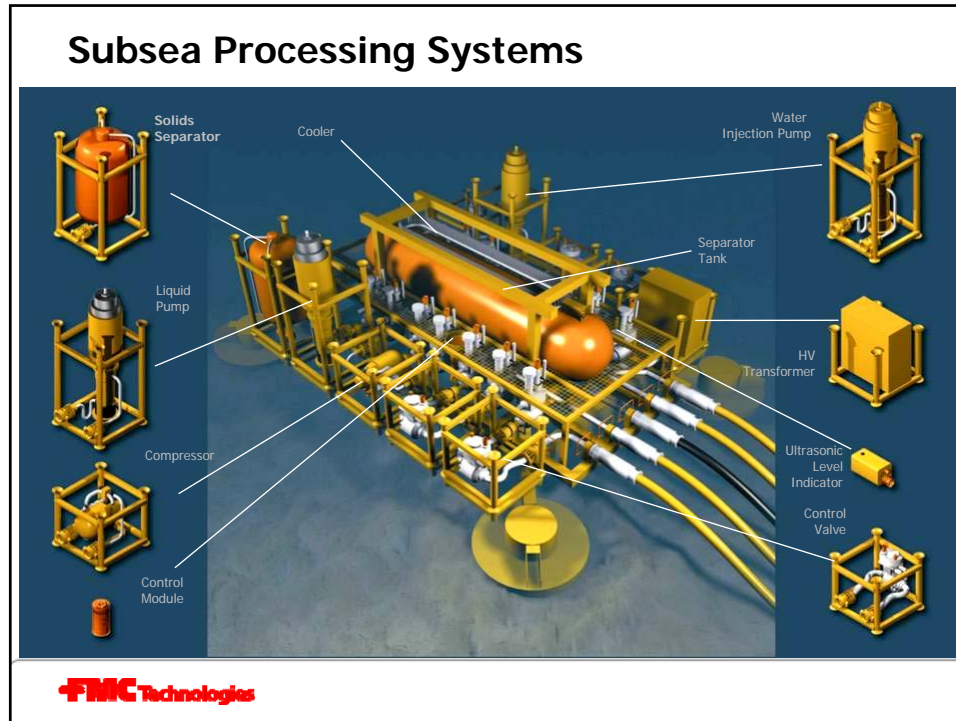


Strategy:

- **Low pressure production GFC**
- **Bulk water separation**
- **Boosting of HC back to GFC**
- **Re-injection of produced water**
- **Maintain high regularity**

Increase oil recovery from Tordis field from 49% to 55% (36.5 MBO)

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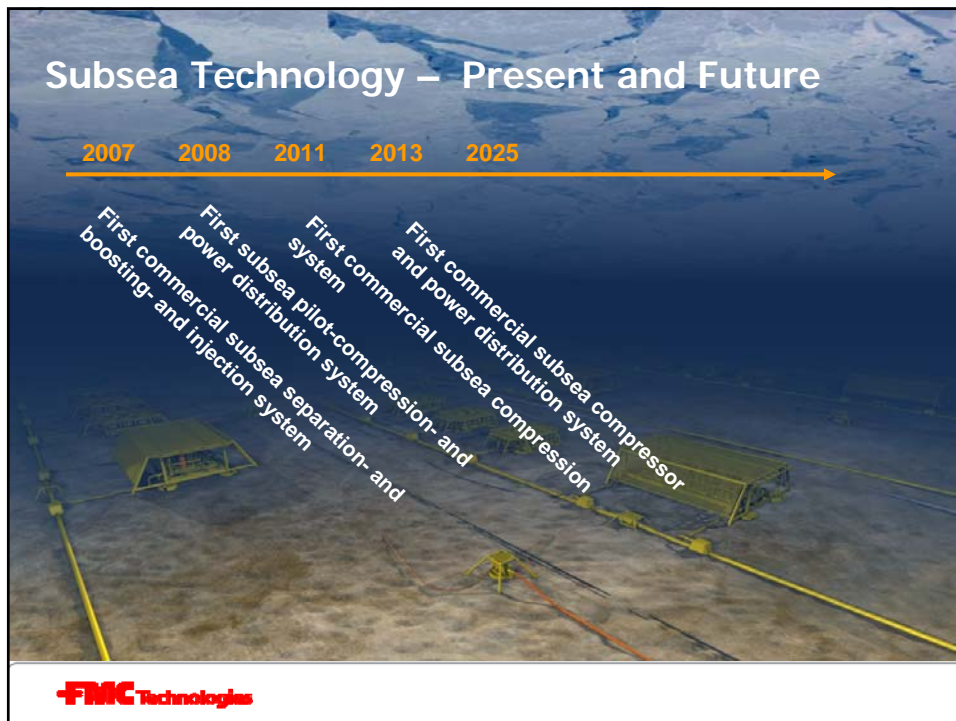


Benefits of Subsea Processing

- Reduced CAPEX: Topsides processing / Pipelines / de-bottlenecking
- Accelerate production / Increase recovery
- Enable marginal field developments: deepwater, long tie-backs
- Extend production in existing fields
- Enable tie-in of satellite developments into existing infrastructure
- Improve Flow Management
- Reduce impact on the environment



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History of Subsea Processing



Draugen, worlds 1st commercial subsea multiphase pump installed

Project	Operator	Year
Seabed pumps * •Draugen •Lufeng •Topacio	Shell Statoil ExxonMobil	1994 1997 2000
Downhole pumps •Lihua •Otter	Amoco TotalFinaElf	1996 2001/ 2002
Control Systems •VASPS	Petrobras	2001



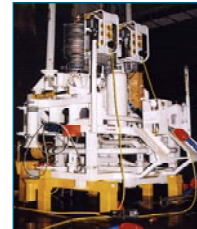
Lihua, horizontal trees including ESP's



* System integration of Framo pumps
** Vertical Annulus Separation and Pumping System

Lufeng, 5 subsea pumps in continuous operation for 5 years

Topacio, 2 multiphase pumps retrofitted into the pigging loop

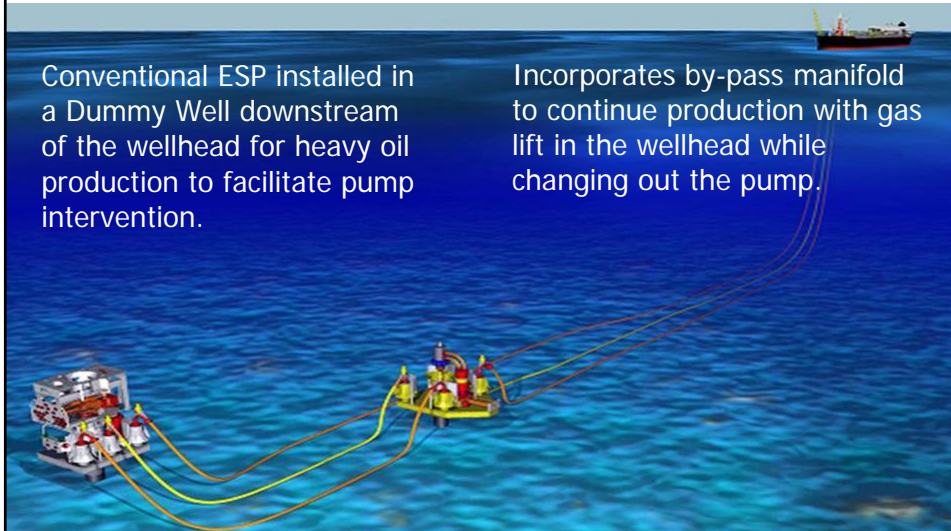


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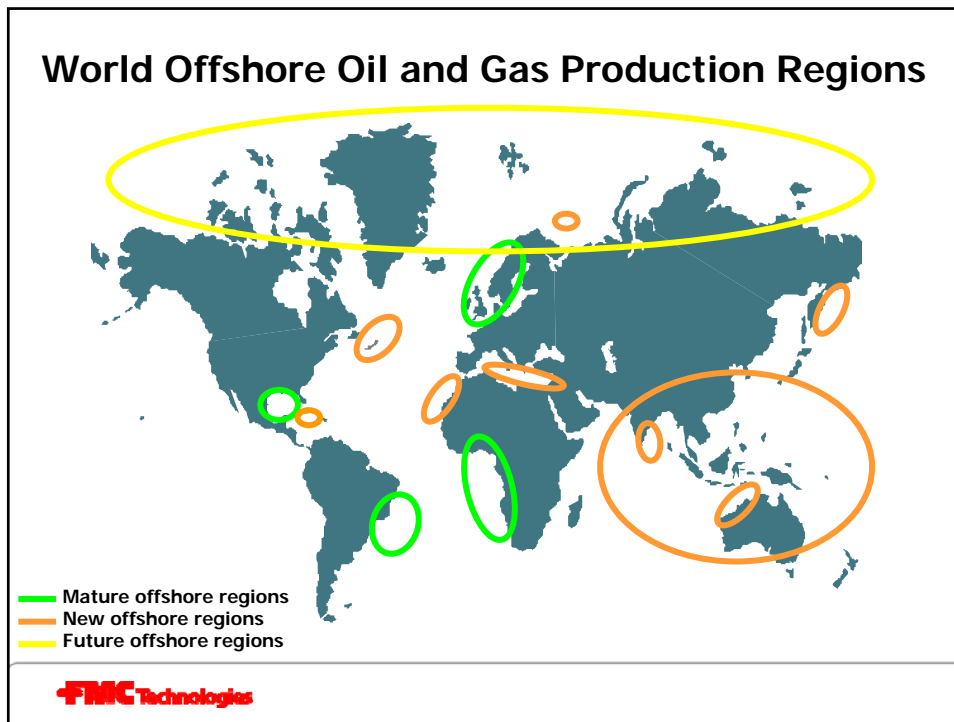
Brazil Subsea Pump Module

Conventional ESP installed in a Dummy Well downstream of the wellhead for heavy oil production to facilitate pump intervention.

Incorporates by-pass manifold to continue production with gas lift in the wellhead while changing out the pump.

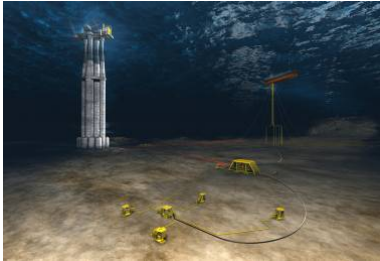



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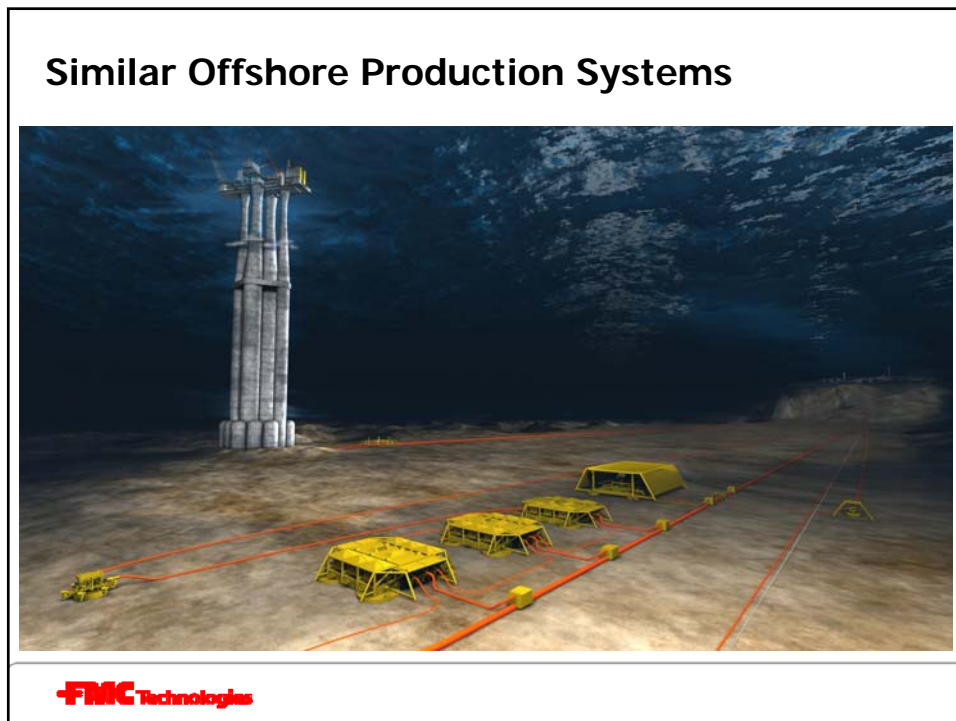
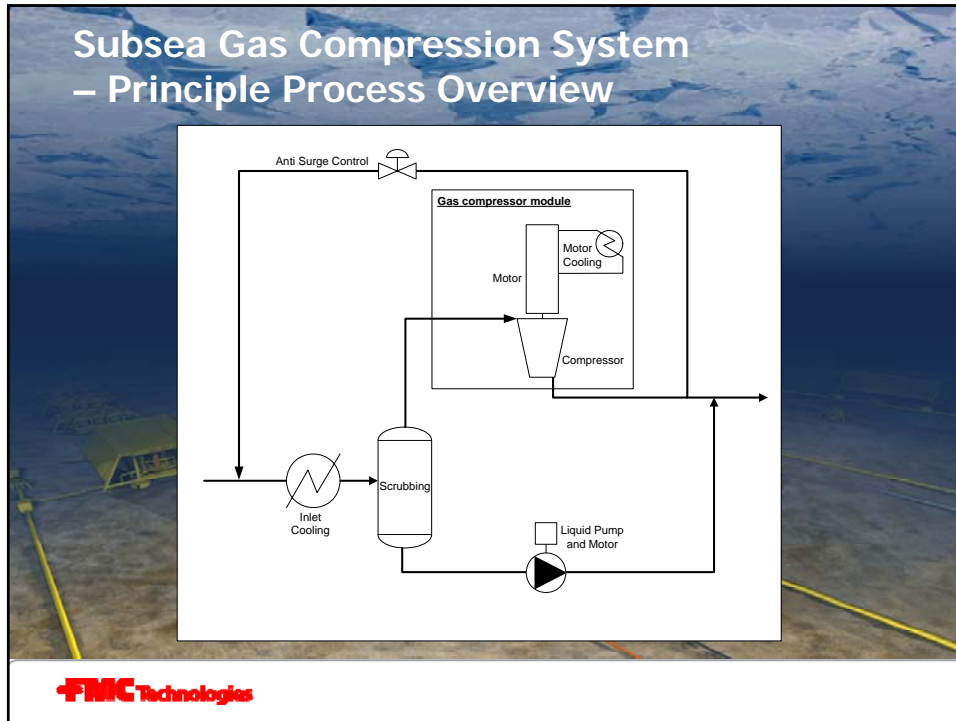


Subsea Gas Compression – The Purpose

- Maintain gas production when reservoir pressure is declining.
- Field development with gas transportation directly to shore without surface facility all through the field lifetime.
 - Save cost of major surface-based production.
 - Be enabling tool for use of existing infrastructure.
- Especially of interest in arctic region due to harsh conditions for surface facilities.
- Significant value driver for gas fields with long step-out distance.

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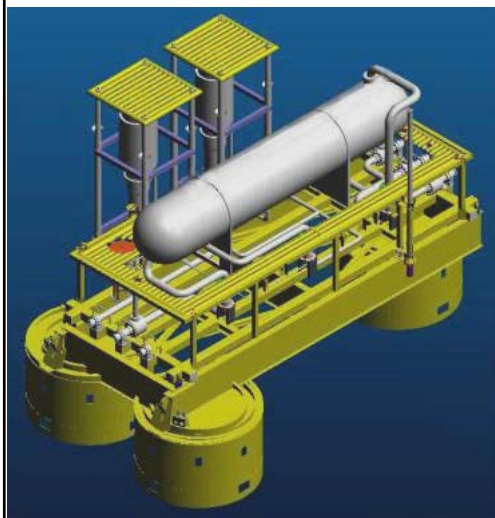


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Process Products Status

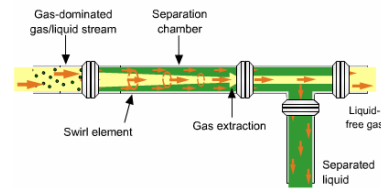
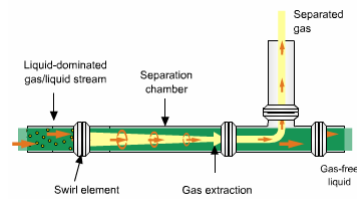


- *Field Proven subsea technology:*
 - Templates and manifolds
 - Control system
 - Connectors
 - Isolation valves
 - Retrievable modules
 - Installation tools and procedures
 - Multiphase pumps
- *Qualified:*
 - Semi-compact retrievable separator
 - Sand Management Systems
 - Level Monitoring and sand detection
 - Process control valve
- *Under development:*
 - Compressor
 - Oil in water monitoring
 - HV Power Supply

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CDS / Statoil Inline subsea water separation - The next step

- Ultra compact separation using High-G separation forces.
- Successfully applied topside.
- System comprising small, modularized components.
- Ideal for deep / ultra deep water applications.
- Qualification for heavy oil subsea separation ongoing.



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Research / Testing Needs

- Subsea Processing
 - Separation technologies for deep water
 - Pumping technology for ultra-deep water
 - Reliable subsea oil-in-water monitoring
 - Subsea Variable Speed Drive & Transformers
 - Etc.
- Subsea Gas Compression
 - High voltage components (connectors / transformers / VSDs, etc)
 - Fast acting process control valve
 - Etc.

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Similar Offshore Production Systems

