20 Years of Subsea Boosting Technology Development
Pushing the Boundaries for Deepwater and Long Distance Tie-backs
Arne B. Olsen
Content

- Historical view
- Technology map and development trends
- Boosting systems references
- Reliability
- Obvious potential vs. actual acceptances
- Latest contribution to subsea processing
- Closing remarks
Pump Technology – Framo Engineering Legacy
First Multiphase Pump Test Rig, 1987
Multiphase Pump Principle Selection

Various pump principles were evaluated and extensively tested in 1987-89

- Positive displacement pump – Twin screw and piston
- Dynamic pump – Helico-axial and CR

The Helico-axial principle was selected:

- Adequate pressure boosting capabilities
- Self regulating principle
- Can operate safely from 0-100% GVF without re-circulation
- Simple and robust design (sand tolerant)
- Compact and low weight
- Easy to marinize
Extended satellite technology could bring 80% of future prospects within the reach of existing infrastructure.
Qualifying Long Tie-back with Electrically Driven System
Pioneering Since Mid-90s

1983
- Legacy Framo Engineering established to develop products for the next decades

1984/5
- Screening boosting technologies
- First prototypes tested

1987
- Selected the Helico-axial pump principle

1994
- Developed the electrical power and control system for subsea pumps

1997
- First commercial subsea electrical booster pump installed at Lufeng field

2000
- First true subsea multiphase pump installed at Topacio field

2001
- First subsea water injection pump installed at Troll

2006
- First subsea seawater injection system at Colomba E

2011
- Deepest, longest tie-back and highest design pressure for Jack & St. Malo

2013
- Largest differential pressure system to Total’s GirRI project (130 bar)
Shaft Power Evolution
Design Pressure Evolution

- 1997, Lufeng
- 2003, Ceiba
- 1998, Troll
- 2006, Columba E
- 2013, JSM
- 2014
Multiphase Pumps DP Evolution

Barracuda, World’s First High Boost
Full-scale Test Facilities
Shell’s Draugen Field – North Sea

1994 First commercial subsea multiphase pump

Shell Draugen Field

650 kW pump
270 m water depth
9 km tie-back

Rogn South Satellite Well (270 m water depth)

3 km

Southern Water Injection Template

Crude pump

Stationary barrel

Inlet mixer

Water turbine

Production

Water Injection

Suction

Discharge

Water Feed

Water Exhaust

Draugen Platform

Optimize
FROM PORE TO PROCESS

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Statoil’s Lufeng Field – South China Sea

First commercial subsea electrical pumps
Production enabler
42 mill barrels of oil pumped
1997 til 2011
ExxonMobil Topacio – Equatorial Guinea

- Main pump has been in operation more than 50,000 hours since 2000
- 1 pump covers today’s required flow rates
- Lifetime expectancy of up to 5 years (ref EM, Oct 2010)
Key data

- 60,000 bbld
- 3 MW shaft power
- 13,000 psi pressure rating
- 4,000 psi boost
- 10% GVF design
- 7200 ft water depth
Total – GirRI Angola Installed  Q4-2014

Scope
- 15 and 7 km tie-back (P80 and P70)
- 1400 m water depth
- 130 bar differential pressure
Effect of Boosted Production

- Boosted wellhead pressure
- Flowing wellhead pressure
- System resistance
- Increased production

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Increased Recovery Over Field Lifetime

- Early Natural Production
- Free Flow to Surface + Boosting
- ‘In-Well’ Lift
- Boosting
- Processing

Optimize from Pore to Process

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Field Redevelopment - Example

- Two MPPs
- One MPP
- Natural

Installation

Cumulative Oil (MMstb)

Year

2014 2016 2018 2020 2022 2024

10 MMstb

29 MMstb

Natural Production Ceases

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OneSubsea Pump System Reliability

Figure 1 - MTTF\textsubscript{A} and MTTF\textsubscript{A+B+C+D} plotted from 2006 until today.
Still a Slow Boosting Market…….

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Latest contribution to the oil and gas market
First and only true wet gas compressor
Boosting of unprocessed well streams, from 0 to 100% liquid content
No need for anti-surge control systems, inter-stage coolers, or inlet scrubbers
The OneSubsea Multiphase Compressor unit is based on well-proven solutions from OneSubsea pump technology
First commercial application is for Statoil’s Gullfaks field
Unmatched Operation Experience
Subsea pumping improves the economics by reducing backpressure on the reservoirs, thus increasing well flow rates and total recoverable reserves.

Subsea boosting improves flow assurance by increasing velocity in pipelines, increasing temperature and stabilising production.

Our portfolio of proven, reliable systems has successfully increased production rates from 30% to 100% for operators.

OneSubsea has been operating in the subsea processing arena longer than any other company in the world, and records today more than 15 years MTTF of our pumps.