FMC Subsea Pumping

Offshore Power and Rotating Equipment
April 2013
Agenda

• Subsea pumps by technology and power
• Multiphase motors and pumps
• Key Technologies
  ✓ Motor
  ✓ Barrier fluid
  ✓ Hydraulic bundle
• FMC Technologies is the leader in subsea systems integration
  ➢ Collaborating with Sulzer Pumps Ltd. and acquired Direct Drive Systems to provide integrated multiphase boosting systems
Subsea pump units by technology

- FMC integrating 34% of the MPP installations for 18 years
- Vertical integration best practices focus on safety, simplicity, efficiency, barrier fluid system, service & support

Source: INTECSEA-Offshore
Subsea pumps by power - all years

FMC offering one qualified 5,000 psi motor design

Three motor rotor diameters to optimize efficiency

Source: INTECSEA-Offshore 1994-2012
Subsea pumps by technology

GVF vs differential pressure
Operational and conceptual capabilities

- Centrifugal
- Helico-axial
- Hybrid centrifugal-helico-axial
- Twin screw
- Wet gas compressor
- Dry gas compressor

Source: INTECSEA-Offshore
Key technologies – Permanent magnet motor

- **High efficiency** Synchronous motor performance, 3 x 'air gap' and small diameter PM rotor increase efficiency ~10% liberating surface power for other uses
- **High Speed** Selections at 5,000rpm with 6,000rpm capability allow for changes in production and GVF
- **Sealed** Cable wound stator and carbon sleeve rotor allow use of more environmental friendly water-based barrier fluid
- **Eliminates subsea moisture control systems** because barrier fluid is not part of motor insulation system
- **Modular construction** allows same motor and unit concept for all pump types
Key technologies – Barrier fluid system

- **Purpose**
  - Protects motor from process fluid
  - Motor cooling
  - Lubrication of seals and bearings

- **Features**
  - Environmentally friendly barrier fluid (Water/Glycol)
  - Pure mechanically-based system
    - Reduced complexity
    - No control system delay
  - Redundant system

- **Components**
  - Topside hydraulic pressure unit (HPU)
  - Subsea regulation mechanical valves
Key technologies – Pump hydraulic bundle

- **10 years Experience** Sulzer building and installing helico-axial technology for over 10 years

- **Tolerant** Large axial flow path and clearances tolerate large particles and sand production

- **High Speed** Compressor-style assembly guarantees machine balance

- **Resistant** SUME HVOF coatings provide combination of corrosion and erosion resistance

- **Thrust** Balance piston application in multi-phase flow unique to Sulzer over 10 years
Collaboration

- 2006 - Sulzer Pumps sanctions R&D activity into subsea pumping
- 2008 - Joint development agreement with FMC Technologies
  - Develop a subsea pump module to meet market requirements
  - Completion for qualification of first prototype
- 2012 – FMC Technologies and Sulzer Pumps enter long-term exclusive supply agreement
Collaboration – Scope of supply

• Integration into subsea station
• Pipe connection
• Wet mateable connector
• Pump motor unit control system
• Drive system including umbilical
• High pressure barrier fluid supply unit

• Pump motor unit
• ROV panel
• Control logic
• Penetrator (same make as wet mateable connector)
• Instrumentation attached to pump
Subsea Qualification

Test summary

Hydraulic
- Pump performance on single phase and two phase complete
- High boost (+100 bar dP) confirmed

Cooling
- Sufficient margin on design to accommodate higher losses and provide cooling flexibility

Mechanical
- Motor and pump integrated system is predictable and stable

Electrical
- VSD starting / running algorithm confirmed
- Long step out simulations confirmed
- Motor power at step loading confirmed

Pressurizing
- Overpressure limits tested
- Mechanical seal leakage rate as expected

Total 2013 unit running time: 1,000 h, 250 start/stops
Summary

• FMC Technologies is the leader in subsea systems integration
  - Collaborating with Sulzer Pumps Ltd. and acquired Direct Drive Systems to provide 1.5MW-6MW integrated multiphase pumping systems

• Key technologies
  ✓ Motor: efficiency, speed, modular
  ✓ Barrier fluid: environmentally friendly, eliminates moisture control
  ✓ Hydraulic bundle: experience, tolerant, balanced and resistant

  FMC Integration marinizing best of all technologies
Thank you