All-electric building blocks for subsea new projects and brownfield applications

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Today's topics

- Introduction to subsea electric control systems and actuation technology
- Comparison between hydraulic and electric actuation
- System qualification tests
- Production methods
- Next steps and further developments
Next Generation Subsea Electronics and actuation platform

Vectus™ 6.0

Subsea Production Systems
Workover Systems
Subsea Pumping
Subsea Compression
Subsea Factory

El-drive™
Vectus™ 6.0 subsea control system

Next generation subsea control
- Strategic product development program
- Electronics and Software Platform

Reduce deployment effort and risk
- Planning and configuration tools
- Modular architecture

Enhance operational features
- SEM operation and maintenance
- Advanced condition monitoring

Improve performance
- Processing power
- Interface capacity
- Powerful networking capabilities
El-drive™ – Electric actuators for subsea systems

Motivation for development
- Enabler for optimized life cycle cost for the control system
- Enabler for future ways of developing subsea production systems... going further and deeper
- Higher flexibility in system design
- Compliance to the latest development of specifications for subsea controls equipment

Easily configurable
- Modular architecture
- Verified production method
- Tested and verified interfaces

Enhanced operational features
- Advanced condition monitoring
  - Valve profile
  - Vibration
  - Actuator monitoring
- 4000 meter design
Benefits electric vs hydraulic actuation

Study performed on a medium sized SPS system

- Electric branch valves
- Electric chokes

Study shows a lifetime saving of up to 25M$

- Less hydraulic consumption
- Less power need for HPU
- Faster start up of system (Less lost production well time)
- Higher ability to detect failures with additional monitoring

Automatic control of electric chokes gives better valve control accuracy… higher production
Rotating El-drive™ actuator key properties

**System capability**
- Very Compact (< 85cm high)
  - Easy to integrate and install
- Horizontal or vertical installation
  - Higher flexibility in system design
- Standardized interfaces and 4000 meter design depth
  - Standardized component, reduced cost
- Condition monitoring of valves and actuator (torque profile / internal sensors for integrity)
  - Ability to ensure operational integrity

**Reliability**
- Modular and flexible design with common qualified building blocks
  - Easily scalable and reduced cost for new generation actuators
- Dual motor/gear oil system
  - Longer life time
- Metal compensator
  - Ability to plan intervention
  - Longer lifetime
- Proven production method
  - Less cost and higher quality
Common building blocks

- Stackable modules enables easy reconfiguration
- Future flexibility with reduced need for redesign and requalification
- Thermal management through direct convection to seawater through enclosure for each module
- Easy to assemble and test
Electronics – shock and vibration testing

Analysis and design activities
- 3 Prototype stages prior to qualification build
- FEA analysis used as tool and input to modification of design
- IPC 610 inspection of final prototypes

Test results
- No resonance frequencies on board level with amplification above 5 below 500Hz
- No resonance frequencies with amplification above 5 below 250Hz.
- No notching during 2h random vibration
Sub-Module Qualification test

Gearbox
- Very compact, high performance (continuous operation at 1800Nm), Full traceability
- Patent pending axial alignment system
- FEM analysis completed
- Lifetime testing completed successfully

Motor Unit
- Tailor made
- Extensive theoretical analysis
- Lifetime testing completed successfully

System testing
- Qualified modules in system test
- Increased confidence and reduced risk
System pre-qualification test

Complete actuator system test
- Complete unit running in break bench
- Automated Veristand test system, with automated test cases
- Automated sequences on nominal (1800Nm) torque
- Early system test on engineering prototype

Formal System qualification testing
- Experience and risk reduction through early system testing
- Increased confidence and reduced risk
Manufacturability and serial production

Integrated product development
- Verified availability of components
- Producability of design verified

Qualified Production process
- Qualification units built on production line
- Secures high quality delivery
- Fully traceable components
- Contract manufacturer of electro-mechanical products
El-drive™ next steps and future applications

HIPPS and XMT actuation

- Proven electrical latched spring system for final elements
- Proof of concept system built and endurance testing completed on a 7 3/8” valve (TRL 2)
- Release can be done by
  - El-drive™ rotation actuator drive module or
  - segregated and released directly by SEM

Expansion of rotating actuator technology

- Subsea HPU technology
  - utilizing building blocks mounted to a standardized pump system
- Linear process actuator – gear expansion
  - utilizing building blocks mounted to a rotational to linear gear
All-electric Technology Enabler for Subsea

Enabling Future Subsea Systems

- SPS
- WOCS
- Pump
- Compression
- Processing
- SPA

Control Automation / Integrated Operations
Safety System (ESD + PSD)
Flow and Measurements

Vectus™ 6 and El-drive™ Technology
Processor platform, software library, HW/SW architecture, testing infrastructure
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