Subsea Electric Systems Enter a New Era

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Subsea Electric Solutions

Significant benefits subsea:

- **HSE**: no high pressure, no fluid discharge, no chemical exposure
- **Functionality**: speed, accuracy, retrievability, diagnostics
- **Cost**: standard units, no piping or cleanliness issues, no hydraulic fluid consumption
- **Field Upgrade**: Electric actuators may be retrofit subsea

General industry trend offers core technology:
Yr. 2001 FMC Vision: “Components to Systems”

Vision: Electric actuator applications

- Choke control (Field proven)
- Process tank level control
- Upon opportunity ELWIS (Wireless)
- Manifold valves
- E-LWI (hybrid)

Expansion of product portfolio from field proven system

- All-electric Production Control
- On selected fields

- Gas Compressor Surge Control
- Pilot inst. Possible

2001
2005
2010

Innovative Technologies, Creative Solutions
Vision: Electric actuator applications
2001
2005
2010
Application History

Main applications have been manifolds, chokes and flow modules. Some projects are:

2001 Statoil Statfjord SSP
- 16 eActuators and 4 eSCMs for choke actuation

2006 Statoil Åsgard
- 2 eActuators for manifold valve actuation

2006 Statoil Norne K
- 21 eActuators and 6 eSCMs for choke actuation

2008 Petrobras Albacora RWI
- 21 eActuators and 7 eSCMs for pump system valve actuation

2008 Woodside Pluto
- 1 eActuator and 1eSCM for pig valve actuation

2009 Statoil Gjøa
- 6 eActuators for choke actuation

2009 Statoil Norne M
- 2 eActuators and 2 eSCMs for pig valve actuation

2010 Petrobras Roncador
- 6 eActuators for water injection choke actuation

2011 Statoil Smørbukk
- 2 eActuators and 2 eSCMs for choke actuation

2011 Statoil Vigdis NE
- 2 eActuators and 2 eSCMs for choke actuation

2011 Statoil Åsgard Gas Comp.
- 79 eActuators for choke and control valve actuation

2015 Statoil Johan Sverdrup
- 43 eActuators for choke and manifold valve operation

2001-2015, Total Units Sold:
- 205 eActuators
- 38 eSCMs
FMC Experiences – Electric Solutions
Electric Choke Actuation

Electric choke valve control:

- Quick and accurate
- Choke vibration information and exact position available
- Actuator retrievable independent of choke
- Eliminates largest hydraulic fluid consumer
Manifold Valve Actuation – Distribution Simplified

Conventional Electro-Hydraulic Manifold

All Electric Manifold
Added functionality is not enough for easy sell…

«Cost of the choke and/or manifold control function needs to compete with the traditional hydraulic solution»

• Lean Engineering Principles adopted to solve the issue:
  – Cost simulation SW used during design of machined parts
  – Close collaboration with high end machine shop during development
  – Utilization of high end industrial components
  – In-house electronics development

G2i actuator (current)

G2 actuator (obsolete)
Lean Results – G2i actuator

Reduced number of parts & Combined functionality

G2i less than 50% of G2 cost
G2i family of eActuators (Choke & Manifold Version)

Electrically operated:
- Power & Communication via SCM
- Battery powered, trickle charged
- ROV installable
- Canbus SIIS Level 2 electrical interface
- API RP 17H / ISO 13628-8 mechanical interface
- High accuracy position and vibration monitoring
- Fail to position on loss of communication

Typical applications:
- Manifold Valves (5” - 22”)
- Choke Valves
Subsea Processing Plants

- Statoil Åsgard Gas Compression first user
- Statoil: All electric control an enabler
  - All electric a default – no hydraulics
- FMC Technologies chosen for largest contract ever for subsea electrical actuators
  - Field operating successfully
G3 eActuator (Processing Plants)

• 2 versions:
  – High Speed, for low torque valves
  – High Torque, for large bore valves

• Modular design
• Complete dual channel electronics
• Complete dual barrier oil system
• Weight for ROV installation
• 400V 3-phase 50Hz direct drive
• Power consumption 500W nom, max 1500W per channel
• Built in “flight recorder”
General Experience Summary (1) - Reliability

- Reliability has been good:
  - More than 8 million operating hours with FMC Technologies electric actuators with no significant issues reported

- Qualification processes including accelerated life testing tailored for “the electrics” proved to pay off:
  - Early detection of marginal seal solution (first generation)
  - Voltage dependent motor wire compatibility detected before deployment (first process valve actuators)
General Experience Summary (2) - Batteries

- More than 100 of the electric actuators supplied have featured trickle charged batteries
- In operation, the experience with the batteries has been extremely good – exceeded expectations
- Batteries simplify the infrastructure and allow design for average, not peak power
- Batteries are enablers for eliminating springs as shut down power sources
General Experience Summary (3) - Framework

- Industry Standard specifications are not suited for the transition to electric systems. E.g.: September 2016 proposal for API 17D change:
  
  Add to 7.10.1.1

  Actuated tree valves inboard of the wing and including the wing shall be designed to fail closed upon loss of hydraulic supply.

- Implementing electric solutions in projects with a hydraulic biased framework requires flexibility!
# Summary of Performance

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<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
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<tr>
<td><strong>Hydraulic System</strong></td>
<td>- Easy to create large forces for linear movements</td>
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<td>- Fail-to-position well established by spring return at power cut</td>
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<td>- Two different “utilities” required for a subsea system, hydraulic and electrical</td>
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<td>- Complex rotational actuation</td>
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<td>- Issues with cleanliness and compatibility experienced</td>
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<td></td>
<td>- HSE issues; discharge, exposure</td>
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<tr>
<td><strong>Electric System</strong></td>
<td>- Well suited for rotational movements</td>
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<td>- High speed and accuracy of rotational movements</td>
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<td>- Easy to do self diagnostics</td>
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<td></td>
<td>- Difficult to have a simple fail-to-position mechanism on power cut</td>
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<td>- Linear movements require some sort of transition mechanism</td>
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The new Era
Technology avenues

• Hybrid electrohydraulic systems needed going forward
  – Co-existence of electric and electrohydraulic functions

• Two options for safety (SIL) certified shut-down
  – Mechanical Spring
  – Electrochemical Spring (Battery)
eSpring - Electric fail safe actuator

• Electrically operated
  – No external hydraulic supply required
  – Features a small HPU per actuator

• For fail safe applications (SIL applications)
  – XT valves
  – For rising stem valves
  – Fail safe close by valve spring package
  – HIPPS

• ROV installable without need for buoyancy

Norwegian DEMO 2000 project with FMC Technologies, Total and Statoil – but open for additional participants
The new Era

- Field cases show 10 - 30 % CAPEX cost benefit
- Unparalleled interest from Major Operators – Pull & Push market situation
- Batteries and DC motors have had a major technology leap in the past 15 years
- Industrialization of subsea electrical products ongoing
- Electric DHSV progressing
- More than 8 million operating hours of FMC electric actuators
  - The positive results have exceeded our expectations
Thank You!