Improved Reliability, Cost Efficiency Spur Acceptance of Subsea Electric Actuation Technology

Any type of tree can be electrically actuated regardless of configuration, illustrated by the OneSubsea horizontal tree, including electrical actuators and downhole safety valve interface (illustration: Schlumberger)

Incremental implementation of subsea electric controls is quickening adoption of the technology. Operators who opt for incremental or full system implementation of electrically actuated subsea valves are benefitting from increased reliability and reduced capex and opex costs.

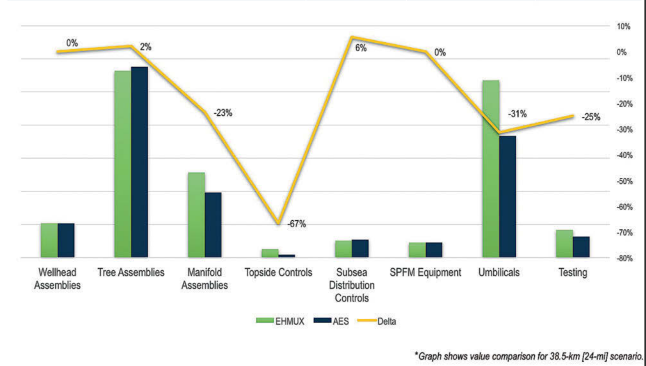
BY ANDREA RUBIO

Increased process control challenges for severe conditions in deepwater have and continue to drive innovations in the domain of subsea controls. More than 15 years ago, OneSubsea introduced electric actuation technology to enable reliable, safe, and efficient operation on the seabed. By using electric actuation technology there is no need for hydraulic fluids, therefore allowing systems to become less complex and more cost effective.

Approximately 12 years after testing the first fully electrically actuated system, has this technology been accepted and plugged in or is it still being proven? The answer is both. Operators continue to show interest in electric systems but the mindset that it is more costly to implement has stifled full system acceptance. As operators consider electric systems, studies being conducted consistently prove these systems are not only effective in terms of equipment and installation cost savings, but also in addressing multiple problems associated with electro-hydraulic control systems.

CO2 Capture Case Study

Stepout Distance	15 km [9 mi]	38.5 km* [24 mi]	90 km [56 mi]
AES savings vs. Electrohydraulic (SPS including umbilical)	11%	14%	20%



In a cost comparison between electro-hydraulic and an electrically actuated production system for use in a CO_2 re-injection project, it was estimated that a 20% savings or more than USD 20 million was possible with electrically actuated controls (illustration: Schlumberger)

Why Move Away from Electro-Hydraulic Systems?

Subsea system designs often involve a large number of remotely controlled processes that include controllers, instruments, and valves of various types and sizes. Some control loops require dynamic performance of valves normally not feasible using hydraulic systems.

Recognised persistent weaknesses experienced when using electro-hydraulic systems include susceptibility to fluid cleanliness, materials compatibility, hydrostatic effects in deeper water, performance limitations for long-distance tiebacks, and reliability issues attributable to hydraulic components failure. For long step-out systems, the performance of an electro-hydraulic system is problematic (slow charge-up, slow vent-down, slow valve opening, and long time between valve operations).

Environmental risks caused by hydraulics, such as leaking and venting, have become a more critical consideration. Other weaknesses of hydraulic drives include weight, complexity, and high maintenance requirements. There also exists a high incidence of thermoplastic hose and fitting failures.

Proven Development

Electrically actuated systems are subsea control systems utilising DC power and electric valve actuation as a replacement for conventional electro-hydraulic multiplexed subsea production control systems.

Since 2008, the world's only production system that is completely electrically actuated has been in service on the Total K5F field in the Dutch sector of the North Sea. The safety critical aspect of the design has not failed. In all situations, the electric actuators have been able to drive the valve to its "fail-safe" position. There are now 3-off Christmas trees in production for this field.

The key advantage of OneSubsea actuators is that the same mechanical fail-safe philosophy as in existing hydraulic valves has been maintained, wherein the spring return force will close the valve in case of a failure.

Milestones in Electric Actuation Technology

Since the late nineties, OneSubsea has been involved in the development of the electrically actuated production control system. In 2006, project execution began for the first electrically actuated subsea production system consisting of 2-off subsea trees with associated production controls system and intervention workover control systems (IWOCS). Delivery and startup of this field took place in 2008.

In summer of 2016, OneSubsea manufactured and installed a third electric tree for this field. This development included a novelty in the controls industry – the inclusion of an electric surface controlled subsurface safety valve, making this the industry's first truly electric tree.

Advantages and Reliability of an Electrically Actuated System

Improved system efficiency is an advantage of electrically actuated subsea production in most scenarios, particularly in ultra-deepwater fields or in long-distance step-outs. Electric motors maintain their high level of efficiency and full torque capability regardless of water depth, enhancing reliability.

In a traditional electro-hydraulic system, the hydraulic power unit (HPU) is by far the chief contributor to topside unavailability for the electro-hydraulic system, and the net result is that relatively a higher availability is predicted for the electric topside equipment. Elimination of hydraulic equipment more than offsets the predicted increase in electrical unreliability. This is due to the increase in the quantity of electrical connectors and an increase in electronics for motor control and subsea power conditioning required for the electrically actuated system. These factors are mitigated by the use of dual redundancy right through to the actuator gearbox.

Using high-voltage DC for long-distance power transmission is far more efficient and reliable than either AC power or hydraulic pressure. Even at distances beyond 500 kilometres (311 miles), the efficiency of DC power is 80 to 90% compared with less than 20% for low-frequency AC. This allows for a reduction in size of the conductors required in the umbilical.

The reliability figure for the electro-hydraulic umbilical system is based on the number of hoses, cables, hydraulic, and electrical connections involved in the umbilical system. For an electrically actuated system, there will be the same number of electrical connections in the umbilical distribution system; the hydraulic hoses and hydraulic couplers will, of course, be eliminated, which would improve the umbilical and flying lead reliability. Removing hydraulic tubing from the umbilical and lessening the number of conductors brings several advantages. The electrically actuated umbilical has a smaller cross section, allowing longer continuous lengths to be manufactured and spooled. Overall weight is reduced, facilitating the use of a smaller installation vessel. And, on very long step-outs, splices in the umbilical can either be minimised or eliminated.

Electrically actuated systems also have the advantage of increased safety and environmental cleanliness. Having zero discharge, electrically actuated systems eliminate the discharge of hydraulic fluid to the environment. Safety issues arising from the use of hydraulic pressure are avoided.

Cost Efficiencies Associated with the Electrically Actuated System

To date, a number of comparison studies have been conducted to perform preliminary engineering for exclusive projects with varying parameters; these studies consistently reflect significant savings and efficiencies are possible when using electrical actuation as opposed to electro-hydraulic control systems. For example, a comparison was undertaken for a CO_2 re-injection project whose scope included wellheads, trees, a manifold, subsea controls and distribution, umbilicals, and testing. An 8-slot manifold with pig launcher and receiver (PLR) connections for the branches was selected along with 6-off horizontal trees with PLR connection on the flow base. No chemical or annulus monitoring was planned for the umbilicals.

The study examined planned capex costs (equipment, installation, and commissioning). Cost savings with the use of electric actuation increased exponentially with the step-out distances that were designed for 15 km (9 mi), 38.5 km (24 mi), and 90 km (56 mi). At 15 km (9 mi), a savings of 11% was estimated while a savings of 20% was estimated at 90 km (56 mi).

Substantial savings were seen in the areas of manifold assemblies, topside controls, umbilicals, and testing. While there was a 2% increase in cost for tree assemblies with the electrically actuated system, there was a 23% savings on manifold assemblies, a 67% decrease in cost for topside controls, a 6% increase in subsea distribution controls, a 31% decrease in umbilical cost, and a 25% savings on testing.

Numerous other studies yield similar business case and technically efficient results, indicating that electric actuation technology can be a sustainable enabler toward making more subsea projects viable. Use of electric systems makes longer step-out distances possible, monetising stranded hydrocarbon deposits via a tie-in to existing production systems. Together with continuous system monitoring capabilities, electric actuation offers increased data that you can use to better understand performance of your subsea equipment, an important requirement for the development of future subsea fields.

Deploying a fully electric subsea production system can be an affordable and reliable option today. In the meantime, hybrid systems utilising electric and electro-hydraulic actuation can serve as a means to transition to all electric. Also, it is expected that system costs will continue to drop as the technology is deployed and efficiencies improve. Electrically actuated systems have the power to bring future subsea developments to fruition. ■

The Author:

Andrea Rubio is the product manager for electrically actuated subsea systems at OneSubsea, a Schlumberger company, where she has worked for the past 10 years. In this role, Ms Rubio leads the company's worldwide electric initiatives that encompass sales, marketing, engineering, and research and supports the innovation and development of new products and services within this field. In her career, Ms Rubio has held the positions of product design engineer, subsea engineering manager, and senior product analyst. She holds a degree in engineering physics from the University of Central Oklahoma, a master of science from the University of Oklahoma in aerospace engineering, and an executive MBA from the University of Houston.