InTech FOCUS

An *InTech* e-edition covering the fundamentals of automation

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Final Control Elements

Remote Mounting of Valve Positioners

IIoT-Enabled Control Valves

Understanding Valve Sensors and Switches

Hybrid Valve Actuator for Subsea Production

Introduction

Digitalization of industrial processes covers a range of systems and devices including final control elements such as valves, actuators and pumps. Industrial Internet of Things (IIoT) technology is transforming or enabling formerly mechanical devices to become connected, communicative and otherwise "smart," and the benefits are being realized in industrial plants around the world. This edition of *InTech Focus* concentrates on understanding the fundamentals of IIoT-enabled valve controllers, including the range of sensors and switches that can make valves and instruments smart, as well as the benefits of remotely mounting valve positioners. You can also get a early look at a hybrid valve actuator that is enabling all-underwater oil and gas production.

InTech magazine is the official publication of ISA—The International Society of Automation. It is published six times per year. *InTech Focus* is its counterpart, brought to you in conjunction with Automation.com. This series of electronic magazines focuses on the fundamentals of essential automation components, such as instrumentation, final control elements, networks, drives, and more. Six times a year, look for *InTech Focus* to learn how to choose instrumentation and control solutions, as well as apply them, calibrate them, and optimize their contribution to efficient operations.

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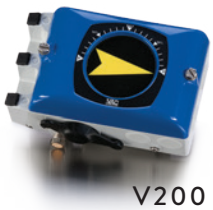

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MADE IN SWEDEN

Benefits of Remote Mounting of Valve Positioners

By Bob Goodwin

Reduce the frequency of maintenance and downtime while improving precision of control and reliability

Often, control valve packages are mounted in harsh environments where remote mounted positioners would be beneficial. Remote mounting is beneficial because it limits the number of sensitive components mounted directly to the valve package. The use of a remotely mounted positioner offers a solution to a tough control valve installation in the facility. We have seen the use of remote mounted positioners reduce the frequency of maintenance and downtime. In these particular

circumstances, remote mounting improves precision of control and reliability, as well as increases the quality of the process.

Remote mounting of valve positioners is not a new concept. The first remote mounting concept was a pneumatic positioner that requires a 3-15psi input signal mounted directly to the valve with an I/P module mounted remotely. This I/P module converts the electrical control input, typically 4-20mA at 24VDC, to a pneumatic output of 3-15psi for the valve positioner. This allows the I/P module to be mounted where its electrical circuits and delicate mechanisms are not influenced by the harsh conditions at the valve.

The I/P can be mounted free standing, or inside a panel. Mounting the I/P inside a panel allows the enclosure to meet an electrical classification, to be cooled in a high temperature area, or to be purged with air or inert gas to prevent a corrosive environment from affecting it. With this solution, the only connections that cross into the hazardous areas are the two pneumatic lines—one to provide supply pressure to the pneumatic positioner to power the valve actuator, and one low pressure signal line from the remotely mounted I/P module to the pneumatic positioner.

Using a pneumatic positioner with a remotely mounted I/P allows the positioner to be constructed of more durable materials and be designed to handle high vibration and high temperatures (above 300°F) that would not allow the use of electrical sensors.

Selecting a remote positioner

To properly select a remote positioner, the following factors must be addressed:

- The electrical classifications of the valve location as well as the surrounding area.
- The temperature of the valve and surrounding area.
- Any environmental conditions that you need to overcome such as corrosion.
- Any process conditions that you need to overcome such as shock or vibration.

Digital positioners change the game

With the introduction of digital positioners, the concept of remote mounting has to be altered. Many digital positioners are not available with construction suitable for use in explosion-proof/flame-proof areas. A potential solution to this is to isolate the sensor from the digital positioner's signal processing and air handling portion (head unit) of the positioner. The sensor may be a potentiometer, or Hall effect sensor. These are small enough that they can be mounted in existing enclosures suitable for use in hazardous electrical locations. The sensor is connected to the

Typical I/P used in a remote mount application.

positioner head unit with a low voltage cable. There will also be one more pneumatic line that connects the head unit to the valve actuator to power it.

Such digital sensors are particularly resistant to high vibration; however, it is difficult to find one to handle temperature higher than 210°F/100°C. That means very high temperature applications may not be the best application for digital products.

Applications using remotely mounted digital positioners also offer advantages for staff safety. One advantage a digital positioner can offer is full calibration capability without entering the hazardous area. This can prevent the need for hot work permits or the use of specialty personal protective equipment. The need for fall protection, ladders, man lifts etc. can also be greatly reduced as direct access to the valve location is not needed for calibration.

Digital positioner solutions are available in a variety of communication protocols with HART being the most prevalent. Other communication protocols include Foundation Fieldbus and Profibus. They can also be configured without digital communication capabilities where the positioner is microprocessor-based, but does not require your plant to have digital communication control systems or software installed.

The VAC line of quality positioner products includes the simple V100, versatile V200, the digital D400 and D500 high tier digital positioner.

Remote mounting for linear applications

Another type of remotely mounted positioner, used mostly in linear applications, utilizes the digital positioner's signal processing and air handling portion in conjunction with a third-party sensor. These sensors are often mounted parallel to or embedded into the cylinder and can include linear variable differential transformers (LVDT), inductive sensors powered by 4-20mA, or unpowered linear variable resistors (linear potentiometers).

These systems allow any stroke length to be used, or for positioners to be applied to a wide variety of equipment that uses pneumatic cylinders in modulating applications. They include dampers and damper drives, knifegate valves, and specialty equipment. The use of this style of linear sensors will require a close relationship between the positioner and actuator manufacturers to provide a fully integrated solution where the positioner and sensor in the actuator are matched to provide the best performance for your application.

If you have a persistent problem with positioner life or control valve performance, consider a remotely mounted positioner option as a solution.

Problems solved with remotely mounted positioners

Below are some examples of situations where offering a remotely mounted positioner has led to a solution.

1. The positioner is not available in the correct electrical area classification.

   Problem: A chemical plant has a control valve mounted within a Class 1, Division 1, Group B Explosion-proof environment. The desired Digital Positioner is not available with a Class 1, Division 1, Group B area classification.

   Solution: Their Digital positioner head unit with a Class 1, Division 2 Group B-G can be mounted outside the explosion-proof area perimeter. A sensor with the correct Class 1, Division 1, Group B certification is mounted on the valve within the explosion-proof perimeter and installed using the correct conduit and seal fittings to ensure that the installation also meets the area classification.

2. The damper is installed in a very hot environment.

   Problem: With temperatures at the damper location averaging 250°F/121°C electrical and electronic components fail rapidly or do not work at all.

   Solution: A Pneumatic positioner constructed with a Nickle plated housing, and silicone elastomers is mounted on the damper actuator. This construction allows the positioner to operate

continuously at temperatures up to 325°F/163°C. An I/P module is mounted in a cabinet nearby that is cooled using a fresh air, or a vortex cooler. The I/P module receives the 4-20mA electrical signal from the control system and outputs a 3-15psi pneumatic signal directly to the pneumatic positioner mounted on the damper actuator.

3. High vibration in a pipe causes instability in a control valve.

   Problem: High frequency pipeline vibration causes instability and oscillation of a control valve. Component failure in both the electronic and pneumatic parts of the positioner causes this instability.

   Solution: Separate the positioner head unit and its vibration sensitive components from the much more durable sensor. The positioner head unit can be mounted up to 33ft/10m away from the valve. The sensor is lighter more durable and able to withstand the vibration in the pipeline restoring control to the process.

4. Very wet or corrosive environment with daily caustic wash down.

   Problem: High pressure caustic wash down can cause corrosion and failure at electrical connections and of electronic components. The wash down fluid infiltrates any less-than-perfect seal and corrodes sensitive electrical/electronic components, causing excessive downtime and lost production.

   Solution: Install a corrosion resistant pneumatic positioner with a remotely mounted I/P module mounted in a tightly sealed cabinet located outside the wash down area. The Pneumatic Positioner with all O-ring seals aided by the natural purge effect of the bleed rate inherent in the pneumatic positioner design eliminates the ingress of the caustic. Remotely mounting the I/P modules moves them out of the wash down area preventing them from being damaged.

If you have a persistent problem with positioner life or control valve performance, consider a remotely mounted positioner option as a solution. Your positioner supplier may want to survey the location to ensure that you get the best possible solution for your needs.

ABOUT THE AUTHOR

With 24 years of experience in the valve and process industry, **Bob Goodwin** began as an inside salesman who then transitioned to outside sales. He has worked as an inside salesman, a field service technician, a territory manager, and a valve product manager. Bob first met Wayne Fleming, founder of VAC many years ago, he was working with a company who was an early adopter of VAC's V100.

As Bob transitioned through his career changes, he continued to market and sell VAC products. With a background in valve automation, over the past 8 years with VAC Bob has concentrated his experience around promoting valve positioners.

"A great thing about VAC is that titles don't really matter. We are a small company and everyone works closely together to provide the best possible solutions to our customers."

One project Bob is proud of is being a part of converting an entire plastic plant to VAC digital positioners. While it may take years to convert, the process of doing so is rewarding knowing he was able to help and advise the end user. Bob takes pride in being able to give our customers the creative, cost effective, and reliable choices that VAC offers. He is a "sales guy, but also a tech". His ability to deliver satisfaction to the customer both on a business relationship level and technically makes VAC proud to have him as our Eastern Regional Manager.

While Bob is out of the office and not traveling to visit customers, he could be found working on old, classic cars. He enjoys going for afternoon drives with his wife and dogs in his 1964 Buick Skylark. Bob also enjoys 3D printing. His 3D printing skills come in handy in our industry. He has created a wrench for removing the calibration port plug on a special version of the V200 positioner.

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Transform Operations with IIoT-enabled Control Valves

Plant production relies on the performance and availability of control valves, which makes them a top priority in IIoT projects

By Clint Schneider and Michael Lester

The promise of new technologies that help companies monitor their systems in real time, as well as collect and analyze data that lead to actionable insights, is an attractive one. With the constant pressure to increase plant profitability, how can organizations capture profit-making opportunities when there are so many areas of operations that require full attention? Skilled resources are limited, expert product support can be difficult to access, unplanned downtime and surprise repairs continue to deplete budgets, turnaround maintenance scope lists always grow larger than planned, and information the team needs to make sound decisions is disorganized or stranded at the component.

The answer lies in digitally transforming your existing systems and resources to enable a more efficient, predictive approach to maintenance that yields both immediate and long-term benefits to operations.

Technician using RFID reader to gather asset management tag information from an installed control valve.
Source: Emerson

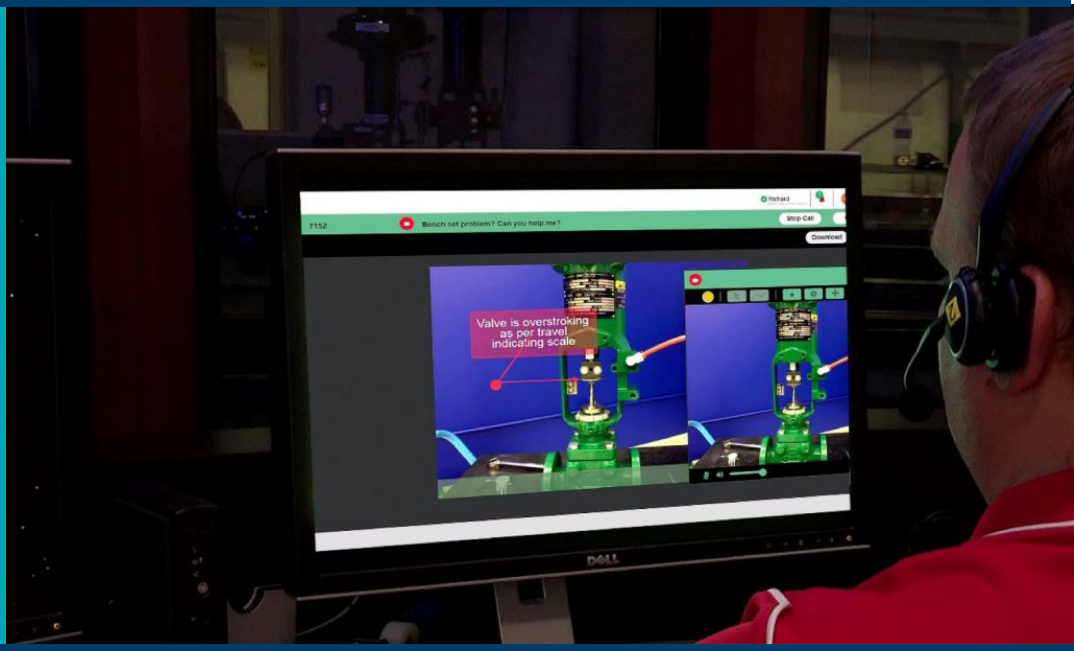
The valve—one seemingly simple component in almost every production environment—can be used to highlight the impact of digital transformation when the right technology is leveraged, and problems are predictively identified to better manage the entire lifecycle of a component. The key is to implement the level of digitalization that best fits your organization.

At a basic level, digital valve controllers enable valve calibration and positioning, and can perform in-the-field diagnostics. Taken a step further, digital valve controllers connected with software can introduce alerts and alarms and gather data from sensors. But getting the data is only a start. It is important to make sense of that data to drive real improvement. If skilled resources are limited, valve digitization can seem like a waste. After all, who will analyze this data collected? It's certainly not feasible to have valve experts at all sites, but remote diagnostics through valve condition monitoring is feasible.

Valve condition monitoring

Fortunately, there's a way to supplement your workforce expertise with an Industrial Internet of Things (IIoT) based service that strengthens valve reliability programs by collaborating with expert resources as an extension of your team. Valve experts utilize software packages that leverage empirical data models to guide end-user maintenance decision making.

How does it work? Diagnostic data is collected and securely sent to experts for further analysis. These valve experts compile a report complete with issue identification and actionable recommendations to work toward resolution. Additionally, technicians can come to your site to complete maintenance or add items to an upcoming shutdown work scope. Plus, with newly implemented technology innovations such as augmented reality, experts are available remotely for immediate support—which is another part of an overall digital transformation strategy.



Expert utilizing augmented reality software to assist on a control valve repair remotely.
Source: Emerson

Monitoring control valves using predictive technologies paired with the appropriate level of preventive maintenance and offline diagnostics offers the most comprehensive solution for complete valve reliability. In-service valve analysis provides additional insight by collecting data on vibration, acoustics, process variables and in-situ (online) diagnostics.

> Effective digital transformation requires personnel to have decision support tools and analytics, which enable faster and higher-quality decisions.

Tools for time series analysis can provide teams with the visibility to see the rapid increase of things like travel deviation before the impact is felt on other equipment or the process. This provides more time to analyze conditions that can cause travel deviation and allow for customers to capture more incremental value by earlier identification. This increased access to actionable information enables a reduction on maintenance spend, helps avoid process slowdowns or unplanned shutdowns, and transforms the maintenance strategy into a predictive approach that helps get ahead of potential problems before they impact operations.

Service efficiencies from IIoT technologies

When it comes to maintaining process equipment and repairing valves, a great deal of efficiencies can be realized. Think of all the tasks that can increase risk to your timeline, budget, and most importantly, people:

- locating valves in the field or in the stock yard;
- validating the construction of valve assemblies;

Experts analyzing the Valve Condition Monitoring report which indicates valve health and includes recommended actions.
Source: Emerson

- reading through written reports to determine work scope;
- shuffling through papers to find installation manuals;
- sending personnel into risky areas of the plant to find critical valves; and
- assembling and disassembling scaffolding to reach valves.

Integrating key technologies into these work practices can improve efficiency, safety, and effectiveness. Two of these technologies are asset management tags and remote assistance.

Asset Management Tags

Data-driven decisions lead to optimized operations planning and better management of your maintenance spend. Radio frequency identification (RFID) technology can gather that data and help you make those decisions.

Asset management tags leverage RFID technology to give you the ability to store and retrieve critical information about a valve's construction, service information, and regulatory certification on a digital chip that stays with the assembly. The tags are intrinsically safe (FM, IECEx, and ATEX certified) and rugged.

> Experts support customer requests through an augmented-reality platform that leads a user through steps to install, configure or troubleshoot valve issues.

Using a handheld RFID reader, the tag contents can be read and loaded into other software for further analysis. The data stored on the tag can be exported to a computerized maintenance management system (CMMS) to give you a full view of your operation. Using asset management tags, you can identify valves, record maintenance activities, and update re-certification dates more safely and efficiently.

Remote Assistance

Effective digital transformation requires organizations to give personnel decision support tools and analytics to enable faster and higher quality decisions. Leveraging embedded expertise to provide actional insights will improve performance. Remote services, such as Emerson's Remote Assistance, is another IIoT-based option for supplementing and supporting your workforce.

As part of this service, Emerson's experts are made available to support customer requests through an augmented-reality platform designed to lead a user through the necessary steps to install and configure or troubleshoot valve issues. This virtual platform enables support from trained

experts located anywhere in the world, without the travel time and logistic costs typically associated with such support. Expert annotation is anchored in the on-site technician's field-of-view, allowing them to confidently execute the trouble-shooting or maintenance activity. Technicians can receive immediate, expert support and better complete repairs to specification.

When implementing IIoT-based technology for your valves, information availability to support decisions for shutdown planning or emergency maintenance is greatly improved. Condition monitoring paired with live subject-matter-expert support is effective at helping maintenance personnel focus on the valves that need attention, when they need it.

These focused, flexible technology solutions can be easily deployed into your existing plant workflows and result in lower variability and increased reliability of your valves. By empowering personnel with data-rich insights, equipping them with the actionable information they need to make informed decisions that lead to measurable performance improvement in the areas of production, reliability, safety, and energy management.

Case Study: Middle East Hydrocarbon Production Company Adopts Valve Condition Monitoring

Status Quo

An energy producing company in the Middle East used the conventional, time-based plant maintenance practices. This means the valves in good condition were dropped and sent in for repair only based on a rotating calendar. Oftentimes, valves that weren't planned for repair had issues that weren't addressed because they weren't flagged for repair within the schedule. The producer couldn't plan for spare parts efficiently because they would have to attend to the emergency repairs that were out of scope, per the schedule.

The hurdles presented with the time-based maintenance led to delays for plant startup. The producer was experiencing increasing reliability issues with control valves at its sites and decided to investigate options to find a resolution.

Continued on page 17

Company Profile

- Delivers 36.83 billion cubic meters of natural gas to customers
- 3 compressor stations
- 23 gas supply stations
- 99.99% gas availability
- 57 gas delivery points
- 7 suppliers feeding into their network
- Gas delivery is 43% OLNG, 25% Power & desalination, 19% Industrial & commercial, 13% Oil operations

ABOUT THE AUTHORS

C. Schneider

M. Lester

Clint Schneider and **Michael Lester** are ISA members and employees of automation and control systems vendor Emerson. He is the director of reliability services for final control products at Emerson. Lester is a member of ISA's Smart Manufacturing & IIOT Division, ISA's Safety & Security Division, and more. He is the director of cybersecurity strategy, governance, and architecture for Emerson.

Valve Condition Monitoring is part of Emerson's Connected Services offering from its Plantweb™ digital ecosystem. Plantweb is a scalable and secure portfolio of transformational technologies, software and services that provide relevant personnel with enhanced insight to enable actions that drive operational excellence. To learn more, visit Emerson.com/DigitalValveServices.

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Digital Transformation

The producer began to explore IIoT solutions and plant digitization, so they met with Emerson to define key performance indicators from a Valve Condition Monitoring program. The team performed a site walkdown to validate the installed base and integrated the DVC6200 PD Digital Valve Controllers and ValveLink software.

As a pilot, the team started monitoring eight valves at a single site. When all stakeholders realized the ease of implementation and potential impact, the producer scaled up to 62 critical valves across its four sites the following year. Emerson's experts delivered reports on a weekly basis to provide insight and predictive actions.

Business Results Achieved

With Valve Condition Monitoring, the producer increased safety by minimizing human exposure to the process through reducing the frequency of plant walkdowns and identifying emissions issues early—which also helps ensure compliance with EPA standards. The producer eliminated unplanned downtime by taking all actions suggested by Emerson's analysts in the condition monitoring report.

The producer also optimized its inventory by identifying bad actors and is able to identify turnaround work scope more accurately to enact a more effective parts procurement plan. As a result, the producer has been able to extend the time between turnarounds by adjusting from time-based maintenance to condition-based maintenance.

The increase in predictive work decreased the emergency work and reduced the overall maintenance spend. The producer estimated the return on investment from Valve Condition Monitoring to be 40 percent of overhauling costs and has identified four additional sites—which include more than 100 valves—to be added to the monitoring scope the next year.

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Sensors and Switches for Valves and Flowmeters

Understand the wide range sensor and switch options available

By Honeywell Sensing

Flow meters can measure and regulate volumetric flow, velocity from which the volumetric flow is determined, and mass flow. Valves control or regulate the flow of gasses or fluids by partially obstructing, opening or closing the pipeline that carries the media. In many applications, they are operated manually by a lever, pedal, or wheel. Valves are often used in oil and gas, chemical manufacturing, water reticulation and mining applications.

Automatic valves with diaphragms or pistons are often actuated by changes in pressure, temperature or flow.

A wide range of sensors and switches, from simple on/off switches to electronic sensors designed to deliver system control, fluid level indication, temperature regulation, along with protection from overheating and starting/stopping the compressor are available. Various package options are available, too, including stainless steel, and those designed for hazardous and harsh-duty applications. There are also several main types of valves. This note describes the types of sensors and switches available for common valve and flowmeter applications.

Types of Switches

Hazardous-location limit switches – These specialized switches perform a number of functions, including monitoring the position of the valve stem, actuator or wheel position, providing on-off position on manual process valves, providing real-time valve status information for improved productivity and safety. As these limit switches are enclosed in an explosion-proof housing, any flame path is extinguished inside which mitigates the risk of causing an explosion at the switch part.

These switch components provide feedback for the user to take action in order to prevent explosions in hazardous environments. Hazardous- location switches are employed in valves in outdoor, above-ground, potentially explosive environments such as oil and gas or water treatment applications.

Figure 1. Sensing and Switching Products Used in Manual Process Valves

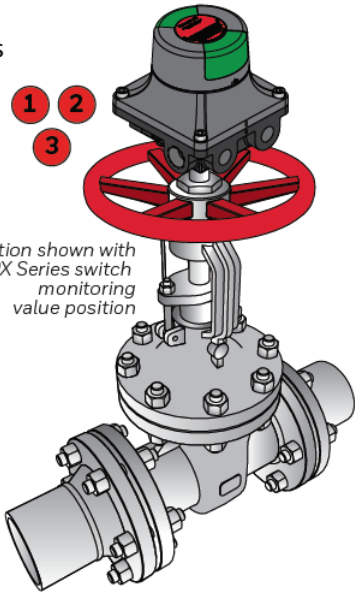
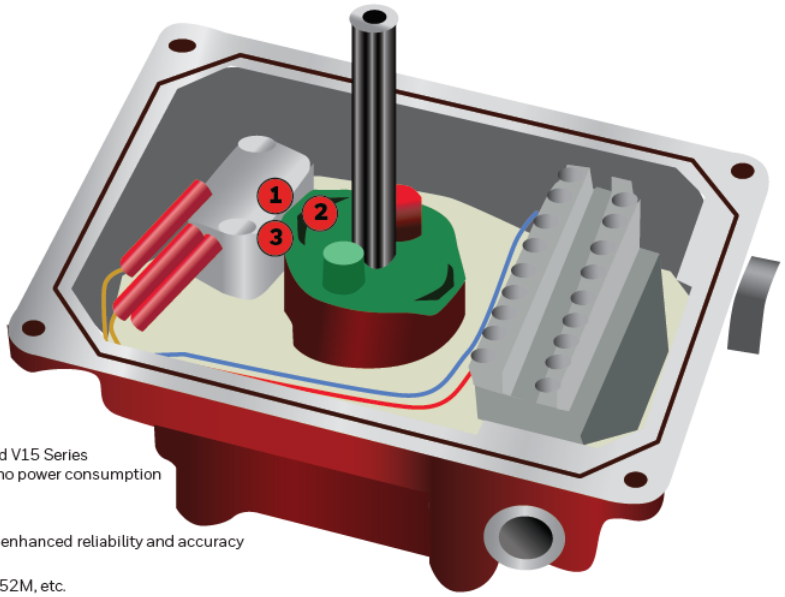


Illustration shown with VPX Series switch monitoring value position

1. **Hazardous Location Position Sensor**
   XYR6000 OneWireless™ Series
   Allows users to remotely monitor valve stem, actuator lever, or wheel position for improved productivity and safety, while reducing total installed cost in hazardous locations.
   Part of a scalable ISA100 mesh network
2. **Hazardous Area Limit Switch**
   MICRO SWITCH VPX/LSX/CX/BX/EX Series
   Monitors valve stem, actuator lever, or wheel position, providing real-time position status for improved productivity and safety in hazardous locations
3. **Limit Switch**
   MICRO SWITCH HDLS, GLS, and Double Break Series
   Monitors valve stem, actuator lever, or wheel position, providing real-time position status for improved productivity and safety

Figure 2. Sensing and Switching Products Used in Manual Process Valves with Actuators



1. **Snap-Action Switch**
   MICRO SWITCH™ BZ, ZW, V7, V15W2, and V15 Series
   Provides position sensing on cams with no power consumption
2. **Position Sensor**
   SMART Position Sensor
   Provides continuous position status with enhanced reliability and accuracy
3. **Hall-Effect Position Sensor IC**
   Hall-effect Series: 2SS, SS40A, SS41, 2SS52M, etc.
   Provides position sensing on cams

Limit Switches – Employed to monitor the position of the valve stem or actuator, limit switches are primarily used on valves in non-explosive environments such as wastewater treatment plants, power generation plant or other factory applications. They also allow users to remotely monitor the valve stem, actuator lever, or wheel position for improved productivity and reduced total installed cost in hazardous locations.

Wireless Limit Switches – Allows users to remotely monitor valve stem, actuator lever, or wheel position for improved productivity and safety, while reducing total installed cost with an economical wireless point-to-point solution.

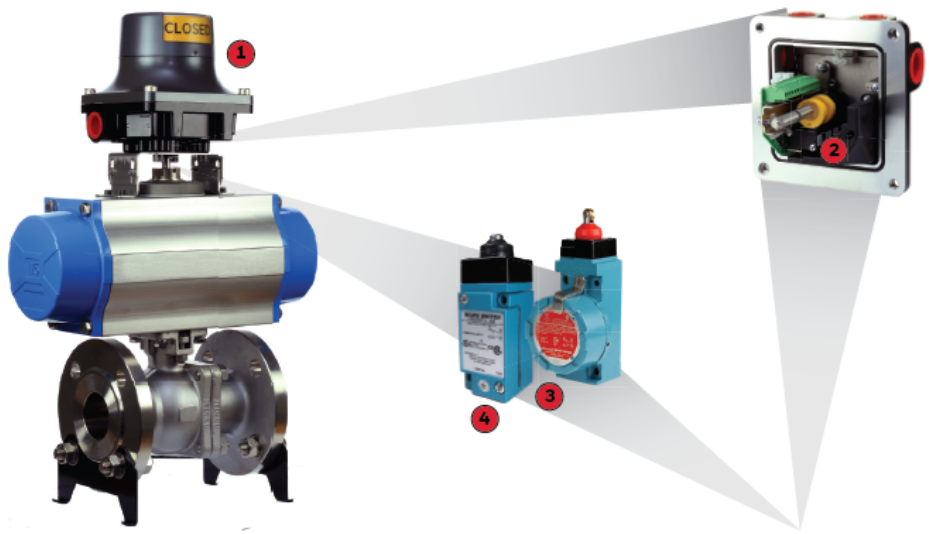
Basic Switches – Snap-action switches monitor the position of the valve handle by indicating if the switch is actuated. These switches are employed on valves used in both non-explosive environments such as wastewater treatment plants and/or other factory applications and also explosive/hazardous applications. In valve monitoring applications, basic switches perform position sensing on cams with no power consumption. In addition to valves, Honeywell's V15W2 Series is suitable for use in hazardous environments such as refrigeration, HVAC, appliances, and paint booths.

Hall-effect Speed Sensors and Sensor ICs – In flow meter applications Honeywell's speed sensors measure flow by monitoring revolutions of the impeller (an inside propeller). Each revolution of the impeller equates to the delivery of a certain amount of fluid. For example, if the user sets a fluid level of five gallons per minute, the speed sensor counts the impeller rotation so that the correct amount of fluid is delivered. In valve monitoring application, Hall-effect sensor ICS measure position sensing on cams.

Position Sensors – In flow meter applications, Hall-effect magnetic position sensors are used to determine valve position. In valve monitors, position sensors deliver continuous position status with enhanced reliability and accuracy.

Pressure Transducers and Switches – In valve actuator applications, pressure transducers and switches measure the pressure of the diaphragm to help regulate and control the flow within the pipeline. The sensors can measure differential pressure by comparing values

Figiure 3. Switches in Valve Actuators and Positioners



1 **Explosion-Proof Valve Position Indicator**
MICRO SWITCH VPX • Valve position indicator in explosion-proof housing

2 **Basic Switch**
MICRO SWITCH BZ, V7, V15, V15W2, and ZW Series • Large, miniature, and subminiature basic switches

3 **Hazardous Location Limit Switch**
MICRO SWITCH LSX, CX, and BX Series • Premium limit switches in explosion-proof housing

4 **Limit Switch**
MICRO SWITCH HDLS, GL, and Double Break Series • Premium heavy duty and standard global limit switches

across the valve. They can also give an indication of valve position related to opening and closing by measuring the pressure value at that time.

Types of Valves

Specifically, there are several main types of valves: Manual process valves, valve actuators/positioners, valve monitors/ indicators, valves and flowmeters, and sanitary and food/beverage valves.

Manual Process Valves – Manual process valves in industrial facilities control the flow of liquid, gas, slurry, or steam. Eighty percent require operators to manually open, close, or otherwise control the valve. At any given time, users may not know the actual position of the valve. Process plants, including refineries, chemical, pharmaceutical, and water treatment plants as well as power generation installations, all need a better way to verify status with or without human intervention, especially in hazardous or hard-to-reach locations. (See Figures 2 and 3)

Valve Actuators/Positioners – A valve actuator is a pneumatic or electric mechanism used in process control systems to automatically open or close valves. Actuators can be used with either linear or rotary valves in industrial, medical, food/beverage, and transportation applications. In standard valves, when the valve is given a command to open to a certain point, there is no feedback to verify that it has opened to that position. Valve positioners utilize a source of power to operate and continuously adjust a valve. The power source can be a manual gearbox or an electronic device with control and measuring devices; Available with hydraulic, pneumatic, and electric operating mechanics, these are often used in pipelines, process plants and in remote areas. Postioners can be used for opening or closing a valve to control the rate of fluid flow based on a signal from a central control system. With a valve positioner, the command is given and the valve positioner reads the opening, verifies position, and readjusts (if necessary) to the exact position needed which allows for excellent precision in the valve setting. (See Figure 4)

Valve Monitors/Indicators – Mechanical or electrical valve monitors and indicators are used in process control to show valve position. They provide an electrical signal, and sometimes visual feedback, to accurately monitor and verify that a valve is in the correct position. Valve monitors are mostly used in conjunction with a valve positioner/actuator to provide information from remote locations that are not easily accessed, or where power isn't readily available. Potential applications include chemical, pharmaceutical, power generation and oil and gas processes. (See Figure 4)

Valves and Flowmeters – Valves control or regulate the flow of gasses or fluids by partially obstructing, opening or closing the pipeline that carries the media. Valves are often used in oil and gas, chemical manufacturing, water reticulation and mining applications. In many of these applications, the valves are operated manually by a lever, pedal or wheel. Automatic valves with diaphragms or pistons are often actuated by changes in pressure, temperature or flow.

Flowmeters can measure and regulate volumetric flow, velocity from which the volumetric flow is determined, and mass flow. The turbine flow meter translates the mechanical action of the turbine

rotating in the liquid flow around an axis into a user-readable rate of flow (gpm, lpm, etc.). The turbine wheel is set in the path of a fluid stream. The flowing fluid impinges on the turbine blades, imparting a force to the blade surface and setting the rotor in motion. Nearly all flow meters must be installed so that there is a significant run of straight pipe before and after the location of the flow meter. This is intended to allow the straight pipe run to "smooth out" any turbulence produced by the presence of valves, chemical injectors and diffusers, and changes in pipe direction. (See Figure 5)

Sanitary and Food/Beverage Valves – Sanitary and food and beverage valves are engineered for pressure control in sanitary (or "clean") environments. They are usually manufactured with stainless steel for sanitary and high-purity applications. These valves are often constructed as a ball valve around a fullbore design that ensures the product passes through the valve with no restrictions on the flow with minimal pressure drop. Sanitary and food and beverage valves are often found in pharmaceutical, biotechnology, food and beverage, cosmetics, chemical and other industries where sanitary process control is required for steam, gases, and liquids such as water-for-injection systems.

FOR MORE INFORMATION

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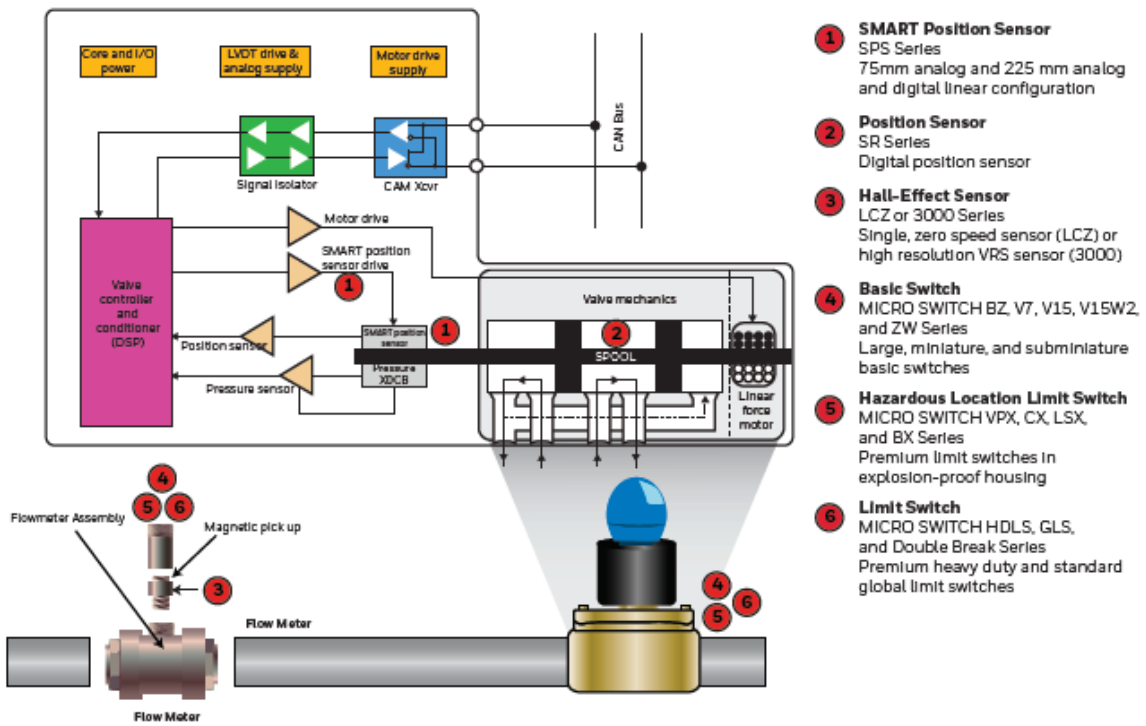

Figure 4. Sensing and Switching Products Used in Valves and Flow Meters

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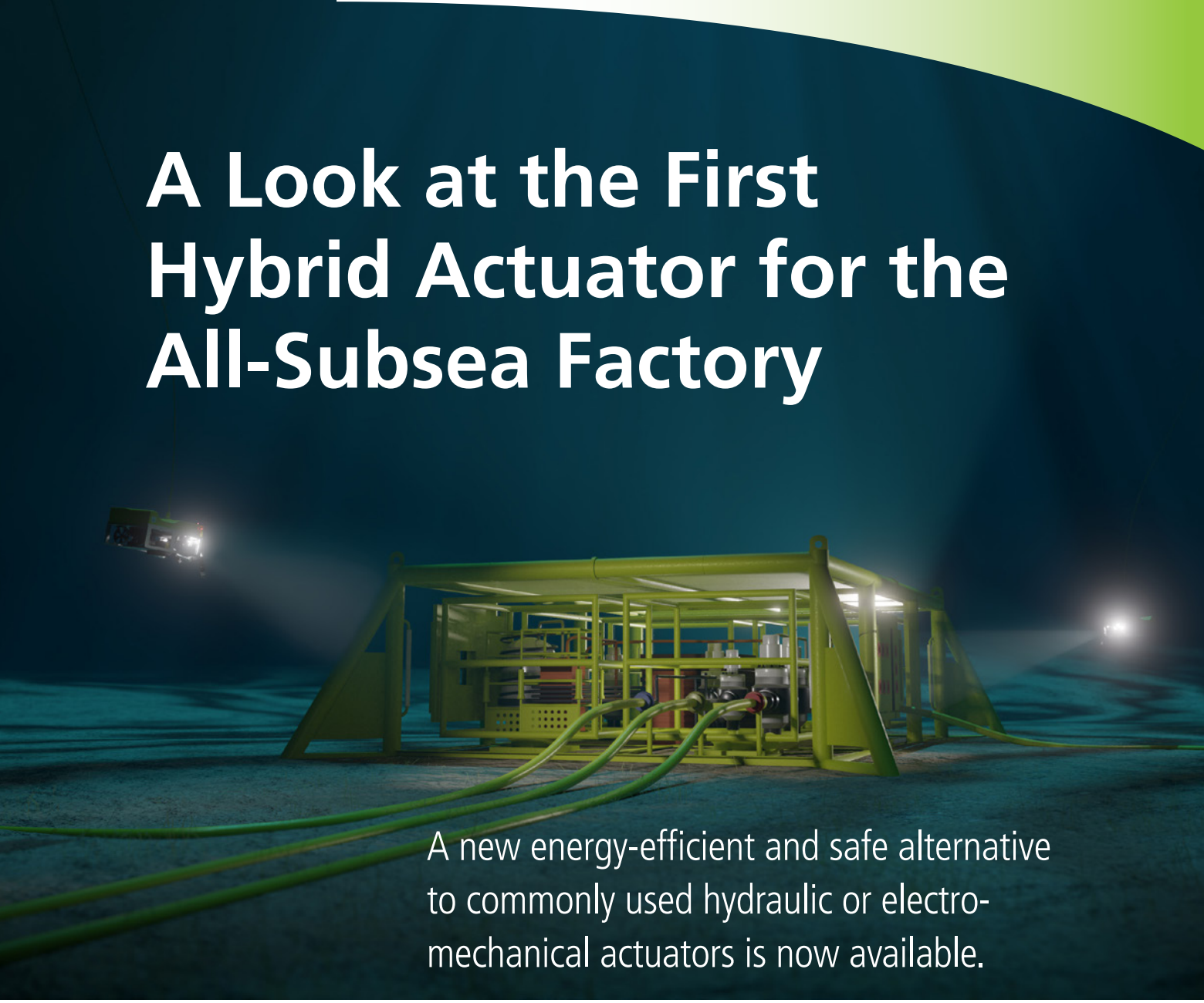
A Look at the First Hybrid Actuator for the All-Subsea Factory



A new energy-efficient and safe alternative to commonly used hydraulic or electro-mechanical actuators is now available.

By Dr. Alexandre Orth

Together with leading equipment suppliers and operators, Bosch Rexroth has developed a completely new concept for deep sea actuators. The best of electro-mechanics and electro-hydraulics in a compact unit for deep sea applications, the Subsea Valve Actuator (SVA) provides up to SIL3 safety, consumes up to 75 percent less energy and is designed for 25-years of operation. The system is suitable for use in the deep sea down to 3,000 meters and deeper, and is designed for maintenance-free operation for 25 years—making it a key component to promote the electrification of production systems in the deep sea.

For the first time, users can now use electrical underwater actuators with the field-proven safety of mechanical springs without having to oversize the electro-mechanics as has been necessary in

the past. In addition, the SVA is more compact, lighter and simpler in design and reduces energy consumption by up to three quarters. Furthermore, integrated continuous and automated monitoring of the system conditions significantly improves the diagnosis of the safety function.

The requirements for subsea production systems are extremely high: External pressure 300 bar, compatible with a saltwater environment, 24-hour operation 365 days a year, 25-year lifetime, no maintenance if possible. Operational safety is especially important for underwater systems that produce oil and gas, to protect people and environments. Additionally, protecting the sea from the pollution that intentional leakage of hydraulic fluid causes is now also a key priority.

Subsea Valve Actuators consume up to 75 percent less power at peak performance.

For each well, a system is used in underwater plants. Because of its similarity to its namesake plant, this type of system is known as a "Subsea Tree." Each "tree" controls the oil and gas production of its respective well via multiple process valves. The process valves are actuated by the SVAs, which in turn, receive their electrical control signals from the Actuator Control Modules (ACM). When required, they must safely close the respective process valve in every operating state, even during power failure.

Self-contained axes with a hydrostatic drive

With the recently developed SVA, Bosch Rexroth provides an energy-efficient and safe alternative to the previously used hydraulic or electro-mechanical actuators. SVAs are self-contained modules with their own closed fluid circuit. A variable-speed motor drives a robust hydraulic pump, which generates flow for the cylinder movements. A safety valve with a mechanical spring ensures the cylinder also changes safely into the fail-safe position if the power fails, without any external power supply. The cylinder, which opens and closes the well valve, can also be actuated externally by an underwater robot via an override. All key components of the drive train are installed redundantly. Altogether, SVAs provide safety on four levels with the redundant controls, the fail-safe spring and the intervention options from outside.

The benefits are especially clear when the solution is compared with the current state of technology. The vast majority of underwater actuators used around the world are still based on conventional hydraulics. This common structure has proven its durability and long-term safety over the past 50 years. However, operators still want to reduce the effort needed because conventional hydraulics require big, central hydraulic power units above water. These supply the actuators with fluid via lines, known as umbilicals, that can be kilometers long. At a working depth of 3,000 meters, several hundred liters of fluid accumulate in the lines alone. This is in addition to the demand for additional hydraulic accumulators and directional valves required for a complex subsea control module.

As the first alternative, equipment suppliers tried to set up electromechanical solutions. These only need to be supplied via power cables and connected to the ACM via a data line. However, because they have no external mechanical intervention options for adjustments, electromechanical solutions have safety-related disadvantages. Due to their lower power density, they also require bigger housings and electrical batteries. The design results in high friction, causing mechanical wear on the power transmission and reducing the required 25-year operating period.

For these reasons, electromechanical solutions are at a critical disadvantage for subsea applications when a fail-safe emergency closure is needed.

Combines benefits of hydraulic and electromechanical solutions

Rexroth's SVA combines the benefits of both hydraulic and electromechanical solutions and eliminates the existing disadvantages. The decentralized fluid circuit means the topside hydraulic power unit (HPU), subsea hydraulic control module and kilometer-long umbilical cords are no longer required for the fluid. The SVAs only require a power supply and a data line, like the electromechanical actuators.

The SVA is a self-contained actuator for opening and closing process valves in the deep sea. The system consists of an electrically controlled drive with a hydrostatic transmission, rather than a conventional electro-mechanical axis.

Hydraulic pumps generate the flow rate for the wear-resistant hydraulic gear. As a control principle, Rexroth uses a displacement system here, which regulates the flow rate with low friction from out of the rotation speed. This simplifies the design because proportional valves are not required and significantly increases energy efficiency. Compared with the purely electromechanical actuators, SVAs consume up to 75 percent less power at peak performance.

Considering all the actuators used to operate a subsea field properly, a huge cost saver for the electric infrastructure (power cable, transformer, frequency converters, etc.) can be obtained. The

motors can then be configured considerably smaller with the same adjustment force of the actuators, which in turn saves installation space and costs.

As part of its condition monitoring capabilities, built-in sensor technology continuously records the operating states within the actuator and reports them to the higher-level master controller. Trends can then be analyzed, allowing deviations to be identified and solved early.

Condition monitoring enables higher safety integrity levels, from SIL 2 to SIL 3

Self-contained industrial axes as a standard

Within the SVA, there are two bars of overpressure at every depth because of the redundant pressure compensation system. This prevents the penetration of saltwater and the need for large housings with a pressure-neutral design. Rexroth only uses underwater cables, even within the axis. All electrical components are also encapsulated. Rexroth's deep- sea specialists utilized the principle of self-contained axes for industrial applications when developing the SVAs. Bosch Rexroth produces the individual components in large-scale series. This reduces costs, creates long-term availability and guarantees production with quality management systems such as ones used in the automotive industry.

Where required, Bosch Rexroth has made modifications to the components for deep sea use. The manufacturer can draw on available concepts here, which are qualified for depths up to 6,000 meters. The system and core components also meet the special requirements of different classification societies for marine, offshore and subsea use.

Working closely with leading equipment suppliers and operators, Bosch Rexroth used the latest simulation technology for the "proof of concept" and built prototypes for field trials. This innovative drive technology combines the best of electromechanics and hydraulics to help ensure safe and reliable conveyance technology on the seafloor and make the vision of an "all subsea factory" a reality sooner.

ABOUT THE AUTHOR

Dr. Alexandre Orth is responsible for the Subsea Automation Systems at Bosch Rexroth. The Subsea Valve Actuator (SVA) from Bosch Rexroth was awarded the "Spotlight on New Technology Award" of the Offshore Technology Conference (OTC 2020). Suitable for use in the deep sea down to 3000 meters and deeper and is designed for maintenance-free operation for 25 years, the SVA is a key component to promote the electrification of production systems in the deep sea. For more information visit https://www.boschrexroth.com/en/us/, www.bosch.com, www.iot.bosch.com, www.twitter.com/BoschPresse