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The next generation of actuators

'Smart' electric actuators offer efficiency, flexibility and connectivity for process applications

With no need for compressed air, early electric actuators could operate with less sound and less maintenance than the predominant pneumatic actuator. Of course, the standard pneumatic option offered its own apparent benefits – performance in extreme temperatures, for example, and an elegant simplicity. As a result, the flow control industry has stubbornly clung to pneumatic actuators, specifically in the US market, for decades.

Now, this market is changing. In the next four years, the market for electric actuators in the US is expected to balloon by 17% annually. This shift comes amid growing interest in interconnectivity, in harnessing the Internet of Things (IoT) and enabling Industry 4.0. While the electric actuator was once a replacement technology for a pneumatic option, next-generation electric actuators offer new functionalities that make them distinct products altogether. These new actuators can connect to networks.

The difference starts at the core of these devices: the motor. Brushless DC (BLDC) technology is making electric actuators more efficient, more adaptable and more connected – and changing expectations for what an actuator can do.

How brushless DC motors think

Outdated versions of DC electric actuator motors use brushes to mechanically connect the rotating and stationary parts of the motor. The resultant friction is necessary for operation, but causes some undesirable outcomes. Brushes wear down over time and must be replaced. Sparking can occur, which can be dangerous in explosive environments. If pushed, the motors will overheat and damage components.

Another more popular option on the market, synchronous motors with AC power supplies, are brushless, but still present some meaningful limitations. For example, AC synchronous motors run at full torque and speed whenever engaged, so these models require downtime. They also lack 'smart' features.

Next generation electric actuators use BLDC technology. BLDC motors are engineered without brushes, instead utilising a 'smart' motor management system to control rotation. With no space wasted on brushes, these compact motors can provide more power and torque in the same dimensions as their brushed counterparts. Without the friction, these actuator motors also require much less maintenance. The brushless design of the RTK® REact DC enables 100% running time.

The RTK® REact DC electric actuator uses a smart controller, seen atop the BLDC motor, to intelligently adjust speed in response to changing conditions

However, a more consequential difference to the forward-thinking engineer than running time is the 'intelligence' of the controller. Because there are no brushes to regulate rotary motion, and no alternating current to alternate magnetism in the motor, BLDC motors charge segments of the stator in a circular pattern to propel the rotor with a moving magnetic field. In order for the system to control the motor's rotation, to 'know' where to align the stator's electromagnetic fields with the correct parts of the rotor, it gathers data on the speed and position of the rotor. To do this, Hall effect sensors are embedded to determine the relative position of motor parts.

These sensors enable intra-motor communication, which does not exist in other technologies. Essentially, they feed real-time information on the outcome of the controller's decisions back to the controller. The system can therefore detect a change in conditions by measuring how real outcomes differ from expected outcomes. For example, if changes to flow conditions cause greater resistance to the operation of the actuator, the Hall effect sensors will be able to sense that the rotor is moving at a lower speed than intended. Then, the intelligent controller will act on that information, accelerating electromagnetic rotations in order to make up for new conditions. This process is similar to how a driver would push down the gas pedal to maintain a car's speed up an incline.

Likewise, if flow conditions require less torque, the BLDC motor can reduce the amount of energy it uses. These 'smart' motors can independently match speed and torque to conditions. As a result, BLDC motors such as the RTK® REact DC

can reduce energy consumption by over 60% compared to synchronous motors.

Programming flexibility for flow control

Additionally, because the BLDC motor's sensors and controller are digital and not mechanical, operators can select the speed at which they want the motor to run. Synchronous AC motors are limited to one mechanically predetermined speed, torque and supply voltage, and each motor requires its own capacitor. So, in order to change the speed of an actuator in a system, a synchronous AC actuator must be replaced with another built to run at the desired speed.

For BLDC actuators, however, changing speed is a matter of programming, not replacement. Models can include switches to select a number of speeds. For example, RTK REact® DC actuators offer four speed presets that can be toggled by operators. The ability for a motor to self-regulate also serves as a maintenance prevention and safety feature; the REact® DC is programmed with over force limiting to protect the actuator.

This flexibility is a boon to process engineers. A system may call for an actuator at one speed with one supply voltage at a critical juncture. Before, a spare actuator matching those precise characteristics would have to be kept in stock. With BLDC actuators, one unit can offer four speeds and can operate with two different supply voltages. This means that operators can keep one BLDC actuator on hand as a backup component to cover the equivalent of eight distinct synchronous AC actuator types used in a process.

A still greater benefit is the flexibility this provides engineers seeking to optimise a system. Engineers often install an actuator with a certain speed only to realise that the control loop does not function correctly. Now, with BLDC actuators, troubleshooting engineers can simply change the speed of the installed actuator instead of replacing it to get a process up and running.

> "The BLDC actuator is a programmable tool able to deliver efficient actuation force according to changeable parameters"

Networking smart actuators for efficient processes

Importantly, the internal communications of smart motors can be networked and monitored on system-wide scales. Actuators such as the REact® DC feature LED lights to indicate actuating direction for easy maintenance, but operators no longer need to inspect each actuator by sight. The REact® DC is built to be networked. This allows operators to remotely monitor temperature, number of strokes completed, running time and actuator position, as well as flow direction and online/offline status for each actuator in a system. Then, operators can communicate with these remote units to make adjustments. This connectivity not only streamlines maintenance, as data can guide preventative measures before failures have a chance to occur, but can reveal data that can be used to make flow more efficient.

Excitingly, the hardware of today's BLDC actuator models enables connectivity now and in the future. Cutting-edge integration – REact® DC actuators feature Profibus and CAN-open integration – will surely be usurped by future communication systems and 'smart' actuators will require little retrofitting to function in these new networks. In the context of market growth driven by the desire to connect, the flexibility of the REact® DC reveals its most salient advantage here: whether one designs a network connected by USB to a central computer or to function with a mobile app using QR codes, the BLDC actuator is a programmable tool able to deliver efficient actuation force according to changeable parameters.

The new, smart actuator

While other actuators simply provide actuating force, BLDC actuators not only provide, but also monitor and adjust that force independently and on an ongoing basis – and according to parameters selected and reselected by operators. These capabilities put this new generation into a class of its own, but the greatest value to this technology is its networkability. As process engineers consider new electric actuators, they should consider BLDC models to unlock efficiency and future-proof their systems.

For more information:
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