

Choosing Electric over Hydraulic Actuation



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In comparing electric rod-style actuators to hydraulic cylinders, which offers you the best solution for your needs?

Hydraulics have been widely used for decades. However, many industries today are replacing their hydraulic cylinders with electric actuators. Hydraulic leaks, efficiency, and accuracy, are just a few reasons people are transferring technologies. Before deciding to replace an existing system these are some of the questions you should consider.

Selection of Actuator Type

Over time, factories and processes have become more automated. As technologies advance, there are more products available for engineers to select from when they are designing equipment. When looking at just the actuators, two of the main technologies are hydraulic and electric.

Hydraulic actuators can have some benefits in certain situations. They have a high power density, low component acquisition cost, moderate to high stiffness, high speed, and are a commonly used technology. However, hydraulic actuators can be less beneficial to an entire system. They have moderate accuracy and repeatability without the additional help of extra tuning equipment. They also have intricate and complex installation and maintenance due to the hydraulic pumps and tubing that are required. Additionally, they have a high installation cost, low energy efficiency, large environmental impact, and limited scalability and modularity. These are the cases where electric actuators offer a much better advantage.

Electric actuators offer high speed and force, are flexible and easily programmable for a variety of load conditions, have high accuracy and repeatability, are efficient, simple to install, require little maintenance, and are environmentally friendly. By not using a hydraulic system, the user can eliminate oil leaks, reduce pollution, and improve worker safety. Electric actuators are a non-toxic solution, which is a necessity in the food industry. Other environmental benefits of electric actuation include higher energy efficiency/lower energy consumption; quieter operation/lower noise levels; and near zero power consumption, when not in operation (hydraulic system pumps operating during idle periods consume substantial energy). In addition, there is no disposal of hydraulic fluids. During normal maintenance or repair of hydraulic cylinders, hydraulic fluids need to be disposed of properly.

Technology Advancements

Traditionally, electric actuators have not had the same power density as hydraulic cylinders, but with recent technological advancements, electromechanical actuators now can match hydraulic force performance in similar package sizes. One of the major advancements in

electromechanical actuation, include the pairing of a rotary servomotor coupled with rotary-to linear mechanical transmission such as a roller screw or ball screw. Roller screws have nuts running along a threaded rod that are geared with respect to each other and a nut housing much like a planetary gearbox. They provide more contact points than a ball screw, which means the applied force is distributed over a larger surface area, resulting in lower stress levels and longer life.

Rollers connect the nut with the screw, creating synchronized movement without recirculation allowing for higher rotational and linear speeds in applications where substantial force is required.

There is also less vibration and noise at higher speeds due to the absence of recirculating balls. The high load capacity of roller screws allows a smaller, more lightweight package than a ball screw — and to further optimize weight and package size, newer models of electric actuators combine the roller screw and the servomotor into one unit. The integration of the motor creates a smaller package size and reduces the number of components. Direct driving of the roller screw mechanism eliminates backlash due to couplings and drive trains resulting in higher dynamic response and better performance.



Along with the pairing of servomotors and roller screws, advances in brushless motors with feedback devices provide higher accuracy and repeatability. Traditional electric actuators typically use single or three-phase induction motors as their driving force. The problem with this design is when the actuator needs to change directions or start and stop; the operation is limited by motor temperature rise and therefore has limited duty cycles. Using a continuous-duty-cycle brushless dc motor along with the pairing of roller screws helps solve this limitation. The feedback device allows for very precise control of both the position and speed of the actuator output rod.

Conversion to Electric Actuation

There are challenges that occur when converting from hydraulic actuator systems to electric ones. If the system has more than one hydraulic actuator, the approach of a piecemeal conversion may be a more difficult process as compared to converting all machine axes at the same time. If you have harsh loading conditions, you should consider bumpers or adjusting the motion profile to alleviate impact shock loads and high vibration. Converting properly from one actuating method to another requires understanding how to size the new actuator appropriately. Measure the actual stroke length and consider the mounting configurations. A simple estimate of force produced from the existing hydraulic system, multiply the piston diameter by the pump pressure. However, this method is extremely conservative and often results in over-sizing of the replacement electric actuator.

For more detailed information on how to properly size and select your electric actuator, please visit www.exlar.com. Knowing the speed (measured time required for extend over retract), how many cycles per minute, hour and day, number of shifts or days per week the actuator is used, and the operational environment including the temperature, dust, liquid, and hazard conditions will help you to choose the correct actuator for your needs.

Industries and Applications Using Electric Actuators

Several industries are utilizing electric actuators for their systems. For example, in the automotive manufacturing world, robotic end tooling, robotic weld guns, bearing presses, and powering position arms all benefit by using electromechanical actuators. The ever-increasing demand for speed and repeatability with less downtime makes electric actuation a better choice. Food processing equipment uses electric actuators for volumetric filling, cubing, conveying, and indexing product. Precision as well as fear of contamination is causing food processing, pharmaceuticals, and medical device manufacturers to switch. The oil and gas industries are using electric actuators to replace hydraulic and pneumatic actuators



due to their environmental benefits and more flexible and precise control. Both hydraulics and pneumatics have the potential for leakage, creating possible hazardous conditions (i.e., contamination or ignitable gas). The military uses electric actuation for its carriers, door hatches, and munitions handling because of its clean, robust, longevity, and maintenance free performance for mission critical applications. Increasingly, electric actuators are providing more effective and complete control over motion.

Making the decision to change over a system from hydraulic to electric is no easy task. Evaluating your system and needs are primary factors in choosing electric or hydraulic actuation. Whether you require higher efficiency or less maintenance, it is clear that as technology advances and demand increases, electric continues to be a viable and competitive option in replacing hydraulic systems for most applications.