How to Select Valve Actuators for Rotary Valves

At times it is necessary for a process engineer to choose between a pneumatically or electrically actuated valve for a system. There are advantages to both styles, and it is valuable to have data available to make the best choice.

Compatibility (Power Source)

First and foremost in the selection of an actuator type (pneumatic or electric) is to determine the most effective power source for the actuator. Points to consider are:

1. Power source availability
2. Torque at the valve stem
3. Failure mode
4. Control accessories
5. Speed of operation
6. Frequency of operation
7. Plant environment
8. Size of valve
9. System component costs
10. System maintenance

The most practical pneumatic actuators utilize an air pressure supply of 40 to 120 psi (3 to 8 bar). Generally they are sized for a supply pressure of 60 to 80 psi (4 to 6 bar). Higher air pressure is usually difficult to guarantee and lower pressures require a very large diameter piston or diaphragm to generate desirable torque.

Electric actuators are often used with a 110 VAC power supply but are available with a wide variety of AC and DC motors in single phase and three phase.

Temperature range. Both pneumatic and electric actuators may be used in a wide temperature range. The standard temperature range of a pneumatic actuator is from -4 to 174^{o}F (-20 to 80^{o}C) but may be extended to -40 to 250^{o}F (-40 to 121^{o}C) with optional seals, bearings and grease. If control accessories are used (limit switches, solenoid valves etc.) they may not have the same temperature rating as the actuator and this should be considered in all applications. In low-temperature applications the quality of the supply air in relation to dew point should be considered. Dew point is the temperature at which condensation occurs in air. Condensate may freeze and block air supply lines making the actuator inoperable.

Electric actuators are available in a temperature range of -40 to 150°F (-40 to 65°C). When used outdoors an electric actuator should be sealed from the environment to prevent the introduction of moisture to the internal workings. Condensation may still form inside, if drawn from the power supply conduit, which may have captured rainwater prior to installation. Also, since motors warm the inside of the actuator enclosure when it is operating and cools it when it is not, temperature fluctuations may cause environmental "breathing" and condensation. For this reason all electric actuators used outdoors should be fitted with a heater.

It is sometimes difficult to justify the use of electric actuators in a hazardous environment, but if compressed air is not available or if a pneumatic actuator will not provide the operating characteristics required, then an electric actuator with a properly classified enclosure may be used.

NEMA guidelines

The National Electrical Manufacturers Association (NEMA) has set up guidelines for the construction and installation of electric actuators (and other electrical devices) for use in hazardous areas. The NEMA VII guideline reads

VII Hazardous Location Class I (Explosive Gas or Vapor)

Meets application requirements of National Electrical Code; conforms with specifications of Underwriters' Laboratories, Inc., used for atmosphere containing gasoline, hexane, naphtha, benzene, butane, propane, acetone, benzol, lacquer-solvent vapors, and natural gas.

Almost all electric actuator manufacturers have an option for a version of their standard product line that conforms with NEMA VII.

On the other hand, pneumatic actuators are inherently explosion-proof. When electric controls are used with pneumatic actuators in hazardous areas they are generally more cost effective than electric actuators. Solenoid-operated pilot valves may be mounted and powered in a non-hazardous area and piped to the actuator. Limit switches -for position indication- may be housed in a NEMA VII enclosure. The inherent safety of pneumatic actuators in hazardous areas makes them a practical choice in these applications.

Spring return. Another safety accessory widely specified in the process industries on valve actuators is the spring-return (fail-safe) option. Upon power or signal failure a spring-return actuator drives the valve to a pre-determined safe position. This is a practical and inexpensive option with pneumatic actuators and is an important reason for the wide use of pneumatic actuators throughout the industry.

Where springs are not practical because of actuator size or weight, or if a double-acting unit is already installed, an accumulator tank may be installed to store air pressure.

Electric actuators are not widely available in a spring return version; however, a battery back up system is an elegant solution. To accomplish the spring-return function an electro-hydraulic actuator is often a good choice. Electro-hydraulic actuation is achieved by energizing a hydraulic pump, which pressurizes a spring-return cylinder. Upon power failure the spring action drives the actuator to the original position. Because only an electric power supply is required for this self-contained unit it is a practical approach to fail-safe electric valve actuation.

Performance characteristics. Before specifying a pneumatic or electric actuator for valve automation it is important to consider a few of the key performance characteristics of each.

Duty cycle. Pneumatic actuators have a 100 percent duty cycle. In fact, the harder they work, the better they work.

Electric actuators are most commonly available with 25 percent duty cycle motors. This means that to prevent overheating in high cycle applications the motor must rest frequently. Because most on-off automated valves remain idle 95 percent of the time duty cycle is not usually an issue. With optional motors and/or capacitors an electric actuator may be upgraded to 100 percent duty cycle.

Stalling. Pneumatic actuators may be stalled indefinitely without overheating.

Electric actuators should not be stalled. Stalling an electric actuator draws excessive current, which generates heat in the motor and can cause damage. Torque switches or heat and current sensors are often installed in electric actuators to protect the device.

Speed control. The ability to control the speed of a pneumatic actuator is an important advantage of the design. The simplest way to control the speed is to fit the actuator with a variable orifice (needle valve) at the exhaust port of the air pilot.

Since electric actuators are geared motors it is impossible to make them cycle faster unless a gearing change is made. For slower operation a pulsing circuit may be added as an option.

Modulating control. In modulating service an electric actuator interfaces well with existing electronic control systems and eliminates the need for electro-pneumatic controls. A pneumatic or electro-pneumatic positioner is used with pneumatic actuators to provide a means of controlling the valve position.

Torque-to-weight ratio. Electric actuators have a high torque-to-weight ratio above 4,000 lbf.in. (450 Nm). Pneumatic actuators have an excellent torque-to-weight ratio below 4,000 lbf.in.

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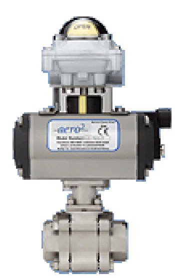

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