When to Select an Electric or Pneumatic Rotary Actuator with Quarter Turn Valves

Pneumatic vs. Electric Actuators

Automated valves need actuators to operate. Since their technologies are so different, determining whether to choose a pneumatic or electric actuator for a process system may seem confusing. Electric rotary actuators are known for their high levels of precision, control, and energy efficiency. Typically, they are used for on/off and modulating control with fail in last place upon loss of power. Pneumatic rotary actuators are initially less expensive, have less moving parts, and hence are easier to maintain. Pneumatic actuators are commonly used when spring return fail-safe conditions are required. For fail-safe applications, pneumatic actuators are less expensive than electric actuators, which require battery back-up for fail-safe functionality. Each technology has its inherent advantages and disadvantages and the criteria below should be considered to ensure the best actuator for the application is specified.

By Brian Booth – Assured Automation

1. Power Source

Determine the most effective power source for the actuator taking into account power source availability, valve torque, functional requirements, accessories needed, valve cycle time, plant environment, and valve size. While pneumatic air actuators are designed to operate between 40 to 120 psi, generally these actuators are sized for plant supply pressure of 60 or 80 psi. Plant air above 80 psi is usually difficult to guarantee at all times. Lower pressures, under 60 psi, will require large diameter pistons to generate the required torque.

Pneumatic Actuators are available in two main styles: rack and pinion, and Scotch Yoke (dual or single). Both of these rotary pneumatic actuator styles provide a compact and economical solution for quarter-turn (90 degree) ball valves, plug valves, butterfly valves, and dampers.

Electric actuators are commonly available in the following voltages: 12 and 24 Volt DC, and 24, 120, and 220 Volt AC, 1-phase. Some larger electric actuators will require 240/480 Volt 3-phase power.

2. Function

On-Off Valves

Both electric and pneumatic actuators can be used in on/off applications and typically operate in a 90-degree rotation, commonly understood as quarter-turn operation (180-degree rotation is available in some models). Scotch Yoke pneumatic actuators are limited to quarter-turn operation due to their inability to rotate the stem more than 90 degrees. Pneumatic actuators can also be used on 3-way, and 4-way valves, provided that the actuator is configured with the proper rotation to match the desired porting arrangement.

Modulating Control Valves

Both electric and pneumatic actuators can also provide modulating control where the valve can be controlled and positioned in between the fully opened and closed positions. This is done in a different manner for each.

A pneumatic actuator would use a positioner accessory which mounts on top of the actuator and controls the air pressure entering the actuator. The supply air flows through the positioner. There are pneumatic and electro-pneumatic positioner types available. Pneumatic positioners are controlled using a 3-15 psi pneumatic control signal, and electro-pneumatic positioners use either or 0-10 Volt DC or 4-20 mA electric control signal.

Electric actuators for modulating control are available using the same electric control signals as mentioned above. These actuators use computer circuitry to read the control signal, receive feedback from the valve stem, which in turn drives the actuator to its desired position.

Both types can provide a feedback signal if specified. Operating times on electric actuators typically run slower than on pneumatic actuators. This is true for both on-off, as well as modulating actuators.

3. Media

When working with flammable media, pneumatic actuators have the advantage of safety. Since pneumatic actuators are not an electrical component, they are not susceptible to any sparking, arcing, or short circuiting, therefore they can be used in hazardous (explosive) areas.

4. Hazardous Areas

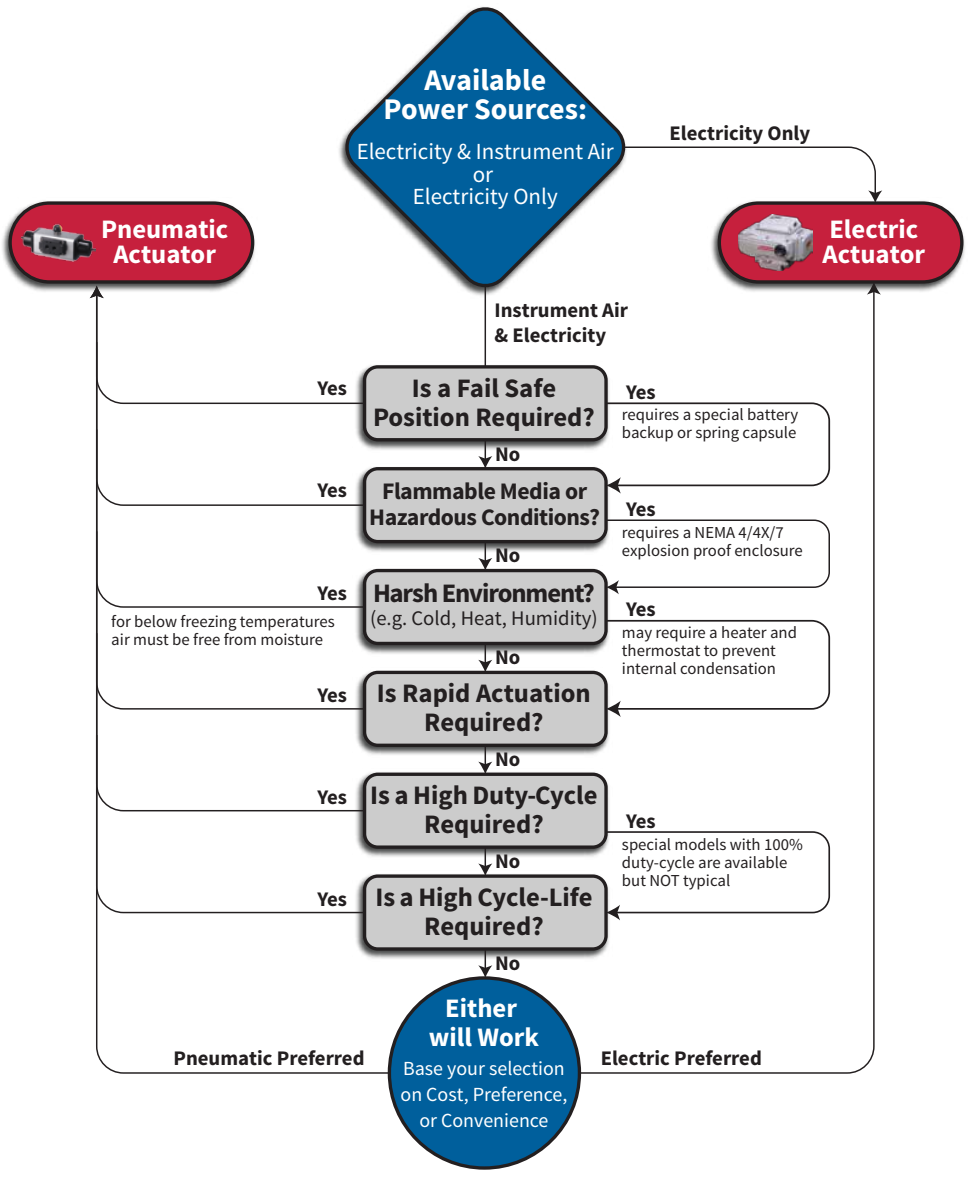
Pneumatic actuators are inherently explosion proof and are a good choice in potentially hazardous areas. However, **any electrical components such as solenoid valves, limit switches, and positioners must be rated for use in these hazardous areas.**

NEMA (the National Electric Manufacturers Association) has set standards for Electrical Component Enclosures. Always be sure to adhere to these for any electric components used.

Electric actuators are available and may be used in hazardous areas, as long as they meet the NEMA standards. Most electric actuator manufacturers have an enclosure option that does conform to Nema 4/4X, Nema 7, Class 1 Div1 or Class 1 Div 2 areas.

Outside the U.S. there may be additional certification requirements for electric equip-

Considerations for Selecting Electric vs. Pneumatic Valve Actuators



ment in hazardous areas. The table below provides a list of certifying bodies.

Ambient Temperature / Environmental Conditions

Pneumatic actuators typically handle temperature ranges between -4 and 175°F but can reach -40 to 250°F with proper seals, bearings, and mounting design. The quality of the supply air pressure in relation to dew point should be considered in low-temperature applications. (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 for temperatures between -40 and 150°F, but are also subject to problems due to moisture and temperature. When used outdoors, electric actuators should be rated for that environment to prevent moisture build up and subsequent potential damage. In outdoor environments, condensation may still form, due to the heating and cooling of the enclosure from the motor's heat. Electric actuators used outdoors should have a heater and thermostat accessory installed to maintain a constant temperature and eliminate the occurrence condensation.

Extreme Heat

When overheating is a concern, pneumatic actuators have an advantage over electric actuators, which may overheat if placed in hot environments, whether indoors or out.

Extreme Cold

On pneumatic actuators the supply air being used must be dry, or the air lines insulated in order to prevent condensation from forming and freezing, which would render the actuator inoperable.

5. Failure Position Upon Loss of Power

All actuators have a failure position. This is the position that the actuator will take upon the loss of power, be it air or electricity. There are three different failure positions: Open, Closed, and Last Position.

Spring return pneumatic actuators will move to the fail position upon loss of supply air. This can be open or closed, and is specified at the time of purchase.

Direct acting pneumatic actuators will simply remain in their last, or current position.

Electric actuators are not widely available with a fail position other than last, however, battery backups or spring capsules are available as options for some.

6. Performance

When deciding between pneumatic or electric actuators, key performance characteristics such as speed, torque, duty-cycle, and cycle-life should also be taken into consideration.

Speed

Pneumatic actuators provide faster actuation times in general when compared to similar sized electric units. Cycle time speeds can be controlled on pneumatic actuators using needle valves on the supply air line. Electric actuators will require a speed control module.

Torque

A good rule of thumb is that pneumatic actuators provide more torque when compared to an electric actuator of similar size and weight.

Duty-Cycle

Duty cycle is the period of time a component is "In-Action" vs. the time "At rest". If a component can run continuously, it has a duty cycle of 100%.

Most electric actuators have duty cycles less than 100% and can only operate intermittently without overheating. For example: If the actuator has a duty cycle of 25%, for every 1 minute of operation, 3 minutes of non-operation is required.

In general, pneumatic actuators can cycle continuously (100% duty-cycle). In some instances though, excessive rapid cycling can cause heat buildup due to friction.

Cycle-Life

Cycle-Life is the number of cycles that a valve or actuator can perform before requiring repair or replacement. Pneumatic actuators typically have a life cycle of 1 million cycles. In contrast, electric actuators have a shorter cycle-life, typically 10,000 to 15,000 actuations.

7. Cost

Installation is not the beginning and end of the deal. Costs often occur after installation. For example, in addition to the procurement and commissioning costs, there are the operating costs of actuator and personnel. Add to that the maintenance costs of inspection, rebuilding, and repair.

Certifying Body	Acronym	Office	Website
International Electric Commission	IED	Switzerland	www.iec.ch
European Committee for Electotechnical Standardization	CENELEC	Belgium	www.cenelec.eu
Factory Mutual	FM	USA	www.fmglobal.com
Underwriters Laboratories	UL	USA	www.ul.com
Canadian Standards Association	CSA	North America	www.csagroup.org
National Institute of Metrology, Quality and Technology	INMETRO	Brazil	www.inmetro.gov.br/english
Gosudarstvennyy Standart (State Standard)	GOST	Russia	www.gost.ru
National Electrical Manufacturers Association	NEMA	USA	www.nema.org
Atmosphères EXplosives	ATEX	EU	ec.europa.eu/growth/sectors/mechanical-engineering/atex/

About the Author

Brian Booth is Vice President of Sales and Product Manager for all thermal and remote shutoffs, including the FireChek® and FM Fire-Safe Emergency Isolation Valves at Assured Automation. The company is a leading provider of Automated Valves, Flow Components, and Fire Safety Products for industrial process control applications. Assured Automation provides state of the art automation ranging from small equipment manufacturers to the Fortune 500 manufacturing, chemical and pharmaceutical companies. The Assured Automation product line consists of a complete offering of standardized automated valve assemblies with a variety of commonly used accessory items. The company's complete valve automation services supply special automated valve assemblies designed around any specified products or particular applications. Full design capabilities are offered including AutoCAD, Solidworks or other commonly used design and drawing programs. In addition to standard products, Assured Automation develops customized solutions for specific customer requirements.