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 pinions, 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-
When overheating is a concern, pneumatic actuators are available for temperature control. Electric actuators are typically used indoors, while pneumatics are ideal for outdoor applications. Pneumatic actuators provide more torque when compared to electric actuators of similar size and weight.

**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. Direct acting pneumatic actuators will typically remain in their last, or current position. Spring return pneumatic actuators will move to the fail position upon loss of supply air. In extreme cold conditions, condensate may freeze and block air supply lines, making the actuator inoperable.

Electric actuators are available for temperatures between -40 and 190°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 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. Electric actuators are typically used indoors, while pneumatics are ideal for outdoor applications. Pneumatic actuators provide more torque when compared to electric actuators of similar size and weight.

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Current models with high duty cycle are available in both typical and fail safe modes. 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.

**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.

### 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 Shutoff 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 Assurred 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.