GREENHECK

Damper Application

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PRODUCT APPLICATION GUIDE

A technical bulletin for engineers, contractors and students in the air movement and control industry.

Actuators for Commercial HVAC Dampers

The purpose of any damper actuator is to control the position of a damper within an HVAC system. Selecting the appropriate actuator for a specific damper requires the consideration of several factors. This article will examine the actuator selection process.

Considerations in the actuator selection process

Note: Damper actuators may be referred to by other names such as damper motors, damper operators, motor-packs, etc.

To determine the most appropriate actuator for a given application, the following factors should be considered:

- Who will supply and install the actuator? Will it be factory-installed by the damper anufacturer? Or will it be supplied by others for field installation?
- What will power the actuator? Will it be manual, electric, or pneumatic?
- What is the actuator function? (i.e., Does it need to be "fail-safe"?)
- What type of control action will the damper perform? Will it be two-position, modulating, floating, or some other type of control?
- How much torque must the actuator deliver to position the damper positively and accurately?
- Other actuator considerations:
  - NEMA ratings
  - Auxiliary switches
  - Other options

Who will supply and install the actuator?

All major damper manufacturers can supply any commercially available damper actuator. Greenheck stocks a wide variety of damper actuators and can supply non-stock damper actuators if required.

A factory-furnished actuator may be ordered from the damper manufacturer installed on the damper or as an actuator kit (for field installation). Dampers may also be shipped without an actuator for cases where the actuator is supplied by the controls contractor.

A factory-installed actuator can reduce the overall cost while ensuring that the actuator is properly installed. Having an actuator factory furnished has the following additional advantages:

- Actuator sizing is optimized for the precise application of torque
- Full function operation testing of damper and actuator prior to shipping from the factory
- Increased reliability
- Less coordination of trades

Factory-installed actuators can be mounted internally (on the face of the damper, exposed to the airstream) or externally. External mounting may require the damper to be furnished with a sleeve or side plate to provide a mounting location external to the ductwork and out of the airstream.

It should be noted that the latest version of the UL555S Standard requires all actuators on UL Classified Smoke and Combination Fire Smoke Dampers to be furnished and installed by the damper manufacturer at the time the damper is manufactured.

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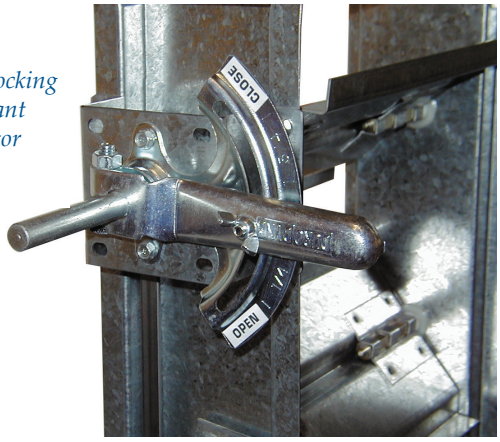
Will the actuator be electric, pneumatic, or manual?

If the damper is to be fixed in one position after initial adjustment (such as a balancing damper), or if its position needs to only be changed once or twice a year (for summer/winter changeover), a manual locking quadrant actuator may be all that is required. If the damper is required to operate automatically as part of an HVAC system, an electric or pneumatic actuator should be provided.



Manual Locking Quadrant Actuator

Currently, most control damper applications use electric actuators. They are available in a variety of drive configurations, however, the HVAC industry has standardized direct-coupled models because of the ease of installation and interchangeability. Electric actuators are available with supply voltages of 24 VAC, 24 VDC, 120 VAC, and 240 VAC. Each is designed for single-phase power. A transformer may be used to reduce high voltage systems (277, 460/480, and 575V) to meet actuator voltage.

Electric External Mount Actuator

Electric Internal Mount Actuator

Pneumatic Actuator

Pneumatic actuators are linear output devices that require instrument air (clean and dry air) for actuation and a linkage system to convert their linear motion to the rotary motion required for damper operation. They are provided with spring return operation, which returns the actuator's linear shaft to a fixed position when air pressure is removed. Pneumatic actuators are simple, reliable, and relatively inexpensive.

*NOTE: Pneumatic actuators should **not** be considered without an available source of instrument air.*

What is the actuator function?

Before an appropriate actuator can be selected, the damper's function in the system must be determined.

FAIL-SAFE

A "fail-safe" style actuator returns to a specific resting position when power is removed or interrupted. These actuators are typically used to return a damper to its open or closed position in the event of a power failure or other emergency. However, some actuators allow the user to specify a position using adjustable stops. If the actuator is electric, it will require a spring return-type actuator. Pneumatic actuators are inherently "fail-safe."

Note: Terminology used by the control industry can be confusing in this area. When an actuator is installed (or linked) to return the damper to its closed position upon power interruption, it is called a "normally closed" (or fail close) installation. An actuator installed to open the damper on power interruption is called "normally open" (or fail open). These terms bear no relationship to the normal position of the damper during HVAC system operation. Unless all parties are familiar with the control industry meaning of the terms "normally open" and "normally closed", it is suggested that the terms "fail closed" and "fail open" be used to prevent misunderstanding.

Note: When specifying or ordering "normally open" (fail open) the damper requires more actuator torque than "normally closed" (fail closed) in the presence of airflow.

SPRING RETURN

A spring return-style actuator, as suggested by its description, uses mechanical spring force to immediately return the actuator to a fixed resting position when power is removed.

NON-SPRING RETURN

A non-spring return actuator stays in its current position when power is removed.

What type of control action will the damper perform in the HVAC system?

TWO-POSITION

A two-position actuator is used when a damper is required to open fully to allow airflow and/or close completely to shut off airflow. If the damper position will not be changed on a regular basis, a manual quadrant may be more appropriate.

Two-position electric actuators are available in two general configurations. The simplest is the two-wire spring return actuator. This actuator is controlled by switching electric power on or off. Power "on" runs the actuator to its "on" position. Power "off" allows the actuator's spring to return the actuator to its "off", "normal" or "fail" position. Other configurations of two-position electric actuators require three or more wires and a three-wire SPDT (Single Pole, Double Throw) switching controller. These actuators are available in both spring return and non-spring return configurations.

Two–position pneumatic actuators work similarly by applying full air pressure (20 to 25 psi; English units) or no pressure to the actuator. They can be linked to open or close the damper at full pressure and vice versa at no pressure.

MODULATING (PROPORTIONAL CONTROL)

The terms proportional and modulating can be used interchangeably when discussing this style of damper actuator. We'll use the term modulating for consistency.

A modulating actuator drives the damper to any position between open and closed when it receives a control signal from some device in the HVAC system. These actuators can accept an analog control signal from sources such as a:

- Building automation system (BAS)
- Programmable logic controller (PLC)
- Measuring and control device

The most common forms of analog control signal are 0-10Vdc, 2-10Vdc, or 4-20mA. Modulating actuators respond to this type of signal in a linear fashion where a signal input of 0Vdc (or 2Vdc; 4mA) equates to one extreme position (typically closed) and a signal of 10Vdc (20mA) equates to the opposite extreme position (typically open).

1. Modulating control on electric actuators is available for several spring return, fail-safe, and other non-spring return actuator models.
2. Modulating control on a pneumatic actuator requires the use of an additional component called a positioner or positioning relay. A positioner regulates the supply pressure to the actuator to adjust its active position based on an input signal (i.e., higher pressure control air or electronic).

How much torque must the actuator deliver to position the damper positively and accurately?

Damper actuator torque (in English units) is rated in inch-pounds (in-lb). The actual torque required to operate a damper is affected by several factors, some of which are under the damper manufacturer's control, but some are not. The torque requirement of the damper itself is expressed in inch-pounds per square foot (in-lb/ft^2). System airflow and static pressure conditions are used to determine torque requirements, and to provide an appropriately sized actuator for each specific damper model and size.

Factors that affect damper torque requirement are:

- **Leakage**
  - Dampers with low leakage ratings, such as those certified to AMCA Class 1 & 1A standards, typically require more torque than lower performing models due to the added resistance of the blade and jamb seals.
- **System velocity and pressure**
  - Increases in system velocity and pressure also increase torque requirements.
- **Damper Construction**
  - Opposed blade dampers require slightly less torque than parallel blade dampers.
  - Manufacturing processes that allow the damper frame and blades to be made square (i.e., not twisted or racked).
  - Different types of bearing options.
- **Installation**
  - Damper is installed square and plumb (not racked or twisted).
  - How the actuator is installed on the damper.
- **Fail open operation**
  - Fail open requires more torque than a comparable fail closed application.

Always select a damper actuator with a rated torque that is greater than the damper's required torque. When in doubt, the next larger-size actuator is always the safest choice.

Greenheck conducts extensive testing on the actual torque requirements of dampers and actuators to ensure that we can confidently offer the most economical actuator suited for the demands of each application. This is especially important when working with smoke and combination fire-smoke dampers which are required by NFPA and UL to have factory-installed actuators.

Other actuator considerations

ENVIRONMENT

Damper actuators are intended for use in clean, dry, indoor applications. Actuators in harsh or outdoor applications may need protective enclosures. These enclosures match National Electrical Manufacturers Association (NEMA) ratings for weatherproof (NEMA 4) or explosion-proof (NEMA 7). These enclosures can affect the cost, installation time, and size of the overall damper assembly.

AUXILIARY SWITCHES

Electric actuators are available with a variety of accessories that may assist in the HVAC system's operation. A typical accessory is an auxiliary switch. Auxiliary switches are optional dry contacts built into the actuator that open or close at a fixed or adjustable position along an actuator's range of rotation (this is often at the end of the actuator stroke). It provides a signal of the damper's position to a building automation system (BAS) or some other control device(s). The exact functions and ratings of auxiliary switches vary by actuator model.

Auxiliary switches are used to turn equipment on (or off) when the damper reaches the desired position. An example of this would be to keep a fan from starting before a damper has opened far enough to permit airflow. Auxiliary switches are often fixed to operate at the end of the actuator's stroke. Some actuators, however, offer switches that are adjustable to operate at any point during actuator travel.

Summary

Selecting an actuator that meets all the requirements of an application is challenging due to the many available options. Improper selection of actuators being furnished results in project delays and extra costs.

Factory-installed damper actuators should always be considered when time and overall costs are a concern. The benefits of a factory-installed damper actuator often outweigh the time required to coordinate these actuator requirements in the field.

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