GREENHECK

Damper Application

DA/103-15

PRODUCT APPLICATION GUIDE

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

Actuators for Industrial HVAC/Process Dampers

Every damper installed in an HVAC system must be equipped with an appropriate actuator to accomplish its intended purpose. Selection of the actuator for a specific damper requires you to consider a number of factors. This article will examine the actuator selection process. (While damper actuators are often called by other names such as: damper motors, damper operators, motor-packs, etc., damper actuator is the appropriate terminology.)

Dampers are available with a wide variety of "factory-installed" actuators. However, many dampers are also supplied for "field-supplied" actuators. These are typically supplied and installed by the building controls contractor after the damper has been installed as part of the mechanical system.

Considerations in the Actuator Selection Process

The following factors must be considered when trying to select an actuator.

1. Who will supply and install the actuator?
2. Will the actuator be direct-coupled or be connected using linkage(s)?
3. What will power the actuator? Will it be manual, electric, or pneumatic?
4. What type of control action will the damper perform? Will it be two-position, modulating, or some other type of control?
5. How much torque is required?
6. Required operation time.
7. Other actuator considerations.

1. Who will supply and install the actuator?

All damper manufacturers can supply a wide variety of actuators. Standard location of actuators on industrial dampers is external (internal actuator mounting can sometimes be used in HVAC systems). When Greenheck supplies the actuators, it is factory-installed, tested, and cycled on the damper before shipment.

When you order the actuator(s) factory-installed by the damper manufacturer, it is usually less expensive and the best way to ensure that the actuator is properly sized and correctly installed on the damper. Greenheck can supply and install most actuators brands and models that are available.

It should be noted that the latest version of ULs Fire Smoke Damper Standards require all actuators on UL Classified smoke dampers be furnished and installed by the damper manufacturer at the time the damper is manufactured.

2. Will the actuator be direct-coupled to the damper's operating shaft, or will it be connected using crank arms and linkage?

In the past, many damper actuators required the use of lever arms (also called crank arms) and linkage rods to convert the rotary or linear output motion of the actuator to the 90° rotation required to operate a damper. Over the years, electric actuators with 90° rotary output designed to couple directly to a damper's operating shaft have become widely available. Use of these direct-couple actuators has greatly simplified the installation of an actuator on a damper by eliminating the need for arms and

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linkage, and the often-frustrating task of adjusting the linkages. Using direct-coupled actuators also ensures that rated actuator torque is applied directly to the damper's operating shaft which simplifies matching an actuator with the required damper's torque.

3. Will the actuator be electric, pneumatic, or manual?

Electric actuators are available with many different supply voltages. Most common voltages are 24 VDC, 24 VAC, 120 VAC, and 240 VAC. Additionally 360 VAC or 430 VAC three-phase actuators are also available. For "fail-safe" operation, spring-return models should be specified (battery backup systems are also available to offer "fail safe" operation).

Pneumatic

Pneumatic industrial actuators normally require an 80-120 psi instrument air supply system. An instrument air system ensures the availability of clean dry air. If such a system already exists or is to be installed as part of a new HVAC system, then choosing a pneumatic damper actuator is a viable option.

Pneumatic actuators have greater torque than electric actuators.

Greenheck stocks a variety of the more popular pneumatic and electric actuators.

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

Manual Quadrant

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

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

Will the damper be used to adjust airflow to a required design setting, and then be locked permanently in position?

This type of damper would be called a balancing damper and would most likely require only a manual hand quadrant or worm gear actuator.

Will the damper be required to open fully to allow airflow and/or to close completely to shut off airflow?

This is called two-position control. If operation is required only one or two times each year (such as for summer/winter changeover) a manual hand quadrant actuator may be appropriate. However, if operation is required on a regular basis, or if automatic changeover is desired, a two-position actuator should be selected.

Electric Actuator with Manual Override

Two-position electric actuators are available in two general configurations. The most simple 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) switching controller. These actuators are available in both spring return and non-spring return configurations.

Will the damper be required to control temperature, pressure, or airflow by moving to any desired position between open and closed as required by a controller?

This operation is called modulating or proportional control.

Actuators required to accomplish modulating control (positioning the damper to any position between open and closed) must receive a modulating control signal from some device (or controller) that monitors temperature, pressure, or some other condition in the HVAC system. The damper actuator selected must be compatible with the control signal generated by the controller. Most electric controllers used in commercial HVAC control systems generate a 2 to 10 VDC control signal (sometimes described as a 0 to 10 VDC control signal). Other controllers may put out a 4 to 20 milliamps DC (mA) signal. It is necessary to specify if the high or low end of the control signal range should open (or close) the damper.

When actuators are supplied as modulating units, most actuators also provide a method of damper feedback. This feedback can be supplied with the same 0-10 VDC or 4-20 mA as the input signal. Note that this feedback indicates the position of the actuator and not necessarily the position of the damper should the actuator slip on the damper shaft.

Direct digital control, or DDC as it is commonly known, uses digital technology to monitor conditions and signal changes required in an HVAC system. DDC controllers generally have provisions for an analog output (also called "AO"), usually a choice of either 2-10 VDC or 4-20 mA. Due to this feature, most DDC controllers can directly operate modulating electric damper actuators.

Will the damper be required to return to its open (or closed) position in the event of a power failure or other emergency?

If this is the case, a "fail-safe" actuator is required. This will require a spring return type actuator model to be specified (battery backup systems or capacitor options are also available).

Terminology used by the control industry can be confusing in this area. The standard terms of "normally closed" or "normally open" bear no relationship to the normal position of the damper during HVAC system operation. When they make reference to the actuators "normal" position, it's when power is not being supplied to the unit.

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

The damper's required torque is a function of its static torque and dynamic torque. Static torque is relatively constant throughout blade rotation. Dynamic torque varies with flow, pressure, and blade position.

Static torque, by definition, is contributing torque sources that are basically constant throughout the entire rotation of the damper blade(s). Sources of static torque:

- Bearing torque
- Axle seal torque (aka stuffing box torque)
- Jamb seal torque
- Linkage torque
- Unbalanced torque.

Dynamic torque is a force which changes as the rotation of the damper blades change. The flow acts differently against the unit creating a changing force:

- Velocity torque
- Pressure torque
- Blade seal torque.

Damper actuators should be sized with appropriate safety factors based on the functionality of the damper and the actuator. Clean air or on/off applications can successfully operate with 25% — 30% margins of safety. While modulating and dirty air applications should consider 50% to as high as 200% safety factors.

For further guidance on damper torque, please reference our application article, DA/102-11 Industrial Damper Torque – How the Options You Select Affect Actuator Selection and Cost.

6. Required Operation Time

As industrial dampers are used in a variety of applications, their desired operation time can widely vary. Typical HVAC applications usually request 15-30 second operation to move the damper from full open to full closed and vice versa.

Occasionally, a process application may require operation speeds of 5-10 seconds. In very special applications, such as emergency isolation, 2-3 second speeds, or faster, have also been specified. Damper designs are reviewed carefully if they are intended for higher speed applications, so the damper manufacturer must be advised at the time of ordering if this is intended.

7. Other Actuator Considerations

Normal HVAC indoor applications can be adequately operated with an actuator rated for NEMA 1 areas. However, other more exposed areas may require enclosures rated for weatherproof or explosion-proof (NEMA 4 or NEMA 7) environments. This will reduce the number of available actuators that can be provided for these applications and can also greatly affect the cost of the actuator.

Electric actuators are typically available with auxiliary switches. Auxiliary switches are used to turn other HVAC equipment on, or off, when the damper reaches a 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.

Industrial grade actuators usually require additional space to open and remove the covers to access the electrical compartments. If your installation location is in a tight, inaccessible space be sure to ask the damper supplier for the space envelope and clearance required to properly install and maintain the actuator assemblies.

Other actuator features that can be used and specified are:

- Visual indicator
- Motor brakes (some manufacturers don't require brakes due to gearing used in the units)
- Heaters and thermostats
- PROFIBUS or some other communication protocol
- Explosion proof options – many styles, types and levels of protection are available
- Special temperature requirement or heat protection.

Summary

The actuator selection process is not a simple one. Often the information necessary for you to select the appropriate actuator is not available. Unfortunately, this can result in improper actuators being furnished causing confusion and extra cost.

Furnishing two-position damper actuators, factory-installed is straightforward and causes few problems. Care should be taken, however, to carefully coordinate requirements when ordering modulating actuators for factory installation.

Factory-installed damper actuators should always be considered when time is available and overall costs are a consideration. 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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