AUTO-FLOW®

Airflow Regulation

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Final Control Elements

Bladder Valve

This unit consists of a metal housing with round duct connections on either end with a rubber bladder inside.

The device regulates airflow by using the internal duct pressure to inflate or deflate the rubber bladder in order to increase or decrease the volume available for airflow through the duct. The bladder valve provides decent linear control. However, the disadvantages of this device far out weigh its one good point. Since the device may be called upon to regulate volume in a fume hood its construction materials are immediately suspect because a rubber bladder would be susceptible to degeneration caused by chemical interaction with certain vapors. Also, since most air valves operate from system pressure their ability to react in a timely manner is severely hampered. Even in the case where an air pressure signal is directly supplied to the bladder, its response time would not be equal in both directions because the bleed off rate of air from the bladder is considerably less than the fill rate.

Commercial Butterfly Control Damper

This damper consists of a round metal blade fixed to a metal shaft mounted through bearings to a round metal body. These dampers may be provided with or without blade edge seals. Since this damper is not typically manufactured for precise blade-edge-to-damper-body-fit it is common to see blade edge seals in applications requiring high turndown (10 to 1), such as laboratories. In use a damper with blade edge seals experiences control hysteresis at low flow rates, making it very difficult to get responsive, stable control on the low end. Also, since the bearing and shaft design are not manufactured for concentricity or low friction this damper does not lend itself to the use of high speed electronic actuation.

An additional disadvantage of all dampers that employ metal blades is noise caused by the passing air hitting the metal blade. This device is generally actuated by pneumatic or time proportional electric actuators. These devices are non-linear in nature due to their quick opening flow curve.

Commercial VAV Box

This unit consists of a simple butterfly blade-style control damper, typically with blade edge seals.

This regulating device presents the same disadvantages as the commercial style butterfly control damper. The unit is generally actuated by either pneumatic or time proportional electric actuators.

Mechanically Characterized Butterfly Damper

This type of commercial butterfly damper design incorporates a means of characterizing the flow curve of the device. Characterization is accomplished by adding a restricting device to the blade. This device is only effective while the damper is operating on its low end.

While this configuration helps to make the flow effects of the damper linear it also adds some undesirable features. Characterization may involve additional moving mechanical parts that are subject to wear or failure, and it may add an additional surface where debris and/or contaminants can collect.

This type of device is generally actuated by either pneumatic or time proportional electric actuators.

Linear Air Valve

The linear air valve consists of a round venturi style body with a spring-loaded floating cone assembly mounted in the inlet side of the venturi. These devices are generally considered pressure independent between about 0.6" w.c. to 3.0" w.c. pressure drop. They function linearly through this range. These valves, by their nature, are very dependent upon smooth repeatable operation in order to function properly. Since this valve relies on a system where a cone assembly floats upon a stainless steel shaft with Teflon bearings, the design is very susceptible to condensable materials that adhere to the shaft and cause loss of pressure independence.

This device has some additional disadvantages in that it requires a fairly high minimum pressure drop of 0.6" w.c. Such a minimum requires the mechanical systems to be larger than what would normally be required, which uses additional energy. Also, this type of device is normally about five to seven times the cost of a standard control device even with flow sensing instrumentation included. Linear air valves are most often actuated by pneumatic operators.

Precision Butterfly Damper

This device improves on standard butterfly design in that it is constructed of thick wall PVC.Thick wall PVC provides the following advantages:

- ensures maintenance of blade-to-body-wall fit even after installation
- provides a good corrosive resistant material
- helps absorb noise

Additionally, the damper blade is manufactured from a precision machined, stainless steel reinforced disc of PVC. The precise machining of the PVC blade allows for a very good blade-to-body fit without the need for blade edge seals. Stainless steel shafts are fitted to the blade and mounted in frictionless Teflon bearings that are fitted to the damper body on a precise center. This technique results in very smooth control and good turndown.

Final Element Actuation and Linkage

Time Proportional Electric Actuators

These devices fit directly over a damper control shaft and control the position of the damper by turning the motor on for either clockwise or counterclockwise rotation. The amount of opening is determined by the on duration and the motor's average travel time. While these motors present a good means of linking the drive assembly to the damper control shaft for minimum loss of mechanical motion, they create major problems related to their slow mode of operation and their need for continual re-calibration of the zero position.

Conventional Pneumatic Actuation

These actuators come in two basic forms. The most common form is the spring-and-diaphragm. The other is the double-acting cylinder.

The spring-and-diaphragm arrangement requires air pressure be applied to the diaphragm in order to cause the actuator shaft to extend. To return to its rest position air must be removed, then the spring will drive the shaft back. The spring has a certain pressure range associated with it that allows the operator to be modulated with or without a pilot positioning device.This actuator has a different time response for each direction of travel.

The double-acting cylinder arrangement utilizes a piston enclosed in a cylinder which requires that air pressure be applied to either end of the piston in order to move the actuator shaft in or out. Loss of air pressure leaves the actuator in its last position. Since in this case the actuator does not have a spring return it must be used with a pilot positioning device. This device normally has equal response time in both directions.

The use of commercial grade current-to-pneumatic pressure transducers and pilot positioners will not provide for fast acting control response. These devices are designed for low volume rates of air delivery and exhaust. When they are coupled with typical pneumatic actuators they yield end-to-end stroke times in the 10 second range.

The speed of a pneumatic actuator is greatly increased by using industrial grade, high volume, high speed I/P transducers and pilot positioners. These devices are designed to supply and exhaust high volumes of compressed air in order to facilitate fast movement of the pneumatic operator. Typical pneumatic actuators combined with these devices yield end-to-end stroke times in the 2 to 3 second range. The major drawback to these devices is their high consumption of instrument quality compressed air, which contributes to increased maintenance and energy costs.

High Speed Electronic Actuators

These devices are specifically designed to actuate a precision butterfly damper quickly and smoothly. The actuator is a linear DC motor on a spring-loaded rack-and-pinon drive with optical position feedback. Since the drive motor is DC-based, a control signal is sent directly to the unit resulting a proportional linear movement. This device has an end-to-end stroke time of approximately 300 milliseconds (total 4 inches). Since a butterfly damper has about 3 inches of effective travel to full flow, the actuator will produce a minimum-to-maximum or maximum-to-minimum response of 225 milliseconds.

Assuming that a constant minimum must be maintained, travel time would always be between minimum and maximum. Since 3” is 75% of 4” when you assume linear travel time you take 75% of 300mS, which is 225mS. If travel is always from minimum to maximum or from maximum to minimum, then travel time will always be <225mS.

Linkage Designs & Control Hysteresis

Most commercial control damper actuator mounting hardware and actuator linkage designs are centered around the need for the devices to meet many different installation configurations and requirements. Because of this desired flexibility actuator linkages usually have a lot of play in them that results in loss of mechanical motion. In other words, there are some points where actuator movement does not result in actual movement of the damper. This effect means that there will be some points where physical movement of the actuator will not result in any effective change in control, a phenomenon referred to as hysteresis. Hysteresis results in poor control stability and affects the system’s ability to perform as desired. The actuator mounting, linkage, and damper shaft connection of the precision butterfly damper and the high speed electronic actuator are specifically designed to eliminate any loss of mechanical motion. The actuator drive shaft clevis is connected to the crank arm by means of a tight fitting pin mounted through a Teflon bearing and secured with a cotter pin. All play in the pin is removed by spring type washers.The crank arm is secured to the damper shaft by a bolt passsing through the shaft, not a setscrew. The actuator is mounted to the damper body on a single pivot point inserted in a Teflon bearing. This system effectively eliminates control hysteresis and provides for smooth tight control.