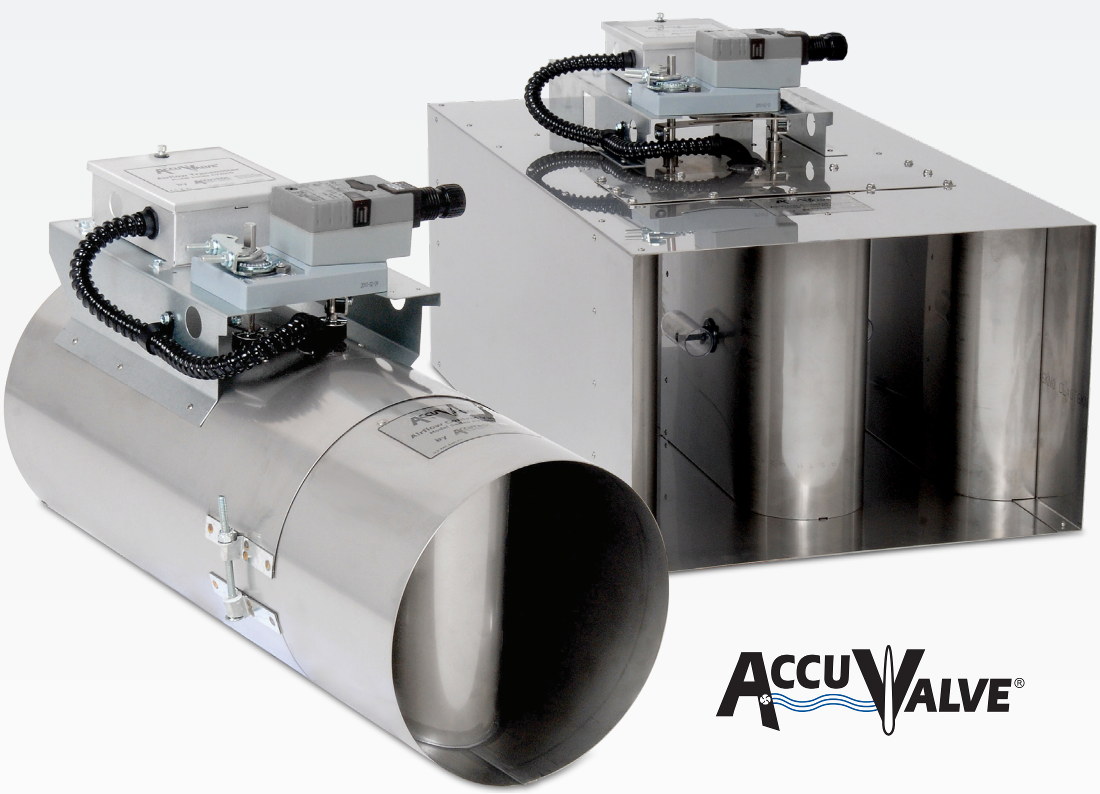
Airflow Measurement without Straight Runs

By Design



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General

When measuring airflow in ducts, it is important that the air impacting the airflow sensor has a uniform velocity profile. No airflow sensing technology is immune to this requirement. The less turbulent the airflow the more accurate the airflow sensor will be.

Often, these conditions are achieved through the use of straight duct runs before and after the flow measurement position. For insertion flow sensors, this is typically the primary method in which acceptable conditions can be achieved. The amount of required straight duct is generally determined based on the duct conditions such as elbows, takeoffs etc. (Figure 1, below). They are usually stated in terms of duct diameters upstream and downstream of the airflow sensor.

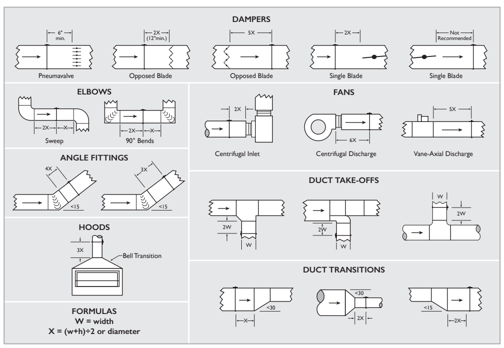

Figure 1

Straight duct runs is such a common method of improving measurement conditions, that it is easy to lose sight of the real issue. Flow sensors do not "need" straight duct runs, but they do need uniform velocity profile. There is another method which is incorporated into the AccuValve® that achieves the same result without the requirement for straight duct runs upstream or downstream of the sensor.

AccuValve® Design

With the understanding that all airflow sensors require a uniform velocity profile, the AccuValve was designed to develop this condition within the valve instead of using straight duct runs. There is rarely room in duct systems to allow for the necessary straight duct sections conventional insertion type airflow sensors require. In order to meet the accuracy and turndown requirements in these facilities it became imperative that a method be developed to measure airflow accurately without the need for straight duct runs into and out of the AccuValve.

Much like a silencer which uses the compression of air to remove turbulence, the AccuValve is designed with a compression section in the front half of the valve, which compresses the air increasing the velocity and making it remove turbulence (Figure 2, below). This is an ideal place for airflow measurement because of two physical phenomena that take place in the compression section; less turbulent airflow and increased air velocity. This eliminates the requirement for straight duct runs into and out of the valve and the increased velocity enables the sensor to read lower then if it was located in the duct section.

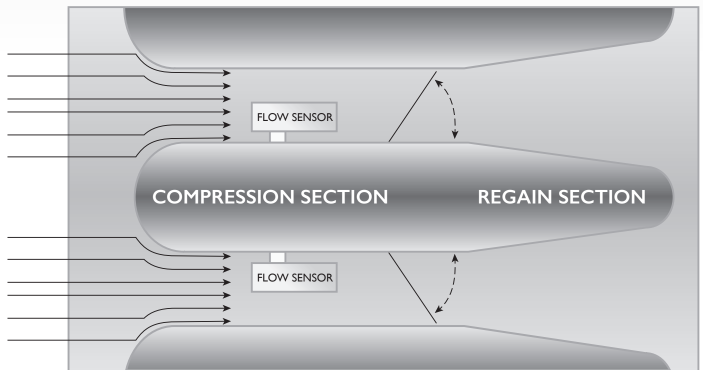

Figure 2

This compression effect has been used in airflow measurement for many years. Placing airflow sensors in the inlet bells of fans uses the same principal. The inlet bell is basically a compression section. The air entering the fan inlet is compressed removing turbulence enabling accurate airflow measurement in what would otherwise be very bad inlet conditions since there is often no duct run at all coming into the fan. Even if the valve has a 90 degree elbow at the inlet (Figure 3, below) the compression section develops laminar airflow enabling the velocity to be reliably measured by the vortex airflow sensors.

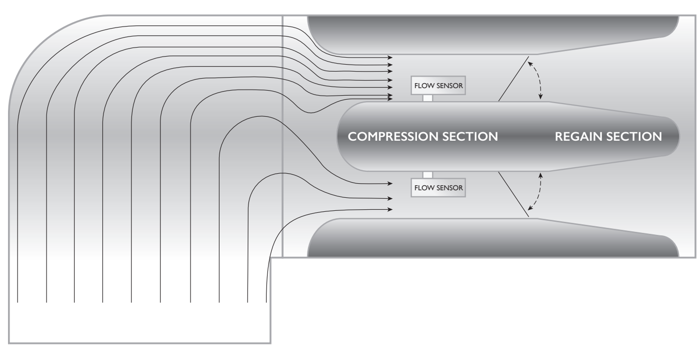

Figure 3

Lower Minimum Airflow Measurement – Greater Turndown

The AccuValve compression section reduces the area in the valve by roughly one half. This of course increases the velocity in each section by a factor of two. This enables the airflow sensor to measure one half of the airflow of the same sensor located in the duct in front of the valve. Figure 4 shows the velocity of the air before the valve and in the chamber of AccuValve. Any airflow sensor has a minimum velocity where it will measure accurately and vortex shedding technology is no exception. The minimum recommended velocity for the AccuValve vortex shedding transmitter is about 350 fpm. Using the increased velocity in the compression section we still measure to the minimum of 350 fpm however the velocity in the duct is down to 175 fpm. This effectively improves the minimum measurement capability by a factor of two.

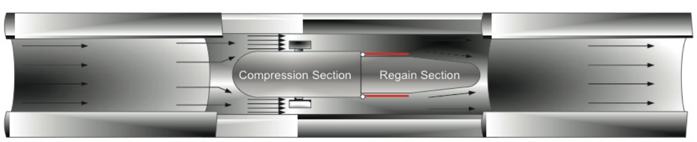

Figure 4

Effect on Pressure Drop

A concern that may come to mind is the pressure drop of the AccuValve®. As energy costs continue to rise it is important that any airflow control device have a minimal impact on duct pressure to ensure the lowest operating cost for the mechanical systems.

When doubling the velocity in the AccuValve it is important that the pressure drop is not significantly affected in the process. The AccuValve was designed with low pressure drop in mind. The compression section incorporates a streamline design to enable the air to be divided into the two sections while keeping the air in the boundary area of the shape thereby keeping turbulence and pressure drop to a minimum.

Also, a static pressure regain section was added to the downstream side (Figure 2, page 2) to enable the air to more gradually decompress again reducing turbulence and regaining much of the pressure loss associated with the compression section. Referring to Figure 5, the coefficient of drag changes based on the shape of the object in the airstream. It is easy to see why the airfoil shape was chosen for the AccuValve. The airfoil shape has the lowest coefficient of drag of any shape so it will have the lowest pressure drop associated with it. Much of the reason for this is the regain section on the downstream of the compression section which allows the air to expand naturally with minimal turbulence and also keeping the air in the boundary layer of the compression/regain sections. Every size AccuValve is tested in accordance with ANSI/ASHRAE STD 130 to determine the minimum pressure drop. Graphs showing the pressure drop of each size AccuValve at varying airflow rates are published in the Accutrol "Low Pressure Drop by Design" cut sheet.

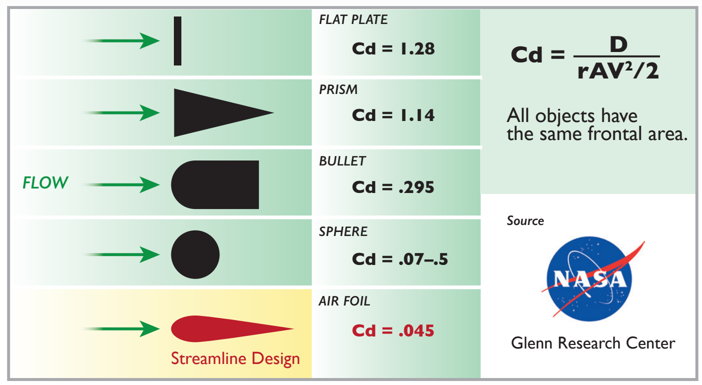

Figure 5

Summary

Measurement of airflow in critical environments such as laboratories, life science and healthcare enables the safest environment since the most critical parameter; airflow is measured and controlled. Older methods of airflow measurement in the ductwork required ductwork design considerations that were difficult and sometimes impossible in the tight spaces that HVAC engineers are limited to.

The AccuValve was designed with the HVAC design engineer and building owner in mind. Instead of requiring long sections of straight ductwork into and out of the valve to provide a uniform velocity profile for the flow sensor the AccuValve is designed to provide excellent conditions for the sensors regardless of the duct configuration into and out of the valve, making layout much simpler and simplifying the design process. This is in addition to using safer more reliable closed loop control.