
Airflow- A Critical Component

Introduction

Airflow measurement is a critical component when assessing an HVAC system. It helps ensure balance, energy efficiency and cost effectiveness of the system. The most effective way to test and verify these components is with airflow measurement instrumentation. These test instruments are called anemometers or thermoanemometers (if they measure temperature). Many anemometers measure airflow, air volume and temperature, while other parameters may include humidity, dew point, and static/differential pressure.

Anemometers are available in two technologies: vane anemometers and hot-wire anemometers. Each has its application limitations, but hot-wire anemometers are more common due to the wider airflow range measured. Manometers are another test instrument that can measure air velocity and volume, but is most commonly used to measure the static and differential pressure of a system. Finally, capture hoods provide direct measurements of air volume through supply and exhaust readings of grilles and diffusers.

Vane Anemometers

A vane anemometer functions by the airflow stream hitting the vane, making it rotate. The rotation of the vane blades is sensed by a magnetic or optical sensor, which converts the signal to a direct Feet Per Minute (FPM) velocity measurement. One characteristic of the vane anemometer is the capability to average air velocities at supply openings, walk-in ducts and filter banks. Cubic Feet per Minute (CFM) calculations are possible by entering the square feet of the vent into the meter.

The most common vane diameter is four inches, which contains ball bearings that prevent, or minimize friction during rotation. An arrow is located on the vane head, which identifies the direction the airflow must travel through the vane to obtain proper measurements. Vane anemometers provide an average measurement range from 50 to 6000 FPM. This range provides an application limitation, since it needs a minimum air velocity to rotate the vane for an accurate reading.

Accuracy is also affected by the angle of the vane in respect to the airflow. An angle of +/-12 degrees typically associates a one percent error to the accuracy of the measurement. The readings are in Actual Feet of Air at its existing density which results in Actual FPM. If Standard FPM is required, multiply the anemometer reading by the actual density divided by standard density.

Mechanical vane anemometers, or swinging vanes, are easy to use and provide direct air velocity measurements without batteries or power. The air stream enters a chamber and

moves the swing vane, which is directly correlated to a FPM measurement. The movement of the vane is frictionless, therefore creating smooth and accurate movement.

Hot-Wire Anemometers

Hot-wire anemometers operate on the principle of heat transfer. The wire element is heated above ambient temperature by passing a current through an electrical resistance, and the energy is converted to heat. The heat is then passed on to the air passing the heated wire element. The meter sends more power to the heated wire to maintain the initial temperature at zero airflow, which converts the power signal to an air velocity measurement displayed on the LCD.

Hot-wire anemometers feature small diameter probes that allow measurements in tight spaces and hard to reach areas. The average measurement range spans from 0 to 10,000 FPM, providing an ideal test and measurement instrument for low-flow applications. The limitation for these anemometers is a maximum temperature tolerance of up to 200° F, limiting them to applications in ambient conditions.

Manometers

Manometers are instruments that measure very low pressures, such as static and differential pressure across filters and between rooms. In conjunction with a pitot tube, a manometer can convert pressure readings into air velocity (FPM) and volumetric (CFM) measurements.

Pitot tubes are stainless steel, double-walled tubes for measuring total and static pressure in ducts and air plenums. The inner tube measures the total pressure, while the outer tube measures the static pressure. The difference between the total and static pressure measurements is known as velocity pressure, or differential pressure (inches H2O). To convert differential pressure (inches H2O) to air velocity (FPM), use the following formula:

$$\text{FPM} = (4005)(\sqrt{\Delta P})$$

Where ΔP = Differential Pressure

When measuring differential pressure, connect a rubber hose from the total pressure port of the pitot tube to the positive input of the manometer, and a hose from the static pressure port to the negative input of the manometer.

Capture Hoods

When measuring volume of air exiting grilles or diffusers, a capture hood provides convenience, time saving, and a one-step, direct volume measurement. Capture hoods are configured with fabric skirts and frame supports to cover grilles and diffusers to channel airflow through the base to directly measure air volume (CFM). The sensors measuring the airflow are normally hot-wire sensors, which provide quick and continuous measurements to the hood's display.

Since the hood is covering the grille or diffuser, flow resistance is created against the air system. To determine the effect of the resistance and the impact on the accuracy of the measurements, duct traverses should be performed. The difference between the measurements with and without the capture hood over the diffuser is the flow resistance that could affect the readings.

A correction factor must be determined to achieve the most accurate air volume measurements, taking the flow resistance into consideration.

$$\text{CF} = \frac{V \text{ (no hood)}}{V \text{ (hood)}}$$

Where:

V (hood) = Flow rate with capture hood in place.

V (no hood) = Flow rate without capture hood (duct traverse measurement)

CF = Correction Factor

Once the Correction Factor (CF) is determined, apply it to the following equation for the most accurate airflow measurement:

$$\text{V (corrected)} = \text{CF} \times \text{V (measured)}$$

Where:

V (measured) = Volume rate measured by the capture hood

V (corrected) = Corrected value for the flow resistance of the capture hood