FLUKE®

Fundamental IAQ/HVAC measurements with the Fluke 975 AirMeter™

Application Note

The 975 gathers ten fundamental IAQ parameters: Temperature, Humidity, Dew Point Temperature, Wet Bulb Temperature, Carbon Dioxide, Carbon Monoxide, Air Velocity, Air Volume, and Percentage of Outdoor Air (calculated from temperature or CO_2). This application note reviews those parameters and the associated functions on the 975. For more detailed information, see other app notes from the Fluke HVAC/IAQ library.

Measuring air velocity in a duct.

Temperature and Humidity

Fundamentals

Temperature and humidity are the foundation of IAQ. We rely on HVAC equipment to maintain acceptable temperature, humidity and ventilation levels for occupant health and comfort, and, now more than ever, to help regulate building health.

The relationship between HVAC equipment, occupied space requirements, building materials, weather conditions and pressure differentials is an ever-changing dynamic process. We expect the HVAC equipment to maintain 68° F to 70° F at 30% relative humidity in the winter and 74° F to 76° F at 40% to 60% relative humidity in the summer.

How easily this is achieved depends on many factors including geographical location, HVAC equipment selection and operating criteria and building design. Temperature control and ventilation are the primary concern in dry climates, while humid climates battle humidity related issues.

In every climate, indoor conditions must be maintained to inhibit or prevent the proliferation or colonization of dust mites, bacteria, viruses, fungus and mold spores, and other bioaerosols. Forty to forty-five percent relative humidity is becoming the recognized ideal indoor condition for human comfort, structural and materials integrity, and discouraging microbial proliferation.

How the 975 measures it

After the Fluke 975 AirMeter™ test tool completes its startup test, the main screen simultaneously displays dry bulb temperature (°F or °C), relative humidity (%RH), CO ppm (parts per million), and CO_2 ppm. Soft keys* toggle between relative humidity (%RH), wet bulb temperature (WBT), or dew point temperature (DPT). When the "MIN MAX" button is pressed, the meter will record the minimum, maximum, and average of all available readings.

*"Soft keys" are meter buttons whose functions vary with each change in meter screen display

Carbon Monoxide

Fundamentals

Carbon Monoxide (CO) is a product of the incomplete oxidation of carbon during combustion and is undesirable at any levels in an occupied space. Carbon monoxide is colorless, tasteless and odorless. The longer the exposure and the higher the concentration, the more CO is retained by the blood, leaving less and less room for oxygen. At lower levels of exposure, CO causes flu-like symptoms such as headaches, dizziness, disorientation, nausea and fatigue. At higher levels of exposure, CO is deadly. If a healthy person is exposed to 200 ppm CO over a one hour period the affects would be barely perceptible, cause illness after three hours, and death after six hours.

The U.S. National Ambient Air Quality Standards for carbon monoxide levels in outdoor air are 9 ppm for 8 hours, and 35 ppm for 1 hour. ANSI/ASHRAE Ventilation standard 62.1-2004 adopts these values for indoor air. These are believed to be acceptable levels of exposure for persons with respiratory or heart conditions. OSHA limits exposure for healthy persons in a workplace to 50 ppm CO for an eight hour period. CO levels in an inadequately ventilated warehouse that uses LP gas fueled forklifts can easily rise above 50 ppm.

The NFGC limits CO in a furnace, boiler or water heater to 400 ppm in an air free sample, which means actual CO readings in the vent would be 250 – 300 ppm, although these levels in a modern heating appliance would be cause for alarm. CO levels in a central heating or water heating appliance vent should be 50 ppm CO or less. CO levels in a kitchen using a gas oven can be 35 ppm. Unvented space heaters pose a significant threat when there is insufficient ventilation. Complete combustion takes oxygen from the occupied space and results in vent products that consist of carbon dioxide and water vapor. As this process continues in a poorly vented space, oxygen is depleted and carbon dioxide accumulates. This deprives the burner of sufficient oxygen resulting in incomplete combustion and the elevated production of CO.

Possible sources of carbon monoxide include the incomplete combustion of any organic compound including wood, coal or charcoal, fuel oil, natural or LP gas, gasoline or diesel fuel, kerosene, cigarettes, and so forth.

How the 975 measures it

The 975 AirMeter™ offers several methods for tracking sources of CO. The meter can be set for "MIN MAX" allowing the user to switch between live, maximum, minimum and average CO readings. The user can walk from space to space to track the highest levels of CO. If CO readings are higher at an air diffuser, then the HVAC system blower is circulating the CO from another location, such as the heating plant. In that case, you would turn the thermostat down and set the system blower to "ON". If the level of CO from the diffuser didn't diminish, the CO is from another source. Check areas where combustion is occurring to find malfunctioning equipment, as well as occupied spaces adjacent to parking garages or warehouses. Those exhaust systems may not be keeping those spaces at a lower differential pressure.

When data logging or trending is needed, the 975 AirMeter™ can record four samples per minute over a four day period. The logging session can be downloaded to a computer for analysis and FlukeView® Forms software can create a graph charting peak occurrences.

Carbon Dioxide

Fundamentals

Carbon dioxide is a normal product of respiration and complete combustion of organic compounds. It is used extensively for many purposes including carbonated beverages. Carbon dioxide is an asphyxiant at high levels and 50,000 ppm CO_2 is considered an immediate threat to life. Normal levels of outdoor environmental carbon dioxide in the atmosphere range from 300 ppm to 600 ppm depending on location and background activity (rush hour in the city). OSHA sets an upper limit of 5,000 ppm CO_2 over an eight hour day, or 10,000 ppm CO_2 over one hour. For typical fully occupied spaces requiring 15 cfm per person, ANSI/ASHRAE Ventilation standard 62.1-2004 requires sufficient ventilation to maintain 700 ppm CO_2 above outside CO_2 levels. This CO_2 level is selected to control odors and contaminant levels and is much lower than CO_2 levels that would begin to affect human activities.

Measuring CO around a gas water heater.

How the 975 measures it

The Fluke 975 measures CO_2 automatically and also uses it to calculate the percentage of outside air. Select "% OUTSIDE AIR" and you'll be prompted for "CO_2" or "Temp" calculations. Next enter the return air value, the mixed air value, and then the outside air value. The greater the differential between indoor and outdoor temperature or CO_2 values, the greater the accuracy achieved. If the outdoor to indoor temperature differential is less than 20° F, then a calculation based on CO_2 is likely to be more accurate. ASHRAE ventilation requirements for most spaces at full occupancy will result in a 700 ppm CO_2 differential between outdoors and indoor occupied spaces. (See ASHRAE standard 62.1 for commercial ventilation, or AHSRAE standard 62.2 for residential ventilation.)

Air Velocity Functions

Fundamentals

Control of air movement enables us to condition it, clean it, heat it, cool it, humidify it, dehumidify it, exhaust it, ventilate it, dilute it, mix it, deliver it, accelerate it, position it, maintain occupant comfort zones, maintain healthy buildings, and the list goes on. Proper air volumes within HVAC ducts are essential in equipment performance. When air volumes within HVAC ducts are incorrect, the air cannot be conditioned as designed, operating costs are elevated, and equipment life expectancy is shortened.

Velocities from registers and diffusers are integral in maintaining adequate air patterns for conditioning the space, while maintaining acceptable noise criteria and occupant comfort levels. Air velocities from registers and diffusers must create air patterns that evenly distribute and mix conditioned air to room air while avoiding uncomfortable velocities in the occupant zone. The occupant zone is normally considered to be below occupant height and one foot or more from walls and air velocities should generally be less than 50 fpm (feet per minute) in order to avoid complaints.

Air volumes from registers and diffusers must be sufficient to provide a change in room heat content at least comparable to the heat loss or gain of the space. Air volumes into exhaust grilles must be sufficient to control odors, gases, or fumes as required by the purpose of the exhaust system. Many circumstances warrant the measurement of air velocities or air volumes and the 975's velocity probe allows for both quick spot measurements of air velocities or patterns and precise duct traversals.

Using the velocity probe for measurements at the air intake.

How the 975 measures it

The Fluke 975 velocity probe contains a thermal anemometer and a compensating temperature sensor that will telescope for readings 33 inches beyond the handle, either in free air, at a GRD (grille-register-diffuser) face, or within a duct. Thermal anemometers are accurate through a wide range of velocities, and are especially preferred for low velocity readings.

Since air density is related to temperature and absolute pressure, the temperature sensor in the probe tip and the absolute pressure determined at meter startup compensate the readings to actual conditions.

When the velocity function is selected, the screen display prompts the user to press a soft key for either "Volume Flow Rate" or "Air Velocity". If "Air Velocity" is selected, the AirMeter screen displays a dynamic live velocity reading at standard conditions (69.98° F and 29.93 in Hg). A soft key enables the user to toggle between "Standard" readings and "Actual" readings, which are compensated for pressure and temperature. The "MIN MAX" function will record the values to allow the user to toggle between "Live", "Maximum", "Minimum", and "Average" velocities. Velocity readings can be captured and saved if desired, or logged at regular intervals for trend analysis.

To calculate cfm (cubic feet per minute) or M^3/min (cubic meters per minute), select "Volume Flow Rate" from the velocity main screen. The air volume calculation is determined by the velocity of the air and the area of the duct (velocity x area = air volume). In order to achieve acceptable levels of accuracy, volume calculations require an average of multiple velocity readings taken at stable points in an accepted grid pattern across the area of a duct or GRD. This is referred to as a traverse, whether the readings are taken within a duct, or at the face of a GRD. The meter can calculate air volume based on an average of up to 99 velocity readings.

The evolution of IAQ

Today, the boundaries of IAQ responsibilities are blurring between professions that share an interest in human and building health. Is the indoor environment contributing to productive employees, attentive students, patient recovery and healthy buildings while reducing the opportunity for structural damage and microbial growth or colonization? Research and education are helping expand the industry as are emotionally driven speculation and litigation. Monitoring and maintaining comfortable, safe and healthy IAQ fundamental values are an essential process in the building environments of today.

Measuring air flow at a supply register.

Fluke. *Keeping your world up and running.*™

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Printed in U.S.A. 11/2006 2802154 A-EN-N Rev A