Over-ventilation wastes money

Application Note

How to reduce energy consumption through ventilation adjustments

When someone asks whether a ventilation system is adjusted correctly, who determines whether it's correct? The leading standard for ventilation system design is ASHRAE 62.1-2007. While the standard contains many variables, calculations, and dependencies for determining different ventilation rates for specific building situations, the common recommendation is 25 cfm (cubic feet per minute) per person.

When designing or adjusting a ventilation system, here are two rules of thumb:

1. Make sure the mechanical systems delivers enough ventilation air to meet the standard. An HVAC system that delivers too little outside air will allow buildup of potentially harmful indoor air pollutants.
2. A system that over-ventilates, i.e., delivers too much outside air, will cause needlessly high energy bills. To prevent this, size and equip the HVAC mechanical system air handling units to deliver the proper amount of ventilation air but not more.

How over-ventilation happens

Many older air handling units use a fixed outside air damper position, usually 15 percent, to deliver what was once thought to be the correct amount of volume. However, in many instances, the damper position is not an actual measurement of outside air flow in cfm.

In these instances the system is conditioning more outside air than necessary.

Here's how to calculate the appropriate percentage of outside air in a ventilation system:

% outside air = 100X return air – Mixed air/Return air – Outside air

Completing this formula on a job site requires entering values for return air, outside air, and mixed air into the formula. These values can be measured as either temperature or CO_2 content.

Using temperature units, %OA = 100X TRA-TMA/ TRA-TOA

Where: TRA is the temperature of the return air, TMA is the temperature of the mixed air, TOA is the temperature of the outside air.

If you know the desired %OA, and you've measured the temperatures of OA and RA, then adjust the damper to obtain the necessary mixed air temperature (TMA):

Collecting air temperature values.

Example (calculating %OA)
Question: What is the current %OA for the following temperature conditions

TRA	= 72 °F
TMA	= 55 °F
TOA	= 30 °F
%OA	= 100X 72-55/72-30
%OA	= 100X 17/42

Answer: %OA = 40 %

This percentage is typical for an HVAC system that uses outside air for 'free' cooling. Fortunately the Fluke 975 AirMeter™ makes these calculations much easier. The built-in keypad menu records the temperatures at the unit and calculates the ventilation air percentages.

A long as you know the CFM produced by the unit, the AirMeter will determine the percentage and volume of outside air.

If you don't know the volume at the air handler, use the Fluke 975 AirMeter™ to measure air velocity at different sampling points in the duct. Enter the duct dimensions and the AirMeter will calculate the CFM air flow of the unit. Now you can determine the percentage of ventilation air.

Calculating the cooling/ heating cost

As much as possible, avoid overventilating a system. It wastes energy. Any extra air introduced into the system must be either heated, cooled, humidified, or dehumidified as needed depending on the season.

Sampling air velocity.

Cooling and dehumidification example:

Excess outside air volume = 5,000 cfm

Entering air conditions measured with air meter:

DB	= 80 °F
WB	= 63.5 °F
Enthalpy	= 28.8 btu/lb

Leaving air conditions measured with air meter:

DB	= 60 °F
WB	= 53.5 °F
Enthalpy	= 22.3 btu/lb

Once you know the total heat in BTUs, you can determine the tonnage and electrical cost for the unit.

Here's the formula for the total heat absorbed by the cooling coil.

Total Heat = CFM X 4.5 X Delta H (difference in enthalpy)

Using the above formula:

Total Heat =
5000 X 4.5 X (28.8-22.3)

Total Heat = 146,250 btu.

Since there are 12,000 btu/ton of cooling, the coil tonnage due to overventilation of this system is slightly over 12 tons. For a chilled water distribution system, the common energy requirement is approximately .8 kW/ton of cooling.

That means the energy consumed by excess outside air is 9.6 Kw (12 tons X .8 Kw/ton).

Now you can calculate the energy cost

1. If the excess outside air is used for 220 hours per month, the total kilowatt-hours of energy used is 2112 kWh of energy/month.
2. If one kWh costs 10 cents, the overventilation cost for one unit for one month is $211.

This is just one unit within a building. If the building's other air handling systems are operating in a similar fashion, the total overventilation cost easily runs into the thousands of dollars.

In cold climates, you can calculate the heating energy in a similar fashion. Any air that overventilates the space will be very cold and must be heated. As an added side benefit, if overventilation is measured and corrected, the system heating coil will not be as likely to freeze up in bitterly cold weather.

Using the Fluke 975 AirMeter™ to measure ventilation rates and adjust the airflow can significantly reduce the energy bill in a typical commercial facility. To document the adjustments and savings for your customer, save the AirMeter readings, download them to a computer, and create a report in FlukeView® Forms software.

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