Demand Controlled Ventilation for Improved Humidity Control

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ABSTRACT

Recently introduced technology makes it possible to continuously monitor for humidity in numerous building areas using a multi-point indoor air quality (IAQ) monitoring system. The shared sensor, multi-parameter system makes it easier for facility managers to control humidity in their buildings. By continually measuring both dewpoint and CO2 levels throughout the facilities, outside air can be minimized without exceeding recommended IAQ guidelines.

INTRODUCTION

The greatest single contributor to building energy loads in humid climates is the cooling and dehumidifying of outside air which is brought in for ventilation. The high "latent load" inherent in this hot, humid outside air is often the reason for installing excess chiller capacity and the cause of peak power demands.

Recent concerns over poor indoor air quality (IAQ) due to inadequate building ventilation suggests probable increases in the quantities of outside air brought into many buildings. Strict adherence to ASHRAE and other codes and guidelines will require more "fresh air" for many poorly ventilated buildings.

Although under-ventilation may be unhealthy, the opposite condition, overventilation, can be costly and often results in poor humidity control. Faced with a lack of information about IAQ levels and building occupancy, engineers are now being encouraged to overdesign ventilation systems to assure compliance with codes such as ASHRAE and OSHA.

VENTILATION DESIGN FLAWS

If a building's HVAC is designed in accordance with ASHRAE 62-89, Section 6.1 (Ventilation Rate Procedure), the outside air volumes must satisfy the needs of the various occupied spaces while at their maximum occupancy. In other words, during the worst case condition of maximum occupancy the building's HVAC must provide adequate outside air for all occupants.

However, if the building is designed to handle the worst case, then, by definition, there is more than adequate ventilation during all other times - - - when occupancy is less than the maximum. Sometimes the difference between maximum (design) occupancy and actual occupancy is significant. Buildings such as libraries, classrooms, and even office buildings experience wide swings in occupancy levels.

The negative consequences of such building overventilation can be quite extensive. Excess chiller capacity often results as does very high energy costs for overcooling and reheating too much outside air in order to dehumidify it during summer months.

Fortunately, buildings that have variable occupancy also have a good opportunities to reduce outside air (OA) during periods of low occupancy. Significant savings can be accomplished by reducing OA damper openings whenever IAQ monitoring indicates that all of the zones served by an air handler are receiving more fresh air than is necessary.

POOR OCCUPANCY ESTIMATES

There is often a problem when the maximum occupancies of all the building zones are added together to determine the total building occupancy. Some HVAC design engineers are guilty of adding up the maximum occupancies of offices, conference rooms and even the cafeteria when estimating the total building load. But workers cannot be in their work area, a conference room and the cafeteria at the same time. This is double or triple counting. Also, there are periods of the year when a significant number of workers may be absent, on vacation or traveling.

The entire concept of supplying outside air to satisfy the needs of assumed occupants is seriously flawed. If heating and cooling controls were designed and operated in a like manner the temperatures would be cycling all over the place. So, why isn't ventilation controlled like temperature; by measuring the desired parameter and having the HVAC system respond in a manned which achieves and maintains the desired set point.?.

This "demand controlled heating/cooling" concept works well and makes obvious sense. So, why is the design and operation of ventilation systems so inexact and problematic?

WHY NOW? WHAT TOOK SO LONG?

The reason for this seeming lack of common sense is that until fairly recently it was not possible to measure air quality accurately, reliably and cost effectively. If you can't measure something how can you control it? The recent introduction of good IAQ sensors and monitoring systems now allows the building manager to continuously monitor actual air quality in numerous occupied spaces in the building.

The second essential ingredient for demand controlled ventilation is an HVAC control system that can respond to information about the air quality in the different building zones.
Before the advent of energy management systems and intelligent building controls it was not possible to examine building air quality conditions and take the appropriate action. However, the sophisticated HVAC control systems that presently exist in many buildings, make demand controlled ventilation both possible and desirable.

IMPROVED MONITORING SYSTEMS

The best means for monitoring IAQ in buildings is presently under debate. While cost and accuracy of air quality sensors has improved significantly, there are still reliability problems that have limited the applications of demand control ventilation. These reliability issues become multiplied when multi-parameter monitoring is considered.

The shared sensor technique pioneered by AIRxpert Systems helps with both the cost and reliability of monitoring many zones of a building. By sharing high reliability (and often expensive) sensors with all the zones in a building through a vacuum draw sampling technique, the AIRxpert system is able to significantly reduce the cost per point monitored. Also, the centrally located sensor(s) can be easily checked and recalibrated; automatically if necessary.

MULTIPLE PARAMETER MONITORING

While the original AIRxpert installation monitored only CO2, the systems now being installed also monitor dew point (and relative humidity). The capability of including VOC monitoring has also been demonstrated in a recent installation. Other IAQ parameters such as CO, ozone, formaldehyde and SOx are also being considered for shared sensor monitoring with the AIRxpert system.

Monitoring multiple IAQ parameters is key to the successful demand controlled ventilation for reducing humidity incurred loads. Once it is determined that IAQ levels in a building are below specified limits the outside air can be reduced for a corresponding reduction in both sensible and latent cooling loads. But both IAQ parameters, CO2 and humidity, must work together. Reduction of outside air to reduce cooling loads can only be done when other IAQ parameters such as CO2 confirm the good air quality that will allow the OA reduction.

IAQ MONITORING EXAMPLES

Figure 1 is a typical "datagraph" depicting the CO2 levels in a typical office building. It demonstrates that air quality is quite dynamic in some areas. It also shows that the return air to the air handler detects no problems while the actual zones are seeing significant IAQ spikes. This emphasizes a serious drawback with monitoring in combined air return ducts rather than in the actual work space(s).

Figure 2 is a typical datagraph of the same building showing the dewpoint in each of twenty-four zones being monitored on a summer day. Because all zones are monitored using the same, high reliability, chilled mirror sensor, their relative dew point values are accurate and reliable. This datagraph indicates the effectiveness of the humidity control in each of the zones being monitored.

Now, with continuous multi-point IAQ monitoring, the outside air can be reduced in the overventilated areas and the affect on both the CO2 and humidity levels can be evaluated. During some summer days, when many workers are out on vacation, the opportunities for outside air reductions may be significant.

THE HVAC CONTROLS INTERFACE

While continuous, multi-point, multi-parameter IAQ monitoring by itself has value for the building manager, the real value comes with having the system interface with the building's HVAC control system to "optimize" the building ventilation. The AIRxpert system does this by sending a signal to the building's energy management system (EMS) telling it when a zone is not adequately ventilated and needs more outside air. The EMS then takes the necessary action to get more outside air to the appropriate spaces.

The AIRxpert system will never ask for less outside air; it only calls for more. This allows the building owner to reduce the minimum OA damper setting with the assurance that the system will open wider when more fresh air is required.

The continuous monitoring of dew point in numerous zones helps the building manager to optimize the operation of the cooling and dehumidification systems. Any HVAC malfunction, such as a stuck damper or zone valve, is quite apparent in the datagraphs. The alert facility manager can use this information to anticipate HVAC problems and correct them before they become "trouble calls".

WHO BENEFITS FROM DCV?

If ever there was a win-win HVAC technology, demand controlled ventilation is it. The most obvious beneficiary, the facility manager, can now provide a good indoor environment at the lowest energy cost. The building owner is relieved of the liability associated with IAQ complaints from workers and tenants.

The workers and tenants themselves benefit from a more comfortable environment where they can work at higher productivity. Any worker complaints can be verified (or disproved) and corrected before they get out of control.

HVAC engineers and contractors will benefit from the opportunities to rezone and otherwise modify ventilation systems in order to better optimize the building operations. And, because demand controlled ventilation requires intelligent building controls to be fully effective, the HVAC controls vendors will get additional business installing and upgrading their systems.

Utilities can benefit from demand controlled ventilation by showing their customers how to use it to provide a quality indoor environment while reducing peak power needs. Several utilities are already evaluating the potential for using DCV for load shifting and peak reduction.

Environmental consultants, especially some IAQ specialists, have given demand controlled ventilation a mixed reception. While continuous multi-point IAQ monitoring eats into their business by reducing the need for regular (and costly) IAQ surveys, there will be additional work analyzing IAQ data and working with others to improve the building operations.

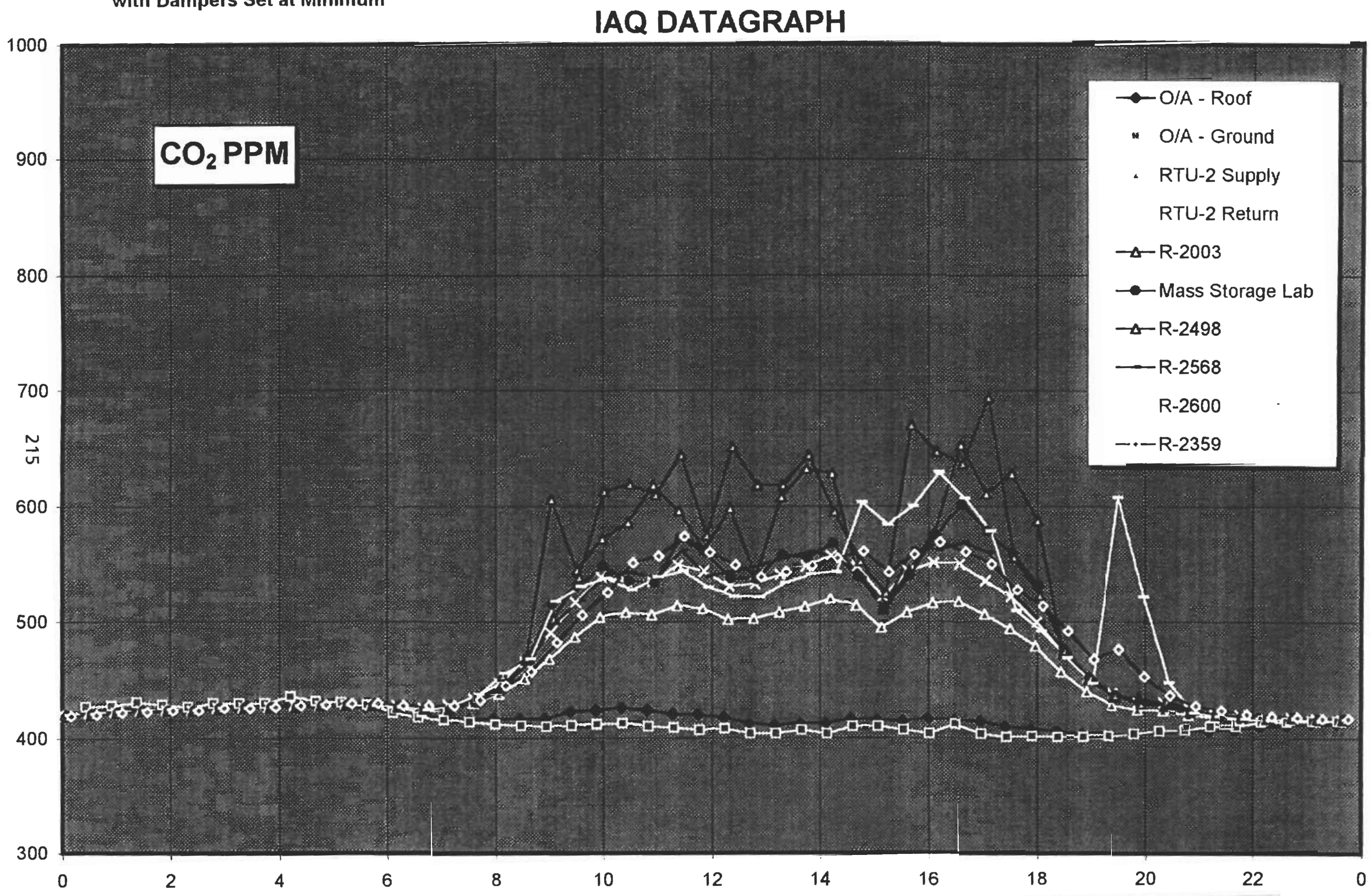
CONCLUSIONS

Demand controlled ventilation, based on shared sensor, multi-point and multi-parameter IAQ monitoring systems coupled with intelligent building controls, can achieve better air quality and lower energy costs. While much more needs to be done to perfect the concept, the basic technology for DCV has been proven and will see much application in the near future. The use of DCV to reduce humidity driven loads in buildings is particularly cost effective and has significant benefits for the building manager as well as the utility company.

Figure 1

BENEFIT to USER:
-- Evaluate O/A Distribution
with Dampers Set at Minimum

NEES Customer "SC"
June 19, 1995

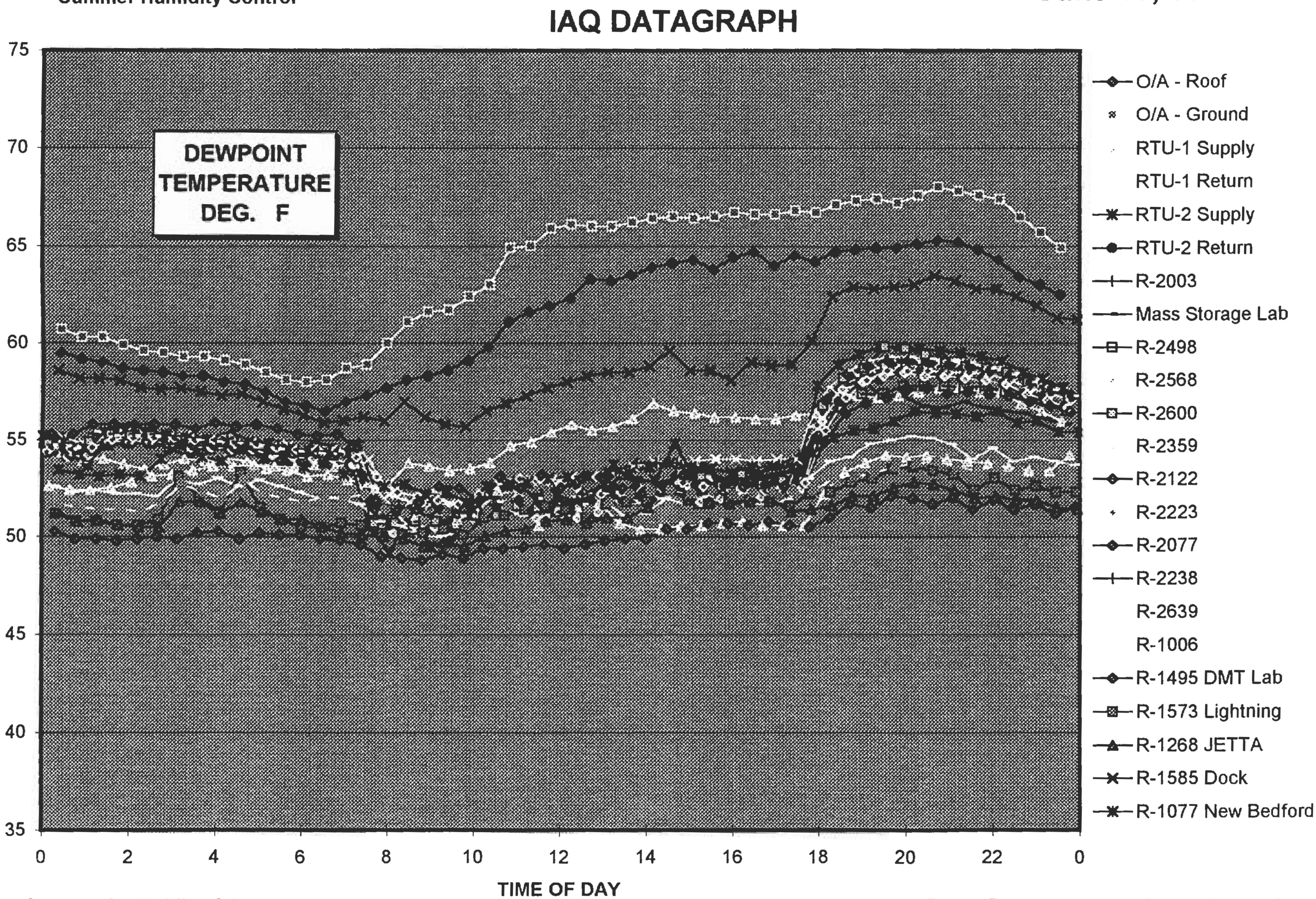


Data Generated by the AIRXPERT/ 6000

Figure 2

BENEFIT to USER:
-- Check Effectiveness of Summer Humidity Control

NEES Customer "SC"
June 19, 1995



Data Generated by the AIRXPERT/ 6000