Measured Containment Control (MCC) of Fume Cupboard Exhaust: Improvements in Safety and Sustainability at a Lower Capital Cost.

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Traditional Concepts of Fume Exhaust Design.

The HVAC requirements of laboratories and, more particularly, fume cupboards have led to them being regarded in some quarters as a form of wind tunnel arranged to waste large quantities of expensive, filtered, heated, cooled, and humidified fresh air. The counterpoint is that these are safety-critical systems and that safety should never be sacrificed on the twin altars of sustainability and functional expediency. Recognising this intent, the traditional operational metrics associated with lab design such as air change rates and fume cupboard flow rates/face velocities have been based on empiricism and 'best guesses' to give acceptable margins of safety. It should be noted that this is a form of open loop design solution that does not respond to potentially hazardous conditions but rather places reliance on predetermined ventilation rates. Too often this comes down to a philosophy of, "If some is good, and more is better, then too much should be just enough."

More recently attention has become focused on this situation with steps being taken to improve ventilation energy efficiency in labs, promoted and encouraged by the Labs21 organisation in the USA and the S-Lab equivalent in the UK and Europe. In particular the concept of VAV control has gathered momentum and received increased acceptance although all types share the common characteristic of being open-loop or feed-forward in concept. That is, rather than controlling against measurements of the level of contaminants within a fume cupboard (the reduction/removal of which is the central objective) the operational criteria are the availability of a predetermined volume flow rate, a face velocity, and a maximum VAV turndown ratio. Such fixed performance metrics (assessed/evaluated/guessed?) cannot respond fully to the linked requirements of functional safety and sustainability.

A New Approach.

Measured Containment Control (MCC) is an innovatory and novel alternative concept for the control of fume cupboards. The basis of the system is that volume control can

be more effectively achieved, in terms of both safety and energy efficiency, by means of direct measurements of contaminants within fume cupboards. The MCC concept uses modulating dampers (effectively the same as more traditional VAV) that are controlled by signals from contaminant and/or condition sensors (volatile compounds, particulates, as examples). Developments in the quality, reliability, and value of such sensors in recent years have removed any concerns regarding their use in safety systems.

Key features include:

- During normal operating conditions the release of contaminants in a fume cupboard will be very low. By continuous measurement of contaminants, MCC will permit the effective and safe use of turndown ratios of 10:1 or even higher.
- When a fume cupboard sash is a fully open for set-up activities (clean conditions) a conventional VAV installation is likely to be exhausting at its maximum rate whereas MCC will operate at maximum turndown.
- In the event of an incident in a fume cupboard (involving a major release of contaminants) the natural response of a user is to close the sash whereupon a conventional VAV installation will reduce the exhaust volume. In such circumstances it is frequently reported that fume escapes into the laboratory, particularly when over-optimistic turndown ratios have been used. MCC will automatically do the opposite in terms of exhaust volume (going up to a maximum) and will dramatically improve containment and safety.
- It is estimated that the daily exhaust volume requirement of an MCC-fitted fume cupboard will typically be only 25% of a CV unit and 50% of the more traditional VAV equivalent. The full life cycle savings in energy will be considerable.
- The use of MCC will have a substantial impact on project capital costs. That is, if less air is being moved through a laboratory the ductwork ventilation systems (both supply and exhaust) can be downsized.

Summary.

By means of a basic functionality rooted in hard objectivity Measured Containment Control provides a logical, closed-loop design solution for the exhaust ventilation control of fume cupboards and other containment devices. It replaces empiricism based on best guesses with ‘real-world’ measurements and offers enhancements in terms of safety, energy efficiency, and the overall capital cost of systems.