The Benefits of Real-Time Over Sampled Data

In a previous IET article the general theme was "you can't manage what you don't measure" and remembering that canaries were used in UK mines up until about 1970, the instrumentation sledgehammer has come a long way in the last 60 years to crack the COSHH nut in terms of ease of use, functionality and portability.

> *"Real-time direct reading methods will continue to evolve as the technology changes to meet customer expectations"*

In many Health & Safety scenarios, physical and chemical agents can be measured using both handheld portable and bodily worn solutions e.g. a handheld gas detector as a pre-entry check for confined space entry used in conjunction with a personal gas badge to protect the individual, post-entry. There are similar parallels in the noise world such as the sound level meter and the personal noise dosimeter; each solution having benefits over the other - both methods being complimentary. Used in combination they give the H&S Manager, Occupational Hygienist or Consultant a better assessment of the risk.

There is one further dimension and that is direct reading, real-time versus air sampling techniques, the benefits of the former over the latter from an industry perspective being eloquently put by Dr Geoff Wilcox in his presentation to the BOHS Conference in April 2009.

Take sampling for dust as an example, which historically involves a bodily worn pump and sampling train ultimately positioned in the breathing zone, with an appropriate medium such as a filter (or an adsorbent tube for vapours). Casella CEL coincidentally celebrates 60 years in pumps in this the UK's Queen's Jubilee year having introduced the first such device for the mining industry in 1952. The sampling procedures and exposure limits developed by the HSE and published in the MDHS series for dust (and similarly NIOSH/OSHA in the USA) are based on this long established gravimetric (pre and post sample weight) method.

The upside of the pump-based method is accuracy, the foundation of the technique being based on the weight of the collected sample, notwithstanding the potential care required to ensure no air leaks in the sampling train and the ability of the pump to maintain accurate flow control (+/- 5% according to pump standard EN1232). Constant flow, time and weight are used to calculate the concentration and further detailed analysis of the sample can be performed in the laboratory. The problems are that there is an inevitable time delay before results are received and whilst the pump itself may be typically £300 to £500 there is the ongoing cost of consumables, which can be considerable. A relatively low pump price means there is a potential to buy several pumps to improve sampling validity but 'wearer compliance' could be an issue should the subject(s) decide to tamper with or discard the pump or try to influence the results in some way. The pump method also only gives the average concentration at the end of sample (which could be a whole shift) but by contrast a real-time dust instrument gives an immediate result with time history profiles all within the control of the user. The price of the instrument is considerably more than that of a pump but there are no ongoing consumables required. But despite the concentration being quick to determine it is only indicative in nature and one doesn't know what the sample consists of which is where the concept of using a combination of methods is recommended.

The generic term for such real-time dust devices is nephelometer defined as any method for estimating the concentration of cells or particles in a suspension by measuring the intensity of scattered light, where the scattering depends upon number, size and surface characteristics of the particles. Casella's Microdust Pro uses a forward light scatter technique and calibration during manufacture is performed

in a wind tunnel with Arizona Road Dust, the accepted 'standard' dust using traceable weights and a high precision microbalance to compare the displayed concentration with the gravimetric equivalent. However, because of the principal of operation, calibration should actually be performed using the customer's own dust but this is not a practical proposition. There is consensus between subject matter experts at the Health & Safety Laboratory and leading Universities involved in particle sensing that the method used by Casella CEL i.e. that the calibration device adopted for field calibration is "good enough" for real-world applications which include:-

Author Details:
Neal Hill, Programme Manager, Casella Measurement
Casella Measurement
Regent House, Wolseley Road
Kempston, Bedford
MK42 7JY
Tel: 01234 844100
Web: www.casellameasurement.com

- Background surveys
- The potential for immediate intervention
- Targeting control measures on tasks with the greatest exposure potential
- Task mapping (concentration profiles in real-time)
- Checking performance of control measures e.g. filter performance
- Indoor air quality assessments

To improve the accuracy and correlation with gravimetric samplers size selective adaptors may be used and work done by the HSL to compare concluded that: "the Microdust Higgins–Dewell cyclone adaptor measurements agreed closely with the reference respirable concentration for all dusts, whereas those for (competitive devices) were different to the reference….whereas the Microdust CIS (Conical Inhalable Sampler) adaptor underestimated the inhalable concentration compared to the reference."

Real-time direct reading methods will continue to evolve as the technology changes to meet customer expectations for increasing granularity of data on which to make better decisions as organisations look to comply with legislation but generally improve the safety health & wellbeing of their employees in the workplace within a Corporate Social Responsibility agenda.

Case Study

Comparison of Portable, Real-Time Dust Monitors Sampling Actively, with Size-Selective Adaptors, and Passively

The performance of three, portable, real-time dust monitors was investigated inside a calm air dust chamber for a range of industrial dusts and two sizes of aluminium oxide dust.

The instruments tested were the Split 2 (SKC Ltd), Microdust Pro (Casella Ltd) and DataRam (Thermo Electron Ltd), which sampled either passively or actively by connecting a manufacturer supplied, size-selective adaptor and an air sampling pump to the inlet of the monitor.

Two size-selective adaptors were tested with the Split 2: the GS-3 cyclone adaptor and the Institute of Occupational Medicine (IOM) inlet with porous foam inserts. Similarly, two size-selective adaptors were tested with the Microdust Pro: the Higgins–Dewell cyclone adaptor and the conical inhalable sampler (CIS) adaptor with porous foam inserts. The DataRam was tested with a GK 2.05 cyclone adaptor since there was no porous foam adaptor available.

The instruments' responses were compared with the reference dust samplers: Casella Higgins–Dewell cyclone for the respirable fraction and IOM sampler for the inhalable fraction. The response of the dust monitors was found to be linear with respirable dust concentration when operated either passively or actively using the cyclone size-selective inlets. Their responses were lower when operated actively with the cyclone adaptors compared to the passive operation and lower still when used with the porous foam inserts. There was also often more scatter in the porous foam measurements, attributable to variable clogging of the foams caused by inconsistent loading with dust. The dust monitor responses were sensitive to changes in particle size when operated passively but much less so in active mode with the cyclone adaptors. The Microdust Higgins–Dewell cyclone adaptor measurements agreed closely with the reference respirable concentration for all dusts, whereas those for the DataRam GK 2.05 and Split 2 GS-3 cyclone adaptors were different to the reference. Concentrations measured with the foam adaptors were considerably lower than both the reference cyclone samplers and the dust monitor cyclone adaptors and increasingly under sampled as they became loaded with dust. Inhalable dust measured with the Split 2 IOMadaptor agreed closely with the reference IOMinhalable samplers, whereas the Microdust CIS adaptor underestimated the inhalable concentration compared to the reference.

Andrew Thorpe and Peter T. Walsh