CASELLA

An overview of particulate and aerosol monitoring
Classification conventions

Many people work in environments where unhealthy concentrations of dust or aerosols may be present. These particles could be carcinogenic, or cause specific pathologies of the lung and respiratory tract that lead to illness or even death. The size convention of particulates varies and is classified by how far they can travel into the respiratory system. Total inhalable fraction is the name given to the mass fraction of total airborne particles that are inhaled through the mouth and nose. Larger particles are filtered out by the linings of the nose and throat. These are typically just visible to the naked eye and have a mean diameter of about 10 microns (10^{-6} m). The thoracic fraction is the mass fraction of inhaled particles that pass further than the larynx. The respirable fraction is the mass fraction that penetrates down to the lowest parts of the unciliated airways. The smaller particulates will find their way into the throat and thoracic region while the tiniest may insinuate themselves into the deepest passageways of the lungs and these are considered the most dangerous. Particle sizes smaller than about 4.5 microns are considered in this respirable category.

Sampling conventions and methods

Personal air sampling usually consists of drawing air through a specially constructed sampling filter placed inside in a holder, or ‘cassette’ and collecting contaminants as the "dirty air" passes through it. A personal sampling pump running at a constant flow rate is used to draw the air through the filter cassette to collect the sample. These particles are then analysed for mass and composition typically by an accredited laboratory. This process involves weighing the filter in its "clean" condition at the start of the work and then again when "dirty" at the end of the sampling run. The difference in weight between dirty and clean in milligrams (mg) gives the accumulated mass. The pump must run at a constant flow rate in litres per minute (L/m) such that if the run duration is known in minutes the total sampled volume can be calculated (flow rate x time) and expressed in litres or cubic meters (L or m^3). The concentration of particles is then expressed as mass per unit volume (mg/m^3). An additional mesh or ‘size-selective’ filter can be used to pass just the particles of a certain size or smaller for examination by gravimetric methods outlined here. These Polyurethane Foam (PUF) Filters are inserted into the cassette before the filter that has been weighed so that the most dangerous particles are captured and analysed. Through various design elements, cyclone sampling head aerodynamics can pass the particle sizes of interest and exclude those particles bigger than required to get a size selection of the total suspended matter in the air.

Limits on exposure

Measurement standards and various regulatory guidelines specify concentrations of contaminants that are thought to represent an acceptable balance between worker safety and the cost of complete hazard removal. In the US some of the main organizations that approve sampling methods and set permissible exposure limits (PEL) for monitoring dusts and particulates are OSHA and NIOSH. Other organizations worldwide are actively involved in designing methods and techniques for sampling. These include the Institute of Occupational Medicine (IOM) in the UK and the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) in Canada. Exposure limits are specified for many potentially harmful materials in relation to their Time Weighted Average (TWA) concentration value. The total volume or sample rate that should be used is also specified. Different filter cassettes have been developed over the years to focus on certain types of particulates. These include the cyclone sampler, the (IOM) sampler, the respirable sampler, the asbestos sampler, etc. It is also possible to sample for vapours or gases in the atmosphere by drawing the sample through a sorbent tube that adsorbs molecules and retains them for later analysis using a GC/MS or other analytic technique, or a direct reading colorimetric tube that contains a reagent that will change colour when exposed to the vapour under investigation. Again, a personal sampling pump is used to collect the sample. Usually a lower flow range in the order of a few tens of mL/min is required to give the sorbent material time to absorb the vapour. A personal sampling pump fitted with a low flow adapter in the inlet line is needed to accomplish this type of monitoring.

Equipment used

Key features of sampling pumps used for these types of monitoring are: light weight (since it is worn for extended periods by a worker) and efficient battery operation to maximize the amount of sample volume or time that can be gathered. Quick recharge times and a choice of power supply options to get the pump back up and running after each use are also important considerations. Small physical size and a low noise pump ensure maximum acceptability of the worker being sampled. The pump should hold the selected flow rate very constant over the entire duration of the test, have a linear flow rate over a wide range, and give the user the possibility of collecting samples at a faster rate where circumstances allow. For exposures that are only likely to occur over short periods a flow rate of up to 4 L/min or more is a distinct advantage. The Casella Tuff™ range of personal sampling pumps are ideal for all the applications listed above and can be used in an extremely wide range of applications. The Casella Microdust Pro can be used for real time particulate monitoring as part of a comprehensive air sampling regime.