Active versus Passive Air Sampling

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Active sampling involves the use of an air sampling pump to actively pull air through a collection device such as a filter. Passive sampling, however, does not require active air movement from a pump. Airborne gases and vapours are collected by a physical process such as diffusion through a static air layer or permeation through a membrane. Most passive samplers used by health and safety professionals operate on the principle of diffusion; therefore, they are referred to as diffusive samplers.

In the main, active sampling is pretty much independent of wind speed; diffusive samplers however do not work at all well under minimal air movement conditions or in the other extreme, high wind conditions. Most active sampling for gases and vapours is personal on sorbent tubes that have a back up section; this enables a quality and reliability check to be performed under certain defined guidelines and leads to very reliable quantification. Most diffusive samplers do not and are not capable of this.

One of the most significant developments in air sampling technology in recent years is the evolution of passive samplers. This technology was first introduced to the health and safety profession in 1973 by researchers Palmes and Gunnison. As the applications for this technology have grown and changed over the years, the number and types of passive samplers that are commercially available have escalated. Passive samplers are now a key component in the arsenal of air sampling devices.

In recent years, there have been a number of initiatives to experimentally verify the sampling or uptake rates in a testing laboratory and validate the performance of the sampler under various environmental conditions. This provides a more reliable assessment of the overall accuracy and precision of the sampling device. Samplers with documented validation studies should be used for compliance or legal applications.

Types of Passive (Diffusive) Samplers

There are two broad categories of passive samplers on the market today that operate on the principle of diffusion: (a) samplers requiring laboratory analysis and (b) direct-reading devices. Direct-reading passive samplers are typically based on colourimetric techniques. The length of the colour band or the intensity of the colour change is read on a scale or compared to a chart to determine concentration levels.

Passive colour tubes are a good example of a direct-reading passive sampler. These tubes simply insert into a holder and clip onto a worker’s lapel. The target compound diffuses into the open-end of the tube, combines with the reagent and produces a colour change that is read from the tube scale in parts-per-million-hours (ppm-hrs). The user simply divides the reading by the number of hours sampled to determine the ppm exposure.

Passive samplers that require laboratory analysis typically use a solid sorbent material or chemically treated paper to collect airborne contaminants. When validated, these methods can be as reliable as active sampling methods.

Passive samplers containing solid sorbent are used widely today for workplace sampling. The most popular samplers contain charcoal sorbent and are used to collect organic vapours such as benzene, toluene and xylenes. Following sampling, the analytical laboratory can remove the solid sorbent, extract the collected contaminants and analyse by gas chromatography. Research is ongoing into the use of passive samplers containing solid sorbents for low-level determinations in indoor air quality and ambient air studies. For these applications, the sampling and analysis method must allow the measurement of sub-parts per billion (sub-ppb) levels.

Operating Principle of Diffusive Samplers

The operating principle of diffusive samplers is the movement of contaminant molecules across a concentration gradient. Simply, the airborne contaminants diffuse from an area of higher concentration in the workplace environment to an area of lower (or zero concentration) in the collection device. Fick, a pioneering researcher, is credited with defining the rate at which chemicals diffuse. Fick’s First Law of Diffusion is represented by the following formula:

\[ Q = D \times (A/L) \times C \times T \]

Where:

- \( Q \) = amount collected (ng)
- \( D \) = diffusion coefficient (cm²/min)
- \( A \) = cross-sectional area of the diffusion path (cm²)
- \( L \) = diffusive path length (cm)
- \( C \) = airborne concentration (mg/m³)
- \( T \) = sampling time (min)

Note that the diffusion coefficient (D) is specific to the contaminant being sampled. Each contaminant has its own diffusion coefficient determined by its unique chemical and physical properties. The parameter \((A/L)\) is specific to the sampling device and is determined by the sampler’s geometry. The product of \(D \times (A/L)\) is the theoretical sampling or uptake rate of a diffusive sampler for a specific compound.

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There are several advantages of each system – active and passive, such as size and weight and thus worker convenience and initial cost. However, two prime factors affecting reliability (discussed later) are very important.
New Class 1 Sound Level Meter with Simple Operation and Future Proof Upgrade Options.

Cirrus Research (UK) are pleased to announce the CR261 Class 1 Integrating Sound Level Meter. This instrument is a precision noise measurement tool which can be used for a range of applications and measurements. Providing the basic noise level parameters, Sound Level, Leq, Lmin, Lmax and Lden(12), the CR261 can be used for Occupational Noise Measurements as well as for basic noise level testing. The basic instrument can be upgraded to add data logging and PC display, at which point it can be used with the Deaf Defier software to produce graphs, reports and export data. The data logging upgrade can be added by the user at any time by simply purchasing a license key and unlocking the instrument via the Deaf Defier software. The CR261 meets the very latest standards for Sound Level Meters, IEC 61672-1:2002 as well as the EN and BEL EN equivalents.

The overall sampling and analytical error of these devices is usually stipulate a minimum sampling time of 5 minutes. This is in keeping with OSHA-validated methods using passive samplers. Users should follow closely the manufacturer, OSHA, or an outside laboratory and are not adequately retained. This can be a concern in areas of transient peak exposures.

Reliability of Passive Samplers

Passive Samplers are a very easy option for users and an unobtrusive device for wearers. Caution should be exercised, however, when selecting a passive sampler for compliance or legal applications. The performance of passive samplers can be affected by a number of environmental factors. Steady air (surface velocities less than 25 ft/min) can significantly reduce the sampling rate of a passive sampler. Alternatively, high air velocities may damage diffusion in samplers that do not contain a wind barrier. Very high concentrations of the target compound or interference may cause loss. High humidity may also limit the capability of the sampler to adsorb or retain the contaminant for subsequent analysis. Reversal diffusion may also be a factor whereby some chemicals diffuse onto the sorbent but are not adequately retained. This can be a concern in areas of transient aerosol exposures.

Sampling time is also an important consideration when using passive samplers. A sampler should follow closely the supplier’s recommendations for minimum and maximum sampling times. These guidelines will help to ensure that the sampling time is sufficient to collect enough contaminant for laboratory detection without overloading the sampler.

Passive samplers that have been treated and evaluated by the manufacturer, OSHA, or an outside laboratory and are used within operating guidelines are a reliable sampling tool. The overall sampling and analytical error of these devices is comparable to that of active sampling methods.

MDHS 89 Volatile Organic Compounds in Air

Passive Samplers in Workplace Health and Safety Programmes

8-10 TWA Exposures

Passive samplers that have been validated for designated compounds as a reliable, cost-effective and easy means of assessing 8-hour exposure levels. They eliminate the expense of pumps and related accessories and the time for training, calibrating and maintenance.

Short Term Exposures

OSHA-validated methods using passive samplers typically stipulate a minimum sampling time of 5 minutes. This allows passive samplers to be used to assess short-term exposure limits (STELs) of designated compounds.

Indoor Air Quality

Some passive samplers have been evaluated and found to be acceptable for indoor air sampling. Due to the low contaminant levels in this environment, the minimum sampling time of 24 hours for this type of sampling. Being hung in an area, users should ensure that there is adequate air movement to avoid starvation of the sampler (as described above).

Passive samplers are a worthy consideration.

New TSI Model 8375 ACCUBALANCE® Modular Air Balancing Tool for HVAC Test & Balance and Industrial Hygiene

TSI (UK) announces the new TSI Model 8375 Modular Air Balancing Tool. This exceptionally sensitive testing device for the HVAC test and balance and the industrial hygiene professional features a multi-purpose digital manometer that can be used with a variety of common test and balance tools. Available tools include a capture hood, a relative humidity and temperature probe, an air flow probe, a pilot probe, static pressure probes, and a velocity matrix. The optional velocity matrix provides fast readings of 16 measuring points simultaneously, making it ideal for a wide variety of measurements in fume hoods, Biological Safety Cabinets, and HVAC systems. Technicians will appreciate the light weight (2.5 kg) and ergonomic design of the ACCUBALANCE® capture hood base assembly, especially when making over-the-head measurements – as well as the fact it can be powered by AC mains or just 4 AA rechargeable or alkaline batteries. The Model 8375’s meter is easily attached/detached from the ACCUBALANCE® base assembly to use with various accessories to perform a wide variety of measurements: air temperature, relative humidity, differential pressure, static pressure, air velocity or volume, and lab hood face velocities. Data logging allows test data to be downloaded to a PC using the included TIS LogFlex® software program.

The Next Generation of Personal Noise Dosimeters with the NoisePro® Series

Quest Technologies Inc (USA), an employee-owned world leader in the development and manufacturer of monitoring instrumentation and software for Occupational and Environmental Health & Safety (OEH&S) applications is proud to provide a noise monitoring system that goes beyond documentation. Regulations are not the only reason to manage occupational noise exposures. Worker compensation and health care costs are at all-time highs with no changes in sight. Hearing conservation is now an act of responsible fiscal management. The opportunity exists to proactively control or reduce over-exposures.

The NoisePro® Series, combined with QuestSuite® Professional application software, is the one and only “Systems Solution” to enable organizations to proactively manage noise induced hearing loss. More than just a record of history, the NoisePro Series provides real-time compliance indicators and optional vibrating alarms to promote effective self-management of noise exposures and HPD use. Advanced analysis tools contained in QuestSuite Professional enable the evaluation of engineering and administrative controls prior to their purchase and implementation.