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DETERMINATION OF FILTER AND CASSETTE MASS INSTABILITY IN ASCERTAINING THE LIMIT OF DETECTION OF INHALABLE AIRBORNE PARTICULATES. S. Paik, J. Vincent, University of Michigan, Ann Arbor, MI

In the gravimetric assessment of workplace aerosols, there is an increasing need to confidently measure smaller and smaller collected masses. This is due to the low concentrations present in many workplaces, driven by low occupational exposure limits. It is also influenced by the desire, in some instances, to sample at lower flow rates.

To accurately measure a small collected mass, it is important to know the limit of detection (LOD) and limit of quantification (LOQ) of the analysis performed, determined by the mass variability of a given sample. The two sources of variability in a typical industrial hygiene air sample are that contributed by the sampling media and that stemming from the collected material itself. The latter likely depends on what the collected material is and should be determined on a case-by-case basis. The mass stability of commonly used sampling media, however, can easily be determined.

Of particular current interest is the measurement of inhalable aerosols, as defined for many substances in the list of ACGIH TLVs®. One popular method is the use of a filter contained within a small cassette, where both are weighed. A study, therefore, was undertaken to determine filter and cassette mass variability during gravimetric assessment of airborne particulates, corresponding to those collected by an IOM sampler.

Three types of filter (Teflon®, glass fiber, and PVC) were investigated in combination with two types of cassette (plastic and stainless steel). For seven days, the substrates were repeatedly weighed and standard deviations of paired mass differences were calculated. Results indicate that collected masses as low as 0.1 mg can be confidently assessed when any of the filters above are used with stainless steel cassettes. Plastic cassettes, however, showed a consistent decrease in mass over the duration of the experiment, suggesting a longer required conditioning time.

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THE USE OF FLUORESCEIN IN AEROSOL STUDIES. J. Kesavanathan, R. Doherty, U.S. Army Edgewood Chemical Biological Center, Aberdeen Proving Ground, MD

Fluorescein has been used as a tracer in aerosol studies for the detection and quantification of aerosols. This paper summarizes a sequence of experiments conducted to confirm our procedure for the recovery and detection of fluorescein from filters. In addition, flourescein-tagged oil droplets were used to determine aerosol transmission efficiencies through transport tubes. Two aerosol transport tubes were tested using three particle sizes and the results were compared with calculated values.

Our results confirmed the following: 1) The optimum excitation and emission wavelengths for fluorescein are 492 nm and 516 nm, respectively; 2) changes in orientation/position of the test tube containing the sample in the fluorometer can affect the fluorescence at higher gain settings; 3) for fluorescence measurements to be accurate, sample measurements have to be significantly higher than the fluorescence of water-filled test tubes; 4) below the self-quenching limit, the fluorescence increases linearly with increasing fluorescein concentrations; 5) after the pH level of the recovery solution has reached 8.0, there is no significant effect on fluorescence for further increase in pH; 6) the change in pH does not affect the shape or position of the emission spectrum peak; 7) our procedure fully recovers fluorescein from glass fiber filters; 8) fluorescein samples, prepared for fluorometer measurements, were stable over at least a 12-day period; and 9) measured and calculated aerosol penetration values of two transport tubes agreed for 5, 11, and 15 ?m particles.

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PERFORMANCE OF PERSONAL DATA RAM IN PASSIVE AND ACTIVE MODES WITH AND WITHOUT INLET HEATER UNDER HIGH RELATIVE HUMIDITY. B. Samimi, J. Quintana, San Diego State University, San Diego, CA; M. Kleinman, R. Delfino, University of California, Irvine, CA

During the use of the MIE passive personal data RAMs 1000 (PDRs) to measure outdoor particulate levels, we observed extraordinarily high levels of peak particulate levels during 24-hour outdoor sampling. This occurred mostly in the early morning hours, which appeared to be caused by water condensation on the instrument's optic system. Because of this problem, it was necessary to examine other alternatives for a less-biased sampling strategy.

Four PDRs were used to collect co-located outdoor samples in order to compare passive and active sampling with and without the MIE Inlet Thermal Adapter, which is expected to reduce the relative humidity (RH) of the air before reaching the instrument's optic sensor. The co-located samples were collected for 24 hours on three consecutive days when the RH reached saturation condition during the night.

For active sampling, the passive PDRs were equipped with the MIE Active Sampling Adapter and were then operated by means of personal sampling pumps with a flow rate of approximately 2 L/min. The PDRs were randomly assigned as "Active Cold" (without the MIE Thermal Adapter) and "Active Hot" (with the Thermal Adapter). Two PDRs were also operated in passive mode.

The concentrations of particulate matter in mg/m^3 were logged and downloaded into a computer and matched with the downloaded RH/temperature data, which was monitored by a HOBO Pro-System. In a second round of sampling, two co-located passive and active PDRs were operated for seven consecutive days outdoors.

The results indicated that both "Active Cold" and "Active Hot" samples produced reasonably good results without the outrageous high readings during the high moisture conditions as frequently observed with the outdoor "passive" samples. The "Active Hot" samples, however, showed consistently 10%–15% lower TWAC and maximum concentrations than the "Active Cold" samples. The association between moisture saturation and the PDR's biased reading was documented.

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APPLICATION OF ASPIRATION EFFICIENCY PREDICTIVE MODELS ON ESTIMATING THE DIFFERENCE BETWEEN TOTAL AND INHALABLE AEROSOL EXPOSURES. P. Tsai, National Cheng Kung University, Tainan, Taiwan Republic of China; J. Vincent, University of Michigan, Ann Arbor, MI

This study is designated to investigate the possibility of using semiempirical aspiration efficiency predictive models to predict the performance difference between inhalable and total aerosol samplers.

Field samplings were conducted at 10 workplaces located in 5 nickel-associated industries. About 5 to 10 workers were chosen randomly from each workplace. Each worker was requested to wear an IOM inhalable sampler and a 37-mm filter cassette simultaneously to measure both inhalable and total aerosol exposure levels ($_mC_{IOM}$ and $_mC_{37}$). The $_mC_{IOM}/_mC_{37}$ factor (S_m) was estimated for each workplace. The personal inhalable dust spectrometer (PIDS) was used to estimate aerosol size distribution. PIDS sampling was conducted by using the mannequin sampling method, assuming that aerosols were spatially homogeneous.

For each workplace, three PIDs were used and continuous sampling was conducted for at least four days during field sampling. An anemometer was used to measure environmental wind speed and totals of 20 measurements were obtained per workplace.

By applying predictive models, the obtained size distribution and wind speed were used to predict the collected concentrations for both IOM and 37-mm filter cassette ($_pC_{IOM}$ and $_pC_{37}$). The $_pC_{IOM}/_pC_{37}$ factor (S_p) was estimated for each workplace. Significant differences were found between the S_m and S_p for all selected workplaces. However, an empirical relation of $S_m = 1.82\ S_p - 8$ ($R^2 = 0.72$, n = 10) was established in this study.

It is concluded that directly using predictive models to estimate aerosol sampler performance might not be realistic because of the inadequacy of the predictive models at low wind speed situations. Although empirical relation between S_m and S_p was found, it is purely empirical and, thus, should be used with extreme caution.

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FILTER LOADING WITH LIQUID AEROSOLS. G. Earnest, NIOSH/Division of Physical Sciences and Engineering, Cincinnati, OH; D. Chen, D. Pui, Particle Technology Laboratory, Mechanical Engineering Department, University of Minnesota, Minneapolis, MN

Filter pressure drop and collection efficiency have been evaluated for fibrous filters as they were loaded with polydisperse liquid aerosols. This fundamental study relates to the control of worker exposures to metalworking fluid (MWF) mists. Test aerosols included MWFs and simple organic liquids to provide a range of densities, viscosities, and surface tensions. Filters consisting of either synthetic or natural fibers with packing densities from 0.01 to 0.10 were tested. Fiber wetting and liquid-fiber contact angle was evaluated. Face velocities ranged from 10 cm/s to 150 cm/s. The computer-controlled system operated and maintained the airflow rate, particle counter, and data transfer. A laser particle counter sampled air upstream and downstream of the filter. This counter samples particles in the range of 0.3–25 µm.

Pressure drop across the filter and fractional collection efficiency was generally found to increase as the filters were loaded with polydisperse liquid aerosols; however, for conditions of both low-face velocities and low-packing densities, temporary reductions in fractional collection efficiency were observed. The efficiency reductions typically occurred for submicron aerosol diameters; however, they occasionally occurred at larger diameters. Mathematical models were developed to describe changes in pressure drop across the filter and collec-

tion efficiency during loading. The pressure drop model was based largely on the theory of flow of fluids through porous media. Filter pressure drop and collection efficiency appeared to be strongly influenced by the face velocity and the revised packing density resulting from collected liquid.

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THE CONTRIBUTION OF AN INDUSTRIAL PARK TO PM_{10} CONCENTRATIONS OF A LOCAL COMMUNITY. S. Lung, C. Liu, C. Huang, Chung Shan Medical and Dental College, Taichung, Taiwan Republic of China; H. Chen, P. Shieh, Environmental Protection Administration, Taipei, Taiwan Republic of China; I. Mao, National Yang-Ming University, Taipei, Taiwan Republic of China

This study's objective was to assess ambient PM_{10} concentrations in communities with different characteristics. One residential community, one business district, three business-residence mixed areas, and one near-industrial-park community in Taiwan were selected for comparison. They are all located within a 3-km radius of some Taiwan-EPA monitoring stations. The influence of different surroundings on ambient PM_{10} concentrations was investigated. The major factors affected PM_{10} concentrations in communities were also explored.

Sampling was conducted with personal environmental monitors (PEMs) with 37 mm Teflon® filters, connected to SKC AirChek 52® sampling pumps. The flow rate was set at 2 L/min. They were placed 2 m above ground. Five sampling locations were chosen in each community. The sampling time was 24 hours. An EPA's automatic monitoring vehicle was operated in the community at the same time. The measurements obtained were also compared with those from near-by monitoring stations.

The results showed that PM_{10} concentrations of residential, business, mixed, and near-industry communities were 29~191 $\mu g/m^3$, 63~255 $\mu g/m^3$, 15~220 $\mu g/m^3$, and 110~265 $\mu g/m^3$, respectively. PM_{10} concentrations in the near-industry community were significantly higher statistically than those measured in other communities. Twenty-seven measurements of 108 samples exceeded the PM_{10} 24-hour ambient air quality standard (125 $\mu g/m^3$). Ten of the measurements were from the near-industry-park community. PM_{10} concentrations obtained from automatic monitoring vehicles and near-by monitoring stations also showed the significant influence of the industrial park to PM_{10} concentrations in local communities. A countermeasure should be enforced to reduce the industrial park's particle emissions and to protect public health in near-by communities.

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CLEARANCE WAITING PERIOD AFTER LEAD-BASED PAINT ABATEMENT. W. Friedman, Office of Lead Hazard Control, U.S. Department of Housing and Urban Development, Washington, DC; S. Grinshpun, K. Willeke, K. Choe, M. Trunov, S. Trakumas, University of Cincinnati, Department of Environmental Health, Cincinnati, OH; P. Middendorf, V. Ainslie, Georgia Institute of Technology, Atlanta, GA; J. Millette, MVA Inc., Norcross, GA

Clearance testing of lead dust loading on horizontal surfaces is required after lead-based paint abatement in certain U.S. pre-1978 residential and other facilities. A waiting period is required between cleanup and clearance so most airborne dust can settle. The current waiting period guidance uses a tranquil particle settling model assuming perfectly calm room air — an untested assumption.

The evolution of the airborne particle concentration and size distribution following "worst-case" dry sanding or dry scraping of lead-based painted wooden doors was evaluated in a 860 ft^3 environmental test chamber using real-time particle size spectrometry and chemical analysis, and used to project floor lead loadings as those particles settle. Size-fractional airborne particle concentrations decreased exponentially, with or without air exchange. Even very low levels of air mixing affect particle settling.

These results are consistent with the stirred model (constantly mixed air), which predicts longer settling than the tranquil model. A data-based method was developed for calculating the underestimate of lead loading from conducting clearance testing at a finite time rather than waiting forever. About 90% of airborne lead mass settled 1 hour after active abatement, before final cleaning.

Cleaning (even when less stringent than recommended by HUD) followed by a second waiting period further decreased airborne lead; the additional floor dust lead loading after the 1-hour second waiting period is <20 ?g/ft^2. For this "worst-case scenario," the lead loading underestimate is <~30%. For more realistic conditions, underestimates are projected to be <<40 ?g/ft^2, the new HUD clearance standard for floor dust lead.

The laboratory findings above were confirmed in a second laboratory's chamber, and in initial field trials in older housing. This study demonstrates that there is no need to increase either waiting period, even using the data-based air mixing model, and suggests ways to decrease overall waiting.

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FIELD TESTING OF INDIVIDUAL VERSUS COMPOSITE DUST-WIPE SAMPLES. W. Strauss, A. Pate, J. Holdcraft, Battelle, Columbus, OH

Use of composite wipe samples for clearance testing has attractive qualities, including possible economical savings from reduced sample analysis. A composite wipe sample is a group of individual wipe samples collected from multiple locations of the same residential surface type (floors, window sills, or troughs) that are combined into a single analytical sample.

The current HUD guidelines suggest that composite wipe samples may be used for both clearance testing and risk assessment, while comparing the results to standards developed for individual dust-wipe samples. However, if the goal of clearance testing is to ensure that no single area within a residence is hazardous to occupants, clearance standards specifically designed for composite samples might be necessary to offer occupants a similar degree of protection.

Battelle conducted a field study designed specifically to investigate the performance of composite dust wipe samples (compared with individual wipe samples) used for either risk assessment or clearance testing. In this study, the environmental sampling personnel from three field participants collected side-by-side duplicate dust-wipe samples from multiple selected locations in approximately 250 residential units that required either risk assessment or clearance testing.

The duplicate wipe samples were split: one was analyzed as an individual dust-clearance sample, and the other was composited along with other wipe samples from the same component type. Visual inspection information was also integrated into the sampling protocol, in which inspectors guessed the dust-lead loading and commented on the "dirtiness" of the surfaces being tested.

Results of the study demonstrated comparability of dust-lead loadings between the average of individual samples and their associated composite samples (p-value < 0.01), and that visual inspection was predictive of dust-lead loading outcomes for all three residential surface types (p-value < 0.01).

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PERFORMANCE OF A PROPOSED STANDARD METHOD FOR LABORATORY EXTRACTION OF LEAD FROM MULTIWIPE-COMPOSITED DUST SAMPLES. G. Dewalt, D. Cox, R. Schmehl, QuanTech, Inc., Arlington, VA; K. White, Consultive Services, Virginia Beach, VA; E. Pinzer, W. Friedman, U.S Department of Housing and Urban Development, Washington, DC

All lead paint, duct, and soil samples collected from federally regulated lead-based paint activities must be analyzed by laboratories recognized under the National Lead Laboratory Accreditation Program (NLLAP). These regulations allow settled dust sampling by composited dust wipes that use up to four wipes per composited sample. Currently, no laboratories are recognized for analysis of composited dust-wipe samples. With the possible exception of a previous limited study investigating the performance of two methods (July 1996, EPA 747–R–96–003), no recognized standard method for the extraction of lead from composited dust-wipe samples is available.

We performed a study to select a recommended standard method for laboratory preparation of composited wipe samples for lead analysis. This study differs from the previous work in that the experience and knowledge of the larger laboratories actively processing wipe samples were used to identify and evaluate suitable extraction methods for processing dust samples containing four composited wipes.

Two rounds of single blind four-wipe-composited samples were used to generate a recommendation. The first round was used to evaluate existing dust-wipe methods conducted by nine selected laboratories for performance on composited wipe samples. Data from this round were used to identify and propose a suitable recommended method. Performance of this recommended method was measured by having these same nine laboratories process 432 samples during Round 2 using the recommended method.

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ASSESSING THE APPROPRIATE PARTICLE SIZE FRACTION TO USE FOR THE ANALYSIS OF SOIL AND DUST SAMPLES FOR LEAD. S. Roda, S. Clark, J. Buchanan, S. Spalding, University of Cincinnati, Cincinnati, OH; W. Friedman, U.S. Department of Housing and Urban Development, Washington, DC

Ingestion of lead (Pb) resulting from hand-to-mouth transfer of lead-contaminated soil or dust is one of the most important pathways of lead exposure in children. As part of the exposure assessment process, the source and location of the lead is determined using soil and dust sampling strategies and techniques devised to collect and analyze samples representative of particular areas or locations. However, to reliably assess the amount of lead in a sample portion that may present the greatest health

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