cyclones only approximately follow respirable or thoracic curves. This study describes a new type of size-selective sampler able to meet predetermined requirements with higher accuracy.

It is known that a sampling efficiency curve of any shape may be approximated using several impactors, each of which simulates a portion of a given curve. In the proposed sampler, particle-laden air is divided by directing the incoming air to a plate with a plurality of sized nozzles, each leading to a chamber with a collection substrate and a sized outlet orifice, i.e., the sampler contains a number of impactors arranged in parallel. The pressure drop across each impactor is equal to the pressure drop across the entire sampler. The inlet nozzles are sized to achieve desired cuts. The cut-off sizes are determined by the number of collectors incorporated into the sampler, overall sampling flow, and shape of the curve the sampler is designed to follow. The outlet orifice in each impactor is complementary to its inlet nozzle and is selected to assure the required flow rate through each impactor. Air passing through the exit orifices enters a common passage and the remaining particles are collected on a filter.

A respirable sampler containing four round-nozzle impactors in parallel and operating at 4.0 L/min flow rate was designed. Fifty percent cut-off sizes obtained experimentally for each impactor operating at 1.0 L/min were 2.7, 3.8, 4.7, and 6.0 micrometers. The overall sampling efficiency of this sampler followed the ACGIH/ISO respirable curve more closely than did that of respirable cyclones tested.

67.

RESPIRABLE CONCENTRATIONS OF WELDING FUMES AT AN ELECTROMOTIVE PLANT USING VARIOUS EXPOSURE ASSESSMENT TECHNIQUES. S. Erdal, S. Todd, H. Kimberly, D. Vinson, L. Conroy, University of Illinois at Chicago, Chicago, IL.

Welding fumes have been associated with a number of health outcomes. Some of these include respiratory health effects, neurological health effects, and cancer. Welding processes produce a majority of particles in the respirable aerodynamic size range. We have performed an exposure assessment study in an electromotive plant to study respirable particle exposure associated with various welding processes performed in the plant. A majority of workers employed sheilded metal arc welding, stick or rod welding, and/or gas-metal arc welding processes to weld electromotive parts. We established static sampling stations at three different locations in the plant. Two of these locations were in the plant where about twenty welders at different locations worked, with one station closer to workers (Station 1), and the other station in the main area of the plant (Station 2). The former station is designed to capture respirable dust concentrations in a close proximity to the workers, and the latter station was designed to capture general area exposures experienced by the workers. A third station was placed in a location where most of the electricians in the plant worked. We used a personal exposure monitor (PEM) with 2.5-um cut-off, a SKC cyclone for respirable dust collection, and a Respicon sampler as exposure assessment techniques to obtain measurements of respirable dust. The total sampling duration was from 6 to 8 hours, and the sampling was conducted on Mondays for five consecutive weeks. The respirable concentrations using PEM varied from 220 to 1658 ug/m^3 at Station 1, and from 302 to 482 ug/m^3 at Station 2. The respirable concentrations using the SKC-cyclone varied from 231 to 299 ug/m^3 at Station 1, from 335 to 415 ug/m^3 at Station 2. The use of various exposure tools was very beneficial in terms of understanding potential respirable exposure range and to gain insight into the performance of these samplers.

68.

LIMITING PARAMETERS FOR ALVEOLAR DEPOSITION OF ULTRA-FINE AEROSOLS. N. Esmen, S. Erdal, University of Illinois at Chicago, Chicago, IL.

Recently, considerable interest has been shown in the health effects of inhaled ultra-fine aerosols (diameter <0.1 micron). Based on their dynamic properties, the inhaled ultra-fine aerosols are inherently unstable and their constituents will rapidly coagulate resulting in shifting size distributions and reduced concentration. Their size distribution and concentration shift are based on the initial concentration and size distribution of the aerosol as well as the transport time available. In this respect, there are important questions in regards to the size distribution and the concentration of the aerosol that is expected to penetrate to the alveolar spaces and the critical aerosol transport time. The concentration and time-based limiting size distribution of an insoluble ultra-fine aerosol, that may be calculated ignoring condensation effects, can be taken to be the overall limiting behavior for all such particles. Therefore, the time dependent number concentration, coagulation-driven asymptotic size distribution, and critical coagulation time of such an aerosol are important limiting parameters of ultra-fine particle exposure.

Using the self-preserving particle size distribution function, empirically determined Brownian, and turbulent diffusion coefficients and inhalation times, the alveolar penetration size distribution of an initially monodisperse (0.1 micron diameter) aerosol is calculated as a function of time. The shifting size distribution, initial number concentration, and normal inhalation parameters were then used to calculate the limiting concentration that can reach the alveolar spaces as ultra-fine aerosol.

For 0.1-micron unit density spheres, these calculations suggest that the self-preserving limiting alveolar concentration of ultra-fine aerosol is less than 50 ug/m^3. The limiting size distribution follows aging fume distribution closely. Therefore, the smaller or soluble aerosols are expected to have a lower limiting alveolar concentration. The calculated values agree very well with the available experimental results.

69.

A COMPARISON OF METHODS TO MEASURE AEROSOL SURFACE-AREA. A. Maynard, B. Ku, NIOSH, Cincinnati, OH; P. Andresen, G. Ramachandran, University of Minnesota, Minneapolis, MN; P. Pai, B. Prasad, University of Mysore, Mysore, India.

.There has been mounting evidence that for some classes of aerosols, particle surface-area is a more appropriate exposure metric than mass concentration. However, appropriate means to measure surface-area exposure within occupational settings are not widely available, and in most cases have not been evaluated extensively. Here, we present an initial comparison between four methods of measuring or estimating aerosol surface area.

The four methods investigated include: surface-area derivation from particle mobility diameter measurements; estimating surface area from transmission electron microscopy (TEM) measurements; diffusion charging (using the LQ1-DC diffusion charger from Matter Engineering, Switzerland); and estimating surface-area from aerosol number and mass concentration measurements. Laboratory-generated monodisperse and polydisperse silver particles with morphologies ranging from spherical to fractal-like were used to evaluate the methods side-by-side. In addition, field data from indoor exposures to cooking smoke in India was used to compare diffusion charger measurements, and surface-area estimates from number and mass concentration measurements.

Calculations of mean particle surface-area using the silver aerosol showed good agreement between the TEM, diffusion charging, and mobility diameter measurements for spherical and fractal-like monodisperse particles smaller than 100 nm. Comparisons using polydisperse aerosols were more ambiguous, but in general showed good agreement between these methods. Estimates of aerosol surface-area using number and mass concentration measurements were in general agreement with mobility diameter-derived measurements for compact particles. However, estimated surface-area was lower than anticipated for fractal-like particles Field comparisons between the diffusion charger and the number and mass concentration-based method indicated that, with the use of a suitable calibration factor, aerosol surface-area exposure may be estimated to within a factor of 1.4 at concentrations above 500 μm^2/cm^3. (The diffusion charger used measures concentrations up to 2000 μm^2/cm^3, and it is expected that occupational exposures exceeding 10^6 μm^2/cm^3 will not be uncommon.)

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