

RESEARCH PAPERS INVOLVING THE TSI RESPICON™ SAMPLER

APPLICATION NOTE ITI-080

1. Li Shou-Nan, Lundgren D.A., Rovell-Rixx D., Evaluation of six inhalable aerosol samplers. *American Industrial Hygiene Assoc. Journal*, Vol. 61(4), pg. 506-516 (2000).

Six inhalable aerosol samplers were evaluated experimentally as area samplers using monodisperse solid particles with aerodynamic diameters ranging from 5 to 68 μm . Sampler performance and inside particle loss at two test wind speeds (0.55 and 1.1 m/sec) and three wind orientations (0, 90, and 180 degrees) were investigated. The six inhalable aerosol samplers tested were a RESPICON™ sampler, an Institute of Occupational Medicine (IOM), a seven-hole, a conical inhalable sampler, a prototype button sampler, and a closed-face 37-mm cassette. The area sampling performance of the RESPICON™ sampler matched the inhalable convention fairly well. The sampling performances of the other five samplers depended on wind speed, wind direction, and particle size, and they may not be appropriate for area sampling if the wind speeds are greater than 0.5 m/sec.

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2. Koch, W. Dunkhorst, W. Lodding, H., RESPICON TM-3 F: a new personal measuring system for size segregated dust measurement at workplaces. *Staub Reinhaltung der Luft*. Vol. 57(5), pg 177-184 (1997).

In this paper a new device for health related dust measurement at workplaces is described. The instrument is a personal dust monitoring and sampling system. The inhalable, the thoracic and the alveolar fraction of the airborne dust are simultaneously sampled, and monitored on-line. The sampling characteristics of the device follow the convention of the European Standard EN 481. The measuring principle is a combination of inertial classification and concentration enrichment using a virtual impactor, filter sampling and aerosol photometry. The instrument is described in detail and the results of test and calibration measurements as well as measurements at workplaces are presented.

3. Koch, W. Dunkhorst, W., and Lödging, H., Design and Performance of a New Personal Aerosol Monitor. *Aerosol Sci & Tech.*, Vol. (31), pg.231-246 (1999).

Three particle size fractions of the airborne dust are defined in European and US standards for health-related dust measurements at the workplace: the respirable, the thoracic, and the inhalable fraction. We developed a novel instrument for personal, time-resolved concentration monitoring and sampling of these three fractions. The instrument combines inertial classification, filter sampling and photometric aerosol detection. It consists of a two-stage virtual impactor (cut-off diameters of 4 and 10 μm), three filters, and three light scattering photometers. The virtual impactor serves as a particle size classifier and a coarse particle concentrator. This enrichment compensates for the decreasing particle mass-based photometric sensitivity with increasing particle diameter. The optical sensors are calibrated in-situ via the mass concentrations obtained gravimetrically from the filter samples. The device operates at a flow rate of 3.1 l/min. There is good agreement between the experimentally determined particle size-dependent collection efficiencies and the definition curves of the corresponding dust fractions. The size dependence of the sensitivity of the inertial concentrator and photometric detection units follow the definition curves qualitatively. Exposure data were obtained for different workplace environments characterized by temporally and spatially highly fluctuating concentrations. The field measurements have shown that the instrument is practicable under rough industrial conditions and that it enables a more comprehensive and more realistic characterization of the individual exposure of workers to health-endangering dusts than was previously possible.



4. Rando, R., Poovey, H., Mokadam, D., Glindmeyer, H., Performance of the RESPICON for size-selective sampling of wood dust. *2000 American Industrial Hygiene Conference & Exposition*, Orlando, FL, May 20–25, 2000.

The RESPICON™ sampler is a three-stage virtual impactor that simultaneously collects the ISO/CEN/ACGIH size fractions of inhalable, thoracic, and respirable particulate. The device is especially attractive for sampling of wood dust because virtual impaction onto glass-fiber filters minimizes dust overload and particle bounce, and the sampling inlet geometry should prevent intrusion of large wood chips. The performance of the device for wood dust was evaluated against reference size-selective samplers: the IOM sampler (inhalable dust), the GK 2.69 cyclone (BGI, Inc.) (thoracic dust), and the SKC aluminum cyclone (respirable dust). Side-by-side personal monitoring of wood dust exposure using the RESPICON™ sampler and reference samplers along with cascade centripeter area samples was performed in a small woodworking shop. Eight sets of samples were collected in the breathing zone (BZ) of an individual sanding pine and oak boards using an electric sheet sander. According to the reference samplers, the mean (range) dust levels for sanding of pine were: inhalable, 9.19 mg/m³ (5.34-12.1); thoracic, 3.86 mg/m³ (2.76-4.58); and respirable, 1.79 mg/m³ (1.50-2.26). For sanding of oak, the mean dust levels were: inhalable, 5.08 mg/m³ (2.43-8.09); thoracic, 1.75 mg/m³ (1.46-2.17); and respirable, 0.94 mg/m³ (0.47-1.63). According to the centripeter, the MMADs of the dust averaged 7 mm and 6.4 mm, for pine and oak, respectively. Overall, there was no significant difference in the performance of the RESPICON™ sampler for size-selective sampling of the dusts of the two wood types. Regression analyses of the results from the RESPICON™ sampler against the respective reference sampler yielded the following slopes: inhalable dust, 0.98; thoracic dust, 1.0; and respirable dust, 0.80. These data suggest that the RESPICON is appropriate for size-selective sampling of wood dust, although the respirable fraction may require an adjustment factor for improved accuracy.

5. D. Stephenson, D., Spear, T., Seymour, M., Comparison of Methods for Personal Sampling of Inhalable and Total Abrasive Blasting Aerosol, *2001 American Industrial Hygiene Conference & Exposition*, New Orleans, LA, June 2–7, 2001.

Inhalation of occupational aerosols remains a significant cause of mortality in the work environment. During the 29-year period from 1968 to 1996 NIOSH has documented over 113,000 workplace related pneumoconiosis deaths among United States (U.S.) residents, age 15 and over. Exposure to occupational aerosols is estimated by the physical sampling of air in a worker's breathing zone. The traditional approach to evaluating worker exposure to aerosols that pose a health risk when particulate matter is deposited at any site within the pulmonary system is commonly referred to as "total aerosol" sampling. In the United States, the traditional method for collecting "total aerosol" is through the use of a 37-mm, closed faced sampling cassette. Since the late 1970's "total aerosol" sampling using this device has been scrutinized because of its decreased collection efficiency when used with aerosols having relatively large particle sizes (approximately 45 µm or greater). This limitation has resulted in a new aerosol size fraction termed "inhalable aerosol" which is expressed as a sampling convention, which samplers for this fraction must emulate. The RESPICON™ sampler is a sampling device marketed as having the ability to accurately collect an aerosol's inhalable fraction. This research uses aerosol data collected during abrasive blasting operations to perform a side-by-side comparison study investigating differences in the collection efficiencies of the 37-mm total aerosol sampler and the RespiCon™ inhalable aerosol sampler. Research results include the estimation of total and inhalable aerosol exposure by the quantification of TWA mass concentration values, the determination of statistically significant differences between TWA concentration results obtained from each total and inhalable aerosol sampler, and the estimation of a conversion factor between the two measures of exposure.

6. Roy Rando, Halet Poovey, Dinkar Mokadam, Joseph Brisolara, Field Performance of the RESPICON™ for Size-Selective Sampling of Industrial Wood Processing Dust. *Journal of Occupational and Environmental Hygiene*, Vol. 2, 219-226 (2005).

The RESPICON™ sampler is a multistage virtual impactor that simultaneously collects the ISO/CEN/ACGIH size fractions of inhalable, thoracic, and respirable particulate matter. The field performance of the device for measurement of industrial wood processing dust was evaluated against reference size-selective samplers: the IOM sampler (inhalable dust), the GK 2.69 cyclone (thoracic dust), and the SKC aluminum cyclone (respirable dust). Seventy-one sets of area samples were collected from 10 wood processing plants, with the samplers mounted either in the free-field or on a two-dimensional “bluff body.” The geometric mean (range) dust levels across all plants measured by the reference samplers were: inhalable, 1.35 mg/m³ (0.11–11.06); thoracic, 0.31 mg/m³ (0.05–1.38); and respirable, 0.10 mg/m³ (0.02–0.54). In comparing the RESPICON™ sampler with the reference samplers, there was no significant difference between sampling in the free-field versus bluff-body modes. For inhalable dust, there was no significant difference between the RESPICON™ sampler and the IOM sampler after applying a correction factor of 1.5x to the extrathoracic data obtained from the RESPICON™ sampler. Without the correction factor, the RESPICON™ sampler undersample inhalable dust by an average of 23%. For thoracic dust, the RESPICON™ sampler was shown to oversample the extrathoracic dust fraction resulting in an overall error of 48%. A simple correction based on the inhalable and thoracic dust levels reported by the RESPICON™ sampler is proposed. For respirable dust, there was a significant difference between the RESPICON™ sampler and the SKC cyclone, but the data were equivocal due to imprecision in measurement of the low respirable dust concentrations encountered and the likelihood of bias in the reference sampler. Overall, the RESPICON™ sampler appears to be a suitable size-selective sampling device for industrial wood processing dust, although adjustments should be made to the inhalable and thoracic dust results.



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