

expose 48 diffusive samplers and 8 reference samplers to uniformly conditioned air with less than 2% analyte depletion at an air velocity of 10 cm/sec.

Exposure Time: Test conditions can be held constant and uniform for more than 8 hours.

Analyte Generation: Simultaneous delivery, vaporization, and dilution of ppm to sub-ppm levels of controlled concentrations of multiple test analyses is routine. Gas phase analytes have also been tested.

Construction Materials: All internal surfaces are constructed from PFA and polypropylene.

Airflow: 5 to 150 cm/sec (10 to 300 ft/min)

Dynamic Response: Response to step change in test concentration is 98% complete within about 40 seconds depending on analyte and airflow.

Temperature: Can be controlled to $\pm 31^\circ\text{C}$ at any temperature between 10 and 401°C .

Humidity: Can be controlled to $\pm 5\%$ at any humidity between 25 and 80% R.H. from 10 to about 301°C .

Pressure: Can be maintained from 10% less than to 10% more than atmospheric pressure.

Since its qualification and acceptance by NIOSH in February 1997 the EVS has been used for a variety of technical studies and diffusive sampler validations. Data are presented from these studies and validations that verify the above specifications.

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PIPERAZINE: DEVELOPMENT AND VALIDATION OF AN AIR MONITORING METHOD. D.W. Huff, P. Murphy, The Dow Chemical Co., Midland, MI

A method has been developed for monitoring piperazine vapor in air by utilizing 900-mg Chromosorb 106 sorbent tubes. This method was validated for use of flow rates up to 1 L/min and air volumes #240 L. The average recovery and standard deviation for piperazine from 900-mg Chromosorb 106 tubes was $101 \pm 4.4\%$ at loading levels ranging from 4.55 to 109 mg piperazine (this corresponds to air concentrations ranging from 0.0054 to 0.13 ppm based on a 240-L air volume). The 900-mg Chromosorb 106 tubes were desorbed in 10 mL of $8 \text{ H } 10^3 \text{ M}$ 1-naphthylisothiocyanate (NIT) in dimethylformamide (DMF) to derivatize the piperazine and analyzed by high performance liquid chromatography with ultraviolet detection at 280 nm. Storage stability studies indicated that samples could be stored for at least 2 days at ambient (-231°C) or 2 weeks at freezer temperatures (-101°C) without significantly impacting recoveries.

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PHOTOACOUSTIC FTIR SPECTROSCOPY FOR CRYSTALLINE SILICA ANALYSIS. Z. Zhuang, D. Schwerha, B. Chen, G. Feather, S. Soderholm, NIOSH, Morgantown, WV

The National Institute for Occupational Safety and Health (NIOSH) *Manual of Analytical Methods* includes three laboratory methods for measuring crystalline silica: X-ray diffraction (XRD), infrared spectroscopy (IR), and colorimetry (VIS). The purpose of this study was to determine if photoacoustic Fourier transform infrared (PA-FTIR) spectroscopy could be a viable alternative for laboratory analysis of crystalline silica samples. One benefit of PA-FTIR spectroscopy is that it is a nondestructive

direct-on-filter method. In a preliminary study, crystalline silica dusts were generated using a fluidized-bed aerosol generator with a quartz stock standard (Min-U-Sil 5). The size distributions of the generated aerosols were determined using a micro-orifice uniform deposit impactor. The samples used in the PA-FTIR analysis were collected using 9-mm portions of 25-mm vinyl metrical (VM-1) filters loaded into 25-mm cassettes, which were attached to nylon cyclones, at a flow rate of 1.7 L/min. The respirable crystalline silica dust samples were weighed and then analyzed by PA-FTIR spectroscopy. Samples with different masses were collected. Multiple measurements of the samples were conducted to determine reproducibility of the analysis technique. The mass medium aerodynamic diameter of the samples on the filters was estimated to be 1.0 mm with a geometric standard deviation of 1.8 by correcting the size distribution from the impactor samples using the ACGIH definition of respirable particulate mass. A calibration curve was constructed. The limit of detection was determined to be less than 10 mg of quartz. Using 32 FTIR scans for each measurement, the relative standard deviation of replicate measurements of one filter was below 10%. These preliminary data indicate that PA-FTIR is worth additional study to determine whether it may be valid laboratory method for direct-on-filter measurement of crystalline silica.

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COMPARISON OF SAMPLING METHODS FOR 1,6-HEXAMETHYLENE DIISOCYANATE DURING SPRAY FINISHING OPERATIONS. E.C. England, G.N. Carlton, U.S. Air Force, Brooks AFB TX; R. Key-Schwartz, NIOSH, Cincinnati, OH; J. Lesagé, IRSST, Montreal Quebec, Canada

This report summarizes the results of a comparison study of isocyanate sampling methods for 1,6-hexamethylene diisocyanate (HDI) in Air Force spray painting environments. This study compared the performance of the Isocheck sampler (Omega, Inc.) and calculated HDI oligomer concentrations from total mass air concentrations against existing NIOSH and OSHA monitoring methods for isocyanates. The results will determine the correlation between sampling results obtained using the Isocheck sampler in field environments and existing sampling methods for HDI. Additionally, because of very limited existing data, the study was accomplished to assess aircraft painters' exposures to isocyanates.

Seven methods for monitoring HDI oligomer and monomer levels were compared. Fifty-eight sampling sets were collected during spray painting of aircraft and aircraft parts at four Air Force bases. Impinger and cassette samplers were mounted side-by-side on a mannequin located in maximum paint overspray areas. Additionally, 58 sampling sets of personal breathing zone samples comparing NIOSH 5521, Isocheck sampler, and total aerosol mass methods were collected. Breathing zone air concentrations of HDI monomer ranged from $0.001\text{--}0.046 \text{ mg/m}^3$. Breathing zone air concentrations of HDI oligomer ranged from $0.01\text{--}2.36 \text{ mg/m}^3$. Calculated 8-hour time-weighted average exposure levels ranged from $0.01\text{--}0.58 \text{ mg/m}^3$ for HDI oligomer.

It is concluded that aircraft painters moni-

tored in this study have exposures to HDI monomer less than the ACGIH TLV-TWA of 0.034 mg/m^3 and exposures to HDI oligomer exceeding the State of Oregon guideline of 1.0 mg/m^3 as a ceiling concentration. Comparison data among the various sampling techniques has been statistically analyzed and will be available for presentation.

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POLYMERIC-HDI AEROSOL SAMPLING EFFICIENCY COMPARISON: IMPINGER VS. COATED FOAM SAMPLER. B. Czarniecki, Czartech Analytical, Novi, MI

Coating systems formulated with prepolymeric isocyanates continue to have wide application due to their high durability characteristics under extreme environmental conditions. Worker exposure to isocyanate toxicity is commonly monitored using toluene-based impingers during the spray application of these products. A novel porous foam matrix aerosol sampling system was coated with 1-(2-pyridyl)piperazine (12PP) using a nonvolatile aerosol solubilizing agent. This sampler was tested against 12PP-toluene impingers (0.5 mg/mL) in an aerosol chamber.

HDI isocyanurate (Desmodur N3390) and aliphatic HDI-polyisocyanate were dissolved in propylene glycol methyl ether acetate and aerosolized in an all glass nebulizer. Aerosol generation was controlled using a mass flow controller. Chamber atmospheres were sampled at 1 L/min for 10 min using side-by-side impingers and foam matrix samplers. Analysis was performed using HPLC with UV/fluorescence detection. Equivalent collection of HDI-polyisocyanate aerosol was measured in aerosol atmospheres of 0.3 mg/m^3 (mean = $2.7 \text{ mg/foam matrix sampler}$; mean = 3.2 mg/impinger); 1.2 mg/m^3 (mean = $15 \text{ mg/foam matrix sampler}$; mean = 13 mg/impinger); and 7 mg/m^3 (mean = $68 \text{ mg/foam matrix sampler}$; mean = 72 mg/impinger). For all conditions tested, $n = 5$ measurements/condition.

These results demonstrate equivalent collection efficiency between the foam matrix sampler and toluene impinger under the conditions studied. The channeled porous cellular architecture of the coated foam matrix may provide the surface conditions necessary for aerosol particle solubilization and favorable mixing of NCO and 12PP reactants.

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THE PERFORMANCE OF BENZENE CHARCOAL SAMPLING TUBES IN THE PRESENCE OF TOLUENE AND XYLENES UNDER VARYING HUMIDITY. G.F. Yeager, Jr., Texas Children's Hospital, Houston, TX; M.T. Morandi, University of Texas School of Public Health, Houston, TX

Benzene, toluene, and mixed xylenes are common components in crude oil and many petrochemical product emissions. Since 1970 NIOSH has recommended the use of activated charcoal for the collection and measurement of these vapors in the workplace. A number of investigations have been conducted to evaluate the effects of relative humidity, competing solvents, and chemical loadings on the charcoal sampling tubes.

Previous studies have indicated problems with sampling efficiencies at relative humidities

Abstracts

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