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relative humidities, the sampler's analyte recovery was above 99%. While particle growth due to the hygroscopicity of sulfuric acid shifts particle collection toward the impactor at high RH, the mass concentration of sulfuric acid was conserved for the combined impactor and filter collection. The storage stability of the H_2SO_4 samples taken every 5 days showed that, for ambient storage, the overall standard error of the samples collected in 25 days was 5.76% with 95% confidence limit of 11.28%, while for refrigerated samples, the standard error was 4.96% and 95% confidence limit was 9.65%, indicating both storage methods impose no significant effect on the samples.

Conclusions: This validated new personal sampler will provide accurate and reliable monitoring of inorganic acid mist in occupational setting over conventional methods which suffer from interferences encountered when using current NIOSH method.

SR-128-09
Analytical Method Validation for the Use of Microfiber Cloth Swatches in Surface Wipe Sampling

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Objective: Wipe sampling of workplace surfaces is a valuable tool for dermal exposure assessments. The purpose of this investigation was to evaluate the use of microfiber cloth swatches, pre-wetted with solvent, as surface wipe media for acrylates. The microfiber cloth, which is designed for cleaning purposes, is physically more durable than other conventional wipe media.

Methods: Sampled wipes were solvent extracted and then analyzed using gas chromatography/mass spectrometry (GC/MS). The following quality control samples were prepared to evaluate the accuracy and precision of the analytical methodology: wipe spikes (extraction efficiency), surface spikes (sampling efficiency), blanks (media interferences), and holding time spikes (analyte stability on the wipe media).

Results: Wipe spikes produced recoveries within 100±25% demonstrating that the target analytes could be quantitatively extracted from the microfiber media. Wipes sampled from spiked aluminum foil demonstrated greater variability with recoveries between 100±50%. The acrylates tested for this study were stable on the wipe media for a minimum of fourteen days.

Conclusions: Microfiber wipes are a suitable media for surface wipe sampling for acrylates and potentially other classes of chemicals. The study demonstrated that quantitative results can be obtained for the analysis of the wipe samples. However the similarity of the transfer efficiency of the wipe sampling to actual dermal uptake could not be quantified.

SR-128-10
Sampling of Semi-Volatile Compounds - A New Sampling System for Simultaneous Sampling of Droplets and Vapors

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Objective: The European Standard EN 13936 defines the basic requirements for semi-volatile compounds that can occur as vapor and particle at the same time at workplaces. Vapor and particles shall not be sampled separately and particles have to be sampled as inhalable fraction. Sampler containing filter and pumped sorbent tube in series are one of the suitable sampling trains. IFA has developed a sampling head (GGP-Mini) which is designed to sample the inhalable fraction at flow rates that can be easily combined with commercially available adsorption tubes. Particles will be sampled on a 13 mm filter. A basic set up with glass fiber filter and charcoal tube was tested.

Methods: Laboratory tests were performed with compounds in a boiling point range from 188 °C (propylene glycol) to 318 °C (n-octadecane). The substances were spiked directly on the filter and then air sucked through (0.33 l/min, 2 h). For further evaluation droplet/vapor mixtures of n-hexadecane, n-octadecane and diethylene glycol with droplet sizes between 1 µm and 4 µm were generated in a flow-tube reactor. All samples were analysed with GC-FID. In the flow-tube the aerosols were analysed online with a particle counter (particle number and concentration) and a flame ionisation detector (total concentration).

Results: Mainly substances with boiling points above 230°C up to 300°C were found on both substrates, filter and charcoal tube. For n-hexadecane with a droplet size of 2 µm the online measurements gives a result of 13 mg/m^3 for the droplets and 24.2 mg/m^3 for the overall concentration. The GGP-Mini showed different results for droplets (8.5 mg/m^3) and vapor (16.7 mg/m^3), the result for the sum of vapor and droplets (25.2 mg/m^3) was in good agreement to the online measurement. Parallel sampling with charcoal tubes without upstream particle sampling showed differences arise as soon as droplets are the dominant component.

Conclusions: All tests have shown that the distribution between vapor and droplets is not constant, and that only the sum of vapor and droplets constitutes a reproducible result. The distribution is dependent upon numerous influencing factors including the concentration of the aerosol, the temperature, and, particularly in the case of polar substances, the atmospheric humidity.

PS401
Poster Session 1
Author Attend Time: Monday 10:00 a.m. - 12:00 p.m.
***All posters are available for viewing in the expo hall from Monday 9:00 a.m. through Wednesday 1:00 p.m.**

SR-401-01
Size Distribution and Estimated Respiratory Deposition of Total Chromium, Hexavalent Chromium, Manganese and Nickel in Gas Metal Arc Welding Fume Aerosols

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Objective: Assess the particle size distribution from 10 nm to >30 µm of total Cr, Cr(VI), Mn and Ni in welding fumes generated by GMAW of mild and stainless steel, establish the fraction of Cr(VI) in total Cr for each particle size range, and provide an understanding of the regional deposition of these metals in the human respiratory system.

Methods: Welding fumes were generated with a robotic welder operating in axial spray mode. Samples were collected using a nano multiple orifice uniform deposition impactor with polyvinyl chloride filters on each stage. The filters were analyzed by inductively coupled plasma mass spectrometry and ion chromatography. Limits of detection and quantitation were experimentally calculated and percent recoveries were

measured from metal spikes. The fraction of Cr(VI) in total Cr was assessed by calculating the ratio of Cr(VI) to total Cr mass for each particle size range. Regional deposition of each metal was estimated according to respiratory-deposition models.

Results: The weight percent (wt%; ± standard deviation) of Mn in mild steel fumes was 9.2% (±6.8%). For stainless steel fumes, the wt%s were 8.4% (±5.4%) for total Cr, 12.2% (±6.5%) for Mn, 2.1% (±1.5%) for Ni and 0.5% (±0.4%) for Cr(VI). All metals presented a submicron fraction between 0.04 and 0.6 µm. Total Cr and Ni presented an additional fraction <0.03 µm. On average 6% of the Cr was found in the Cr(VI) valence state. There was no statistical difference between the smallest and largest mean Cr(VI) to total Cr mass ratio (p-value=0.19), hence particle size did not affect the contribution of Cr(VI) relative to total Cr. The predicted total respiratory deposition for the metal particles was ~20%. The sites of principal deposition were the head airways (7-10%) and the alveolar region (8-9%). Estimated Cr(VI) deposition was highest in the alveolar region (8.8%).

Conclusions: Total fume mass obtained from gravimetric analysis of the impactor stages presented a tri-modal distribution with a substantial contribution of particles in the 0.006–0.06 µm range. Chemical analyses of the individual metals did not reveal as prominent mass in this smaller size range. The discrepancy may be due to the lesser reliability of gravimetric analysis compared to chemical analysis. The wt% of metals in the fumes differed from that of the consumables. Future research should focus on other welding processes such as SMAW, FCAW and gas tungsten arc welding.

SR-401-02
Developing and Validating of a New Filter Holder for Direct On-filter Analysis of Free Silica Samples by Using the XRD Method

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Objective: This study was set out to develop a new filter holder for direct on-filter (DOF) analysis of free silica samples using the XRD method.

Methods: The target uniformity of the deposition of particles on a filter (=0.78) was determined according to NIOSH-7500 method, and was used as a guideline for developing a new filter holder suitable for both the nylon cyclone and 25-mm aluminum cyclone.

Results: A new filter holder with an120° outlet angle and a 50mm cowl length was developed based on repetitive laboratory tests. Field validations were conducted on three selected workplaces in a foundry plant. For any given workplace, two nylon cyclones respectively mounted with a traditional and a newly developed filter holder (denoted as T-Nylon and N-Nylon, respectively) , and two 25-mm aluminum cyclone respectively mounted with a traditional and the newly developed filter holder (denoted as T-AL and N-AL, respectively) were used to collected respirable dust samples. Results show that no significant difference was found among the respirable dust concentrations for samples collected from the T-Nylone, N-Nylone, T-AL and N-AL suggesting that all testing cyclones shared a very similar performance as a pre-selector for collecting the resparable dust. The quartz concentrations for samples collected from T-Nylone and T-AL analyzed using the DOF XRD method were found to be higher than that of the NIOSH-7500. On the other hand, quartz concentrations for samples collected from N-Nylone and N-AL, while analyzed using the DOF XRD method, were found with no significant difference from those analyzed using the NIOSH-7500 method.

Conclusions: It is concluded that the developed filter holder is suitable for collecting and analyzing respirable free silica samples using the DOF XRD method, which will be beneficial for industries on reducing both cost and manpower on free silica analysis as in comparison with the use of the NIOSH-7500 method.

CS-401-03
Controlling Open Pit Mine Ground Worker Respirable Silica Exposure: A Case Study

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Situation/Problem: Open pit mining and crushing of stone provides needed material for the construction industry. A ground worker commonly works around crushing and conveying equipment. The ground worker cleans up material spills from conveyors, picks stone from catwalks and monitors feed piles, material transport and tunnel operations. During these activities, excessively high airborne exposure to respirable dust containing crystalline silica (quartz) was present. Excessive respirable quartz exposure has been linked to lung fibrosis and silicosis. The ground worker's exposure to respirable dust containing quartz was over 2 times the MSHA PEL. The worker wore a NIOSH approved N95 filtering facepiece respirator. Industrial hygiene recommendations following the hierarchy of controls were submitted with emphasis on the need for enhanced dust suppression at crushing and transfer points.

Resolution: Management actions included the installation of cameras for observing the tunnel, the top feeds of the secondary and recrush/tertiary crushers, permitting the worker to spend more time in the control trailer. Cleaning was eliminated in the vicinity of the primary ground area while the primary crusher is operating. Conveyor skirting was improved to reduce spills that required clean up. Improvements in water mist dust suppression were implemented at the secondary and tertiary crushers and at belt transfer points. The employee wears task-based appropriate NIOSH approved respiratory protection in the form of N95 filtering face piece respirators as needed and is included in an effective Respiratory Protection Program.

Results: The enhanced controls resulted in the ground worker's respirable dust exposure being reduced to below the MSHA PEL.

Lessons Learned: A combined effort of modified work procedures, remote process equipment monitoring in conjunction with well designed, managed and maintained water mist dust suppression can provide effective means of reducing crushing plant ground worker respirable quartz exposure.

SR-401-04
Exposure Level of Airborne Fungi in Pig Buildings of Korea

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Objective: This study was performed to assess exposure level of airborne fungi in a pig building of Korea according to pig housing type.