97.

CHALLENGES IN DESIGNING A VENTILATION SYSTEM FOR UPSET CONDITIONS. F. Boelter, C. Schweiger, J. Ruhl, Boelter & Yates, Inc., Park Ridge, IL

A ventilation system was desired to control human comfort related to dust and heat in a chemical plant. During the initial evaluation, furfural vapors as well as dust and heat were evident. Initial estimates called for 250,000 cfm of local and general exhaust ventilation to meet the original objectives. However, the greatest return in employee protection was to focus on dust and heat control on the 2nd floor and to focus on the control of vapors in the basement. Employees were observed entering the basement while wearing an organic cartridge, full-face respirator. SCBAs were available for use during upset conditions; however, they were not used. The typical 1,000 gallon spill during an upset was composed not just of furfural but also of methanol, acetaldehyde, acetone and isobutyraldehyde. The sumps could return the majority of the spilled volume back to process lines within 15 minutes. However, the approximately 10 gallons of residual would evaporate and the area would need ventilation. Further, it was determined that acetaldehyde and not furfural would drive the ventilation design criteria. A dual stage 20,000 cfm ventilation system was designed which would operate in a step mode. Half the volume of exhaust would be drawn continuously during normal operations and respirators would not be needed. During an upset condition, the exhaust volume would automatically step up and thus meet the protection factor necessary if full-face respirators were used. In order to have this system be effective, process changes were also necessary. Therefore, reasonable process changes along with a reasonable ventilation system and a limited condition respiratory protection program were utilized to address an exposure condition unanticipated by the original objectives.

98.

REAL-TIME HVAC FILTER EFFICIENCY TESTING USING OPTICAL PARTICLE COUNTERS. S. Berardinelli, S. Fotta, J. Hayes, E. Moyer, NIOSH, Morgantown, WV

The National Institute for Occupational Safety and Health (NIOSH) has undertaken a long-term performance test of heating, ventilation, and air-conditioning (HVAC) system filters. This testing is being conducted at the NIOSH facility in Morgantown, WV in an air handling unit (AHU) that services the animal quarters. The filtration needs of animal quarters are similar to that of a medical facility due to presence of immune compromised animals. The medium efficiency bag filters in this AHU have been replaced with higher efficiency mini-pleat V-Bank™ filters and have been monitored monthly for filtration efficiency since they were installed. This study required the development of a method to determine the actual HVAC filtration efficiency using optical particle counters while the system was in operation. Grimm aerosol monitors with isokinetic sampling inlets were used to collect particle counts in 15 different particle size ranges from 0.30 um to 20 um. The challenge aerosol was the ambient particulate within the HVAC system. Instruments are placed upstream and downstream of the filter bank and data were collected over 5e days. From these data, filtration efficiency was determined for submicron to supermicron particles averaged over the sampling period. The results indicated the medium efficiency bag filters were 25% efficient for 0.35 um diameter particles, 28% efficient for 0.45 um particles, and 30% efficient for 0.57 um particles. The new V-Bank™ filters were 70% efficient for 0.35 um particles, 74% efficient for 0.45 um particles, and 81% efficient for 0.57 um particles. The V-Bank™ filters have provided superior filtration in the submicron range (for particles less than 1 um) over that of the previous filters and have maintained this level of efficiency during our study.

99.

A COMPARATIVE STUDY OF VARIOUS COMPUTATIONAL FLUID DYNAMICS MODELS FOR THE ASSESSMENT OF BREATHING ZONE SIZE. J. Richmond-Bryant, M. Flynn, University of North Carolina, Chapel Hill, NC

The majority of industrial hygiene studies incorporating computational fluid dynamics use the standard k–ε model with little explanation for model choice. In this study, five computational fluid dynamics models were compared with experimental data for their ability to reproduce the size of the breathing zone, defined here as the time-averaged two-dimensional recirculation zone formed downstream of the body in a uniform flow induced by a hood. This definition for breathing zone was applied because the time-averaged flow streamlines in the recirculation zone circulate along the centerline towards the body. A two-dimensional circular cylinder was used to represent the body. For comparative purposes, all quantities considered were normalized by the diameter of the body. Results from four turbulence models (standard k–ε, extended k–ε, renormalized group k–ε, and anisotropic k–ε) and one vortex model were compared with experimental data acquired at Re = 5,232. Key features of the breathing zone, such as centerline length and angle of separation from the body were used for comparison between the models and the experimental data. For normalized centerline length, three of the four k–ε models (standard, extended, and renormalized group) fell within the confidence bound measured experimentally, [1.59,2.42]. For the vortex method, convergence with respect to breathing zone length could not be proven; therefore, no comparison could be drawn with the experimental data. All of the k–ε models predicted separation angles ranging from 120°-130°; hence, the k–ε models underpredicted the normalized breathing zone width by 12-23%. The vortex method predicted the wake width with negligible error; however, unless convergence is attained with respect to the breathing zone length, this finding is preliminary. It is important to point out that the behavior discussed for each model refers only to the flow analyzed here, and not necessarily for airflow with different turbulence properties.

100.

FILTER EFFICIENCY OF SELECTED HVAC FILTERS. E. Moyer, M. Commodore, J. Hayes, S. Fotta, NIOSH, Morgantown, WV

Air quality begins with good engineering controls in the air handling system (HVAC system). For particulate matter this involves having an air handler containing filters which remove the majority of particulate matter from the incoming ambient air. The National Institute for Occupational Safety and Health (NIOSH) has conducted a study of various bag filters used in its air handler to determine the filtration efficiency of these filters against submicrometer particles (0.03-0.4 micrometers) because this is in the most penetrating size range for these filters. Experimental aerosol penetration data shows that an extremely large range of filter efficiency exists. Aerosol penetration through new filters ranged from less than one percent to greater than ten percent were observed. The values depend on flow rate, surface area of the media, challenge agent particle size, and challenge agent state (liquid or solid). Filters which were removed from the filter bank were also tested to determine the effect of routine inlet air exposure. The filter efficiency of the exposed filters (9 months of use) showed that the six chamber filters had penetrations of from 40% to 60% as compared to the control which had less than 1.5% penetration. Similarly the twelve chamber filters had penetrations ranging from 25% to 50% when compared to the control filters penetrations of less than 3.0% penetration. As expected there was a shift in most penetrating aerosol particle size toward the larger size range which is an extreme disadvantage for filters employed in this application. Both mechanical and electrostatic filters are used in this application. The filtration mechanisms of the various filters tested were evaluated to ascertain the cause of this phenomenon. The electrostatic filters are showing a significant reduction in filter performance over the expected service lifetime of the filters.

101.

REDUCED-SCALE MODELING OF A FREESTANDING EXHAUST HOOD. K. Mead, NIOSH, Cincinnati, OH; D. Johnson, N. Esmen, M. Phillips, University of Oklahoma, Oklahoma City, OK

Local exhaust ventilation (LEV) design equations do not normally account for worker presence, varying cross-drafts, or turbulence. In recognition, the American Society of Heating, Refrigerating and Air-Conditioning

Engineers recommends both fluid dynamic (dynamic similitude scale modeling) and computerized modeling as valuable tools in LEV hood design. Unfortunately, computer modeling often requires assumptions that without experimental verification, result in uncertainty. While similitude modeling is a recognized research tool throughout fluid mechanics, it's historically ignored in industrial ventilation. When it is applied, the modeled streamlines tend to be "uniform" like those within a large booth as opposed to the converging streamlines inherent with freestanding hoods.

The subject research investigated similitude modeling as a research tool for industrial ventilation design then used the model to evaluate effect of worker presence upon LEV hood performance. The research scope was limited to a reduced-scale, water model of a freestanding flanged circular hood (FCH). A glass aquarium was the "room" and a pump the "fan" for the model. Measured capture velocities induced by the FCH were remarkably consistent with ACGIH design equation predictions.

Once similarity was established, the hood's performance in the presence of a worker was determined. An "infinite" elliptical cylinder represented the worker. Fluorescent dye, released through a needle, represented the source. The evaluation technique was generally qualitative, similar to smoke-tests applied to full-scale hoods. During the performance tests, three worker positions were evaluated: (1) worker positioned one diameter (1D) upstream of the source, (2) positioned at a 90-degree offset, 1D from the source, and (3) positioned at a 45-degree offset, 1D upstream of the source. This evaluation revealed a significant performance reduction when the worker was directly upstream of the source. The 90-degree offset resulted in no performance deterioration and the 45-degree offset suggested a possible performance improvement.

102.

A RAPID MEASUREMENT TECHNIQUE FOR DETERMINING PARTICLE PENETRATION OF INDUSTRIAL DUCTWORK. T. Peters, D. Leith, University of North Carolina at Chapel Hill, Chapel Hill, NC

An experimental technique was developed to allow rapid measurement of penetration relative to particle diameter in full-scale industrial ductwork. Using an industrial blower, laboratory air is drawn through a filter, a sharp-edged orifice for flow control, and a test component. A particle time-of-flight instrument (Aerosizer-LD) is used to measure the concentration of a test aerosol - a polydisperse, spherical, glass aerosol dispersed with a fluidized bed generator—relative to particle diameter after injection—upstream and downstream of the test component. The Aerosizer was adapted with a special inlet to enrich the concentration of the high inertia particles, thereby facilitating detection of particles up to 100 μm. Penetration is calculated by dividing the particle concentration measured at the detector when the aerosol is injected upstream of the test component by that when the aerosol is injected downstream. The interior of the test component can be coated with grease to eliminate particle bounce and reentrainment. Using this technique, penetration can be rapidly quantified for particle size ranging from 1 to 100 μm in a matter of minutes compared to weeks using fluorometric techniques. Validation was accomplished by comparing penetration measured with the Aerosizer to that measured using a cascade impactor.

This technique is central to on-going efforts aimed at predicting particle deposition in industrial ductwork. A priori knowledge of the magnitude of particle deposition relative to particle size in the ductwork portion of a ventilation system will facilitate system optimization during the design phase by integrating the relatively unstudied phenomena of particulate transport through ductwork with the well-developed theory of enclosure capture and collector cleaning. Moreover, deposition estimates of this kind will be used to evaluate safety concerns due to particulate buildup, such as explosion risk, and to estimate annual operating costs associated with preventative maintenance, such as periodic system maintenance.

PF 115. Lead I

Papers 103–111

103.

THE DEVELOPMENT AND EVALUATION OF A HOME LEAD SAMPLING TEST KIT FOR IDENTIFICATION OF LEAD HAZARDS. S. Roda, B. Menrath, J. Holly, S. Clark, University of Cincinnati, Cincinnati, OH

Renovation and remodeling activities occurring in and around houses built prior to 1978 may result in occupant exposure to lead. The availability of a home lead sampling test kit allows individual home owners or occupants the opportunity to test for the presence of lead hazards, particularly when planning or engaging in rehabilitation projects. A reliable lead sampling kit also provides a means whereby residents can assist future health programs and research projects in gaining additional information on problems associated with lead hazards. Using volunteers, this research tested the application and use of the kit and its contents through questionnaires and the collection of duplicate samples by a licensed lead inspector. The final product of the research is a home lead sampling kit for the collection of soil, dust wipes and paint chips that has been demonstrated to be reliable and effective. The validation of the kit is based on comparison of data collected from untrained individuals to the choice of sampling locations and results of a trained and licensed inspector. Questionnaire information also demonstrated the importance of the distribution of such kits through health and housing departments, lead programs, and clinics.

104.

ASSESSMENT OF THE ABILITY OF HUD'S PAINT FILM CLASSIFICATION SYSTEM TO PREDICT FLOOR DUST LEAD LOADING. J. Breysse, S. Dixon, W. Galke, J. Wilson, P. McLaine, National Center for Healthy Housing, Columbia, MD

Deteriorated lead-based paint is considered hazardous; however, few empirical studies identify the degree of deterioration leading to the exposure of children to hazardous residential dust lead levels. This study evaluated how well paint condition, as defined under HUD's original 3-level (intact/fair/poor) and its newer 2-level (intact/non-intact) system, correlated with dust lead loading and if the rating system needed improvement. The study also examined how well inspectors could implement either system.

At three U.S. sites, risk assessors rated paint condition using the 3-level system. Modeling was performed to assess the relationship between leaded paint condition and average bare floor dust lead loading in a room. The condition of the most deteriorated leaded paint was an inconsistent predictor of floor dust lead. For the site having post-1950 housing, no relationship between paint in worst condition and floor dust lead was found. For the other two cities having pre-1950 dwellings, the most deteriorated leaded component significantly predicted floor dust lead loading. Further evaluation for these two cities yielded inconclusive results about defining any non-intact leaded paint as a hazard versus only leaded paint in poor condition. An alternative six-level paint condition scale, designed to consider that only the most seriously deteriorated surfaces may contribute significantly to dust lead loadings, was also tested but performed no better than HUD's original 3-point system.

As part of the study design, pairs of risk assessors separately assessed paint condition in dwellings. These risk assessor pairs reached similar conclusions regarding overall paint condition (average inter-rater reliability=0.67, 1.00 being perfect); however, 2 of 8 pairs had an inter-rater reliability below 0.51, suggesting that training could be improved. The performance of the risk assessor pairs using the two-point scale was virtually identical to that of the 3-point scale, suggesting that the reliability of the two systems is similar.

105.

FIELD TESTING OF INDIVIDUAL VERSUS COMPOSITE LEAD DUST WIPE SAMPLES. W. Strauss, J. Holdcraft, A. Pate, Battelle, Columbus, OH; P. Ashley, U.S. HUD, Washington, DC

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), which are combined into a single analytical

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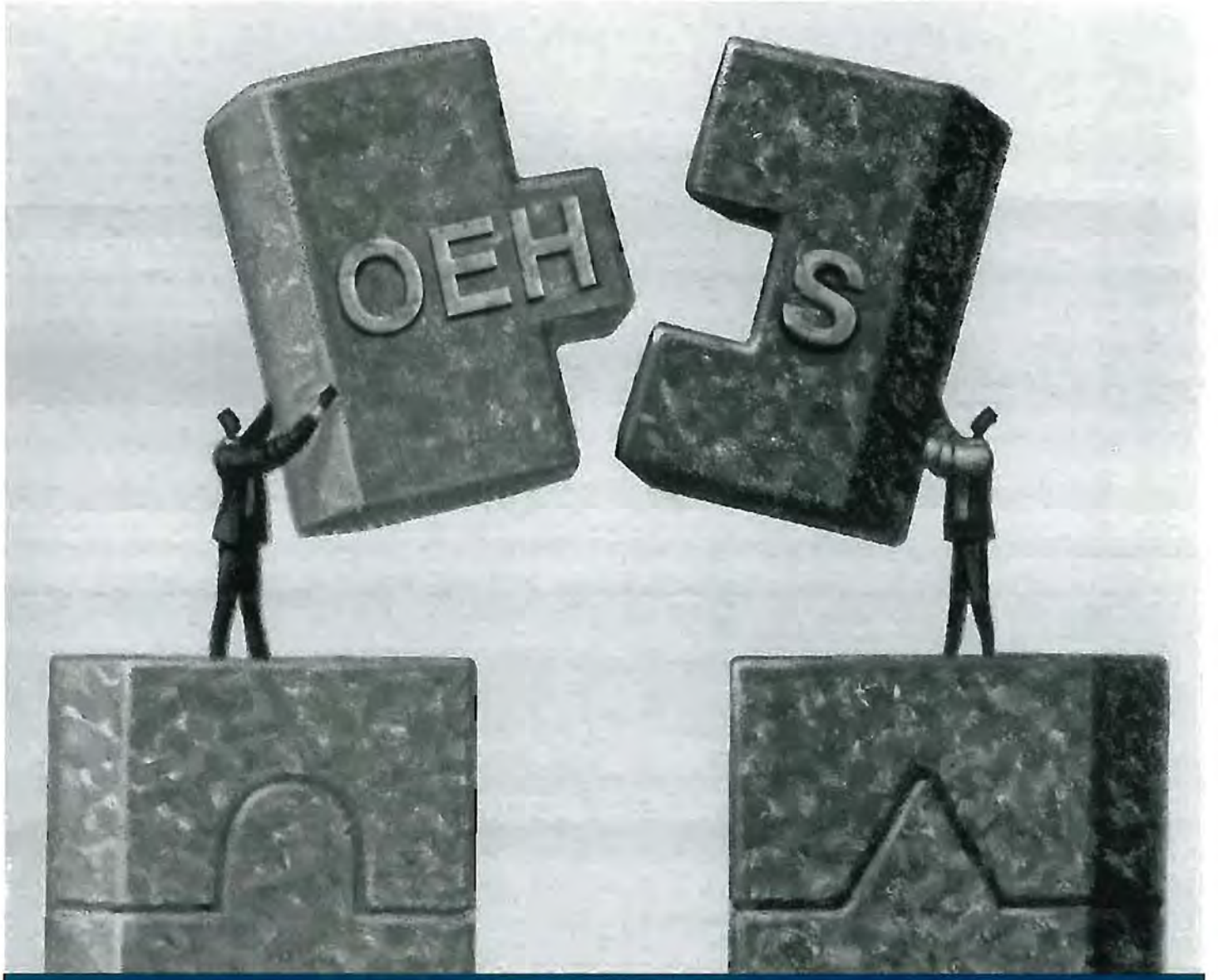

ABSTRACTS

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2002 Abstract Index by Session Topic

PF 101 Agricultural Health and Safety

Papers 1–6

1.

RELATIONSHIPS BETWEEN WORK EXPOSURE AND RESPIRATORY OUTCOMES IN POULTRY WORKERS.

S. Kirychuk, J. Dosman, P. Willson, L. Dwernychuk, University of Saskatchewan, Saskatoon, SK, Canada; J. Feddes, A. Senthilselvan, C. Ouellette, University of Alberta, Edmonton, AB, Canada

A pilot study was conducted on 74 poultry barn workers in Western Canada during the winters of 1998–2000. General respiratory health, current, chronic and work related respiratory symptoms; general work duties, and work-site factors were ascertained, pre-exposure, by questionnaire. Personal airborne exposure levels and changes in symptoms and lung function were measured across the work-shift for all workers. Workers were classified according to the type of poultry operation (floor based, n=53; cage based, n=13) in which they worked. There was no significant difference in daily hours spent in the barn between those who worked with caged poultry (5.41±2.35 hours) and those who worked with floor-based poultry (4.42±2.48 hours). Age of birds was 47.10±58.36 days for floor based versus 155.91±63.01 days for cage based facilities. There were no significant differences in personal environmental measurements between cage-based and floor-based facilities (ammonia 13.22±13.70 ppm, 17.34±16.35 ppm; total dust 5.74±4.85mg/m^3, 10.01 ±8.84 mg/m^3; endotoxin 6046±6089 EU/m^3, 5457±5934 EU/m^3 respectively). There were no significant differences in across work-shift change in pulmonary function indices between workers from cage and floor-based operations. For the entire sample total dust dose (work hours/day x total dust) significantly correlated with across-shift change in FEV_1, whereas endotoxin dose and ammonia dose did not. Stocking density was significantly correlated with average ammonia (ppm, p=0.002) and ammonia dose (ppm x work hours/day; p=0.004) in floor based operations and with total dust (particles/ml, p=0.002) in cage based populations. Stocking density was also significantly correlated with chronic cough (p=0.003) and across work-shift cough (p=0.05) and chest tightness (p=0.06) for workers from floor based operations; and with phlegm when working (p=0.018) and chest tightness across the work-shift (p=0.004) for workers from cage based operations. Type of poultry production operation and therefore type of work exposures appear to significantly impact symptoms experienced by workers exposed to these atmospheres.

2.

DUST GENERATION SYSTEM FOR AGRICULTURAL SOIL DUST.

K. Lee, R. Domingo-Neumann, R. Southard, UC Davis, Davis, CA

Agricultural workers are prone to exposure to mixed dust of inorganic and organic compounds. Diverse working conditions and operations in agriculture make direct measurements of the mixed dust exposure difficult. This study was conducted to develop a new dust generation system to determine possible exposure potency indicators of soil samples. The dust generator consists of a blower, a rotating chamber and a settling chamber. The rotating chamber has inner baffles to provide sufficient agitation of the samples while the chamber is rotating. A blower provides air into the rotating chamber, and the suspended dust is moved to the settling chamber through a perforated pipe. A small fan inside the settling chamber helps maintain suspension of the dust. Various size fractions of dust are sampled on filters suspended in the chamber via outlet ports and attached pumps. Air pressure is released through a filter plate mounted on the wall of the settling chamber. Various operating conditions were evaluated: air intake from blower, speed of rotation, soil mass and sampling time. To evaluate the characteristics of dust from the system, we collected dust samples from agricultural fields while the soil was prepared for