limited number of factors, making it difficult to generalize these findings to complex multi-factor workplace conditions. This study reports the findings of a review and meta-analysis of forty one quantitative experimental studies that reported exposure measurements as part of their test results. Twenty eight potential exposure determinants were divided into four categories and the results were summarized by the categories: 1) Test methods: hood performance was significantly affected by presence of mannequin and tracer type, implying that it is inappropriate to make direct comparison of studies using different test methods. 2) Hood design: factors that consistently showed significant effects on hood performance include slot opening/baffle adjustment, hood design, face velocity temporal variation, and auxiliary air flow temperature. The results for the factor of face velocity were not consistent. Nineteen cases reported no significant relationship between hood performance and face velocity. Eight cases showed improved hood performance with increased face velocity and two other cases reported the opposite results. 3) Room air and environmental factors: both cross-flow and method/velocity of supply air consistently showed significant effects on hood performance. 4) Work practices: many factors (distance between tracer source and hood face, distance between hood face and sampling position, distance between tracer source and sampling position, mannequin/worker movement, mannequin/worker posture, hand movement, pipetting, filtration, centrifuging, weighing, sash movement, and thermal load) showed significant effects but the numbers of cases for most of these factors were very small. Twelve of fifteen cases for the factor of sash height/open area reported improved hood performance with reduced sash height/open area while one case showed the opposite result and two other cases showed no significant relationship.

94.

A REVIEW OF QUANTITATIVE STUDIES ON LABORATORY FUME HOOD PERFORMANCE AND ITS RELATED FACTORS — II. ESTIMATING THE ODDS RATIOS USING LOGISTIC REGRESSION. K. Ahn, M. Ellenbecker, S. Woskie, University of Massachusetts Lowell, Lowell, MA; L. DiBerardinis, Massachusetts Institute of Technology, Cambridge, MA

Performance of a laboratory fume hood is determined by many factors in real working conditions. This study reports the meta-analysis of 27 out of 41 quantitative experimental studies found in the literature that met the following conditions: 1) tracer used was either sulfur hexaflouride or Freon gas, 2) exposures was reported as average concentration, 3) exposure was measured at breathing zone, 4) tracer source was located at least 5.1 cm (2 inches) in from hood face, and 5) each observation represented an independent set of test conditions. The exposure concentration variable from the resulting 551 independent test conditions was dichotomized into pass or fail using the control level of 0.1 ppm that is recommended by ACGIH and ANSI/AIHA. Logistic regression was performed to estimate the odds ratios of hood failure for each potential exposure determinant. The results of univariate logistic regression revealed that many factors had a statistically significant impact on hood performance. The significant exposure determinants for hood failure include cross-flow (versus no cross-flow), decrease of face velocity, decrease of percent auxiliary air, full-open sash (versus partial-open sash), increase of sash open height, as-used hood (versus empty hood), cluttered hood (versus empty hood), decrease of the distance between sash and sampling location, increase of the height of tracer source from hood floor, and presence of a mannequin (versus no mannequin/worker). The factors that did not have a statistically significant impact on hood performance include variable air volume/walk-in hood (versus standard hood), sash open width, ASHRAE ejector (versus other type ejector), and tracer gas flow rate. Most of the significant factors remain significant even after including face velocity and presence of a mannequin/worker in the model to adjust for their effects. Further efforts at multivariate regression analysis are restricted due to the many missing variables in the meta-analysis dataset.

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95.

THE PARADOX OF MIXING IN INDUSTRIAL VENTILATION. C. Feigley, E. Lee, J. Khan, University of South Carolina, Columbia, SC; J. Bennett, NIOSH, Cincinnati, OH

Derivations of dilution ventilation equations often assume that a workroom is well-mixed. A flow rate requirement computed using one of these equations is then multiplied by a safety factor, the portion of which accounting for deviations from complete mixing has been called the mixing factor (Km). Here the scale (S) and intensity of mixing (I) were determined for full-scale experiments at 2 Reynolds numbers and 2 Archimedes numbers, and for computational fluid dynamic simulations of workrooms of various configurations and 5 Reynolds numbers under steady, isothermal conditions. The relationships among Km S, and I were explored. In general, the Km required decreased with increased mixing.

A cursory consideration of these results suggests increasing mixing to reduce the Km value, and thus the required flow rate. However, this is inadvisable if increasing room air movement might interfere with other exposure control methods that rely on keeping incoming clean air and source emissions segregated. These methods include: local exhaust ventilation, air islands, air curtains or push-pull systems, and displacement or plug-flow ventilation. It was concluded that the attractiveness of enhancing mixing increases when: (1) altered flow patterns will not carry contaminants to an occupant's breathing zone before mixing with dilution air, (2) flow patterns can be controlled to sweep contaminants toward exhaust openings, (3) enhanced mixing will not increase contaminant emission rate (for instance, when airflow near the surface of an evaporating liquid increases), (4) other more effective approaches are not feasible, and (5) the objective is to decrease potential exposure throughout the room, not just at a specific occupant location.

96.

USED VENTILATION FILTERS: WHAT IS THAT SMELL? S. Martin, C. Coffey, R. Lawrence, C. Calvert, S. Berardinelli, P. Jensen, W. Jones, NIOSH, Morgantown, WV

A strong odor from used ventilation filters was noticed during annual routine maintenance on the air-handling units at a research facility. Maintenance workers expressed concern of a potential health hazard resulting from direct contact with these filters. This concern prompted a thorough examination of the physical and chemical nature of the filters and collected particulate matter. An examination by light microscopy indicated a predominance of opaque small particles. Electron microscopy confirmed the small size of the captured particles, with the majority being in the submicrometer range. High magnification showed many of the particles to be agglomerations of smaller, roughly spherical subunits, consistent with combustion aerosol.

Representative headspace samples of filter sections were analyzed by gas chromatography-mass spectroscopy (GC-MS). Toluene, xylene, diethyl-benzenes, and 2-methyl furan were found on all samples. A sub-set of samples yielded octanal, nonanal, undecane, hexanal, heptanal, dimethyl-benzene and benzaldehyde. Toluene was also confirmed in air samples collected upstream and downstream of the filter bank.

Given the gas adsorption properties of carbonatious material, it is suspected that these filters are acting like a large gas collection bed. After months of concentrating organic gas, odor is predictable. The source of the gas is probably diverse. First, this sort of particulate matter, as emitted from exhaust, will contain adsorbed gases from the combustion process. Additionally, such a carbon bed could concentrate organics that are normally present in ambient environments. Gases from microbial growth are of particular interest here, since microscopic examination of system pre-filters, showed extensive fungal contamination both in collected dust as well as on the filter framework.

The combined approach of GC-MS along with microscopic examination has proven useful in determining both the gas and solid collection history of ventilation filters. This technique may be beneficial in evaluating potential health effects to maintenance workers and building occupants.

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ABSTRACTS

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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

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