(TWA) permissible exposure limit (PEL) for ClO2 of 0.1 ppm and a short term (15 minute) exposure limit (STEL) of 0.3 ppm. In order to ensure that bleach plant environments meet these standards, the industry employs both fixed and personal alarm-type monitors. Ten commercially available fixed monitors and two personal alarm-type monitors were evaluated in this study. The monitors were exposed to test gas atmospheres containing ClO2 at concentrations of 0.1, 0.2 and 9.0 ppm and their responses recorded. From these data, the precision, accuracy, response time, and recovery time were calculated. Since workplace environments have significant variability with regard to temperature, humidity and air flow rates, the effects of these factors on monitor performance were also investigated. The monitors were exposed to a high temperature (100F) and high humidity (>80%) environment. They were also tested at air flow rates of 50, 100 and 200 ft/min. A test to record and evaluate the zero drift and span drift of the monitors over a 7 day period was performed as well. An additional test was performed to measure the response of the monitors to Cl2.

Generally, the performance of most of the monitors was as expected based on manufacturer's specifications. The accuracy of the monitors was dependent on calibration and the air flow rate of the test gas. The study did identify some important characteristics to consider when selecting a monitor for a particular application, such as response to Cl2 and the expected air flow rate.

132.

SPECIAL PROBLEMS IN MEASURING SULPHURIC ACID MIST. D. Breuer, BIA, Sankt Augustin, Germany

Sulphuric acid is the most significant technical inorganic acid (global production over 100 million tons annually). A connection between exposure to sulphuric acid mist and an increase in the incidence of laryngeal carcinoma in humans has been found in cohort and case-control studies. As a result, sulphuric acid mist has been listed as carcinogenic (ACGIH - A2). In Germany, there have also been suggestions to reduce the threshold value for sulphuric acid mist from 1 mg/m³ to 0.1 mg/m³.

While measuring the sulphuric acid, non-caustic sulphates or other sulphurous compounds can appear in parallel, depending on the work area. The sampling technique is thus of particular importance, because the ionic chromatographic analysis typically conducted makes it impossible to distinguish sulphuric acids from sulphates. Filters, filter-adsorption tube combinations, and impact separators were used for taking samples.

In work areas where only sulphuric acid mist can arise, such as in lead accumulator formation, all the methods can be used without restriction. In work areas where the aerosols contain sulphates, such as in metallic mordant works, all methods can also be used. However, the findings are too high and have to be adjusted to the acid content of the source. If sulphuric acid aerosols and sulphur trioxide are both present, as in the handling oleum, a sampling system should be used that samples vapours and aerosols. Sampling with filters results in findings that are too low.

In work areas where oxidizable vaporous sulphuric compounds are present alongside the sulphuric acid, such as in the production of viscous fibres, a measurement procedure that samples vapours along with the aerosols should not be used at all. This is the only way to avoid uncontrollable oxidation reactions during sampling, which would results in values that are too high.

PF 119. Personal Protective Clothing and Equipment

Papers 133–139

133.

EVALUATION OF PERSONAL PROTECTIVE CLOTHING AND DEVICES. C. Ashley, C. Preston, T. Bernard, University of South Florida, Tampa, FL; D. Bennett, Georgia Institute of Technology, Atlanta, GA

Threshold Limit Values (TLVs) for heat stress and strain are usually based on WBGT for ordinary work clothes with a clothing adjustment factors (CAF) for single and double coveralls. The purpose of this study was to determine the CAF for four clothing ensembles. A climatic chamber was used to simulate three environmental protocols. Study participants wore one of the five ensembles while walking on the treadmill to generate a metabolic work rate of 160 W/m2. Physiological data and environmental data were collected. When the participant's core temperature (Tre) reached a steady state, the Tdb was increased according to protocol. The point at which the core temperature increased steadily was defined as the inflection point. The environmental temperature recorded five minutes before the inflection point was used to calculate the critical WBGT for each ensemble. A three-way ANOVA and a Tukey's honestly significant difference (hsd) test were used to make comparisons among the mean values. The metabolic rate was kept constant in order to make other comparisons valid. The critical WBGT and CAF values for the ensembles were reported as follows, cotton work clothes = 33.6°C (CAF = 0.0, baseline), cotton coveralls = 34.4°C (CAF = - 0.8), Tyvek 1424 = 32.4°C (CAF = +1.2), NexGen = 31.9°C (CAF = +1.7), and TyChem = 26.5°C (CAF = +7.1). Tukey's hsd was 1.74°C-WBGT with the greatest difference seen between the vapor barrier suit and all other ensembles. However, a significant difference was also seen between the cotton work clothes and the Tyvek 1424 and NexGen ensembles.

134.

HEAT STRESS WHILE WEARING PPE: DETECTION AND PREVENTION. A. Ondo, International Union of Operating Engineers National Hazmat Program, Morgantown, WV; B. Lippy, International Union of Operating Engineers National Hazmat Program, Baltimore, MD

Heat stress has been one of the greatest and most overlooked threats to workers cleaning up hazardous environments across the U.S. Department of Energy (DOE) complex. This threat is greatly increased for workers wearing personal protective equipment (PPE) such as chemical and radiation protective suits, a situation which is becoming much more common as DOE increases deactivation and decommissioning activities.

Innovative technologies to measure or manage heat stress encountered by workers show real promise but have not been adequately evaluated. The International Union of Operating Engineers (Engineers') National Hazmat Program, working under a cooperative agreement with the DOE, has evaluated the effectiveness of several of these technologies. The following results are for five tested technologies (Move this to previous line) KoolJacket Lite™ — Core body temperatures were measured while workers wore this cooling vest and performed real tasks. The vest only lowered the subjects' core temperature in 31.5% of the tasks performed. For 10.5% of the tasks there was no significant temperature change and in 58% of the tasks, the core temperature actually increased.

CORETECH™ Cooling Suit was tested for a 2-hour work period and successfully maintained subjects' core temperatures below the ACGIH unacclimatized action limit value (UALV) of 38.0°C.

Based on regression analysis of core temperature data within each task, the three heat stress monitors evaluated would have failed to warn of reaching the ACGIH UALV of 38.0°C in the following percentages of tasks: VitalSense™ (66.6%), Metrosonics hs-3800 (34.6%), and Questemp II (80%).

PPE may increase the risk of heat stress; therefore, chemical exposure risk must be balanced against heat stress risk. These results indicate that not all cooling vests work as designed, and some actually increase risk of heat stress. Additionally, these data indicate that relying solely on heat stress monitors for worker protection may not be prudent.

135.

EVALUATING REUSE OF CHEMICAL PROTECTIVE GLOVES BASED ON BREAKTHROUGH TIMES. P. Gao, N. El-Ayouby, NIOSH, Pittsburgh, PA; R. Hall, S. Berardinelli, NIOSH, Morgantown, WV

Chemical protective clothing and gloves used for adequate protection are usually too expensive to be considered disposable. Decontamination is therefore essential before protective clothing is reused. The objective of

this preliminary study was to define the limits of reuse of chemical protective gloves based on the breakthrough time (BTT). Different glove materials, including neoprene and nitrile synthetic rubber, were selected for this study. The permeation for these materials was measured in a closed loop system using a 2.5 cm permeation cell and a MIRAN infrared analyzer. Neat 99% toluene was used as the challenge chemical. BTT and steady-state permeation rates (SSPR) were determined for triplicate samples of each material. Following the exposure, the samples were thermally decontaminated for 16 hours at 100° C. BTT and SSPR were measured for the second time and the decontamination procedure was repeated. For neoprene challenged with toluene, the BTT increased slightly during the first three exposure/decontamination cycles with BTT of 116, 115, and 109 % compared to that of the new material, respectively, while SSPRs consistently decreased with SSPR of 82, 71, and 70 % compared to that of the new material. On the other hand, the nitrile material challenged with the toluene yielded BTT that is slightly decreased as the result of increasing the number of toluene exposure/decontamination cycles. The BBT of the new material was 24.3 min and decreased by 16% to 20.3 min after four exposure/decontamination cycles. SSPR were virtually unchanged after three exposure/decontamination cycles. Neoprene gloves have a red inner liner. Thermal decontamination affected the color of the inner surface of the neoprene glove material, causing it to become darker. However, no obvious change in nitrile could be detected. These results indicate that multiple reuses of some chemical protective gloves could be safe if effective decontamination methods are used.

136.

PERMEATION OF CAPTAN FORMULATION THROUGH NITRILE PROTECTIVE GLOVE MATERIAL. R. Phalen, S. S. Que Hee, University of California at Los Angeles, Los Angeles, CA

Wettable powders of the fungicide captan (CASRN #133-06-2) are applied in agriculture by spraying over fields, applying onto the soil, or by dipping roots to be planted into a concentrated solution. Potential for dermal contact exists with such applications, the manufacture of captan, and its formulating. However, there are no permeation data available. The aim of this study was to assess the permeation of a wettable-powder formulation (48.9% captan and 1.1% related derivatives) as it would be sprayed in agriculture. A popular disposable nitrile glove material, Safeskin Blue Nitrile of 0.116 ± 0.004 mm thickness, was evaluated. Testing involved using the I-PTC 600 permeation cell in accordance with the American Society for Testing Materials (ASTM) F739-96 method, "Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact". A worst-case aqueous concentration of 217 mg/mL of the 50% wettable powder was tested to maximize permeation. The collection medium was hexane. Samples were collected at 2, 4, and 8-hour intervals. Analysis was conducted using nonpolar capillary column gas chromatography (GC) with electron capture detection (ECD) and mass spectrometry (MS). The GC/ECD least quantifiable limit was about 6 ng whereas that for GC/MS was approximately 30 ng at m/z 79. The collection medium had to be concentrated before an aliquot was injected. The calculated permeation rate by GC/ECD was about 600 pg/cm2/min after 8 hours, a very low rate.

137.

GLOVE PERMEATION AND DETERMINATION OF BENOMYL IN BENLATE 50% WP PESTICIDE FORMULATION BY GC-MS AND GC-EC. H. Zainal, S. Que Hee, University of California at Los Angeles, Los Angeles, CA

Benomyl is the active ingredient of the pesticide, Benlate 50% WP. Long-term human skin exposure to Benlate 50% WP causes skin irritation. Benomyl is a suspected carcinogen. The aim of this study was to investigate the protectiveness of gloves used by farm workers, pesticide sprayers, and formulators. A sensitive analytical technique was first developed to determine benomyl. A mass of 10 mg of benomyl was dissolved in 10 mL methanol. One mL of this solution was evaporated to dryness under a stream of nitrogen. A volume of 0.5 mL of acetonitrile was added, followed by 20 µL of diisopropyl ethyl amine and 20 µL of pentafluorobenzyl bromide. After vortexing and heating at 60°C for 16 hours, evaporation under nitrogen, 0.1 mL water was added. Extraction with isooctane (5x0.5 mL) followed by reducing the volume of the combined extracts to 0.5 mL. On gas chromatographic-mass spectrometric analysis, m/z values of 551, 492, 292, and 181 were observed at a retention time of 41 minutes. This confirmed the formation of di-pentafluorobenzyl carbendazim. Treatment with acetonitrile at 60°C caused the degradation of benomyl to carbendazim that was then derivatized. The base peak at m/z = 492 was used for selected ion quantitation. This resulted in an LQL of 6 ng and a linear range of 10-200 ng. In contrast gas chromatography-electron capture at the same chromatographic conditions resulted in an LQL of 2 pg and a linear range of 4-60 pg. Thus chromatography-electron capture was used as the method of choice. The permeation of benomyl through "SAFESKIN" nitrile glove material using ASTM typeI-PTC 600 permeation cell that employed isopropanol as collection fluid and a challenge solution of 1.2 mg/ mL suspension of benlate 50% WP in water was <100 pg /cm^2/min.

138.

EFFECTIVENESS OF FIVE COVERALLS AGAINST LIQUID JP-8 PENETRATION. R. Walton, U.S. Air Force, San Antonio, TX; D. Carpenter, KARTA, San Antonio, TX

The purpose of the research effort was to identify if any commercially available coveralls provided greater dermal protection against liquid JP-8 than the cotton coveralls currently worn by the USAF aircraft fuel cell workers.

We evaluated five different types of coveralls including the cotton, which served as the baseline. The evaluation criterion was based on three separate parameters: (1) Resistance to liquid JP-8 penetration, (2) Heat stress (3) Ergonomic/Comfort.

The coveralls ability to resist liquid JP-8 was evaluated both quantitatively and qualitatively. We obtained the quantitative data using a new dermal patch (activated charcoal cloth), which were placed inside and outside the coverall in the high contact areas. The qualitative data was based on a study participant questionnaire.

The heat stress associated with each coverall was also evaluated quantitatively and qualitatively. We obtained the quantitative data through environmental chamber testing and again the qualitative data through the questionnaire.

The ergonomic/comfort of each coverall was only evaluated through qualitative data. Again it was based on the study participant questionnaire.

The final evaluation criterion clearly indicated one coverall provided statistically significant increased dermal protection.

139.

SELECTION OF PROTECTIVE GLOVES. N. El-Ayouby, NIOSH, Pittsburgh, PA

Skin disorders resulting from hazardous exposures in the workplace account for 15% to 20% of all reported occupational diseases. Irritant and allergic contact dermatitis and burn injuries caused by chemicals account for about 50% of the skin disorder. A variety of protective gloves are available in the marketplace. However, the user must know the criteria for selecting the proper glove for protection against chemical, physical or biological hazards. The glove material must also not cause side effects to the workers, such as latex allergy.

To develop recommendations for selecting appropriate protective gloves, the author performed a critical review and synthesis of the scientific literature, national standards, pertinent federal regulations, and available manufacturer and other data regarding the performance of gloves against physical, chemical, and biological hazards. Using several industry examples, the author presents a systematic process for appropriate glove selection, reviews the regulations and standards pertaining to gloves, and provides information for establishing a training program for glove usage and maintenance.

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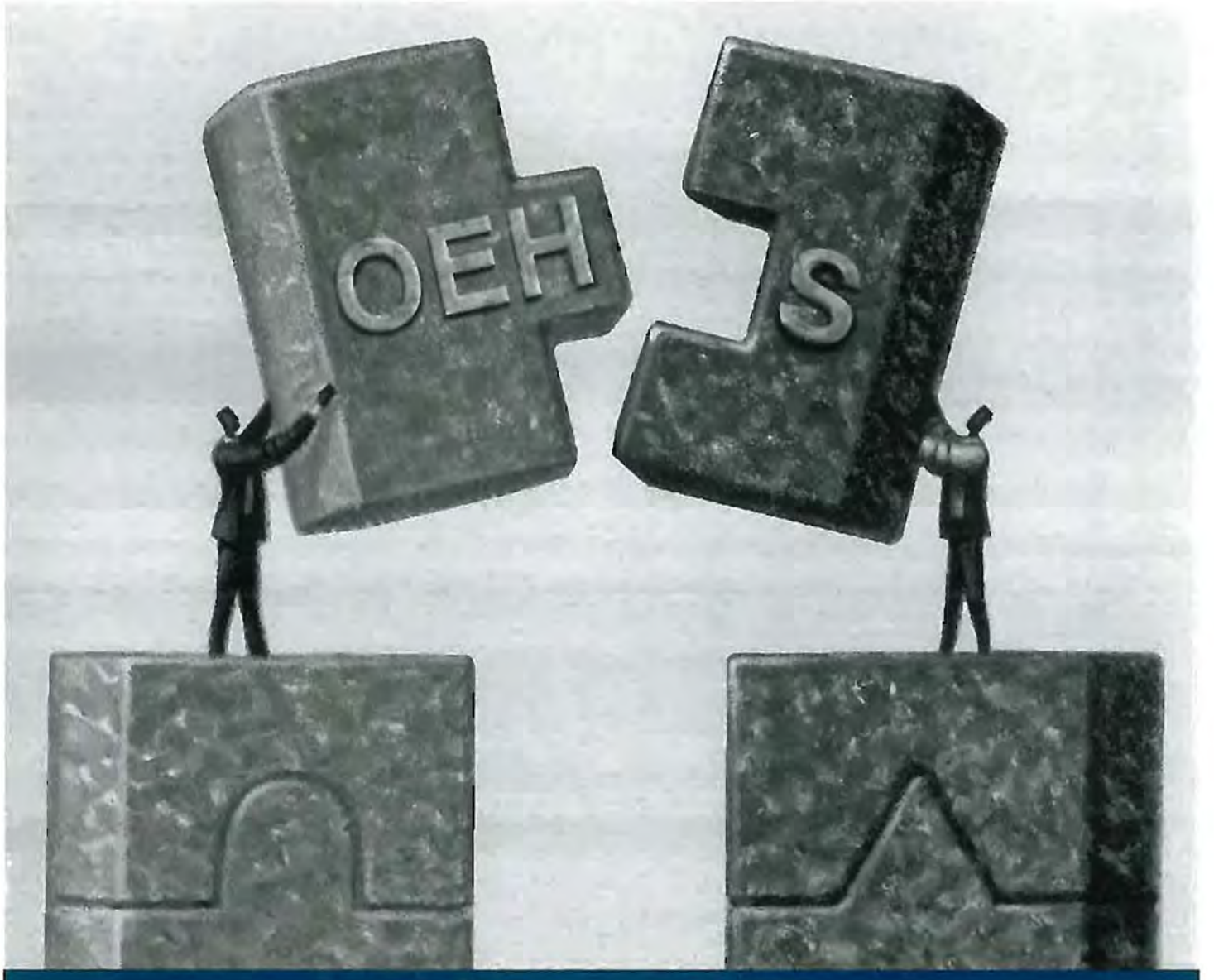

ABSTRACTS

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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