

Papers 163-174

Exposure Assessment Strategies

163

MODEL DEVELOPMENT & VALIDATION ARE THE KEY TO IMPROVING RISK ASSESSMENTS OF INHALATION EXPOSURE **Michael A. Lavjock**, Rohm and Haas Company, Toxicology Research Laboratory, 727 Norristown Road, Spring House, PA 19477; Neil C. Hawkins, The Dow Chemical Company, Chemicals and Metals, Environmental Affairs, 2020 Building, Midland, MI 48674

The need to evaluate human exposure to airborne toxicants lies at the heart of the industrial hygiene profession; however, the adequacy of current methods has come into question as we struggle to use these tools to make critical decisions about the level of risk to human health and its management. In this realm of health risk assessment from airborne toxicants, two particular areas are of concern: the procedures for estimating dose-response relationships and the models used to estimate human exposures. In this paper, we present a case for models as a principal construct of the scientific discipline of exposure assessment. We also explore the adequacy of using currently available exposure assessment models for indoor air inhalation exposures in the context of the uncertainty which exists in both the dose-response assessment and the exposure assessment. Following this, we propose a tiered system for implementing these exposure assessments. Each tier would involve additional research, but also would lead to reductions in uncertainty. Finally, we discuss a necessary national research agenda which will permit the building of validated models for indoor air inhalation exposures among classes of chemicals, building types and exposure scenarios. It is our belief that until such a research agenda is undertaken, modeling of exposures (and therefore risks) using the current, unvalidated approaches provides little more than worst-case estimates which are often not useful for making important decisions about risk management.

164

VOC EMISSION RATE DETERMINATION IN AN OFFSET PRINTING SHOP **R.A. Wadden**, P.A. Scheff, J.E. Franke, L.M. Conroy, C.E. Keil, M.J. Javor, and S.A. Miltz, Environmental and Occupational Health Sciences, University of Illinois at Chicago, P.O. Box 6998, Chicago, IL 60680.

A two day test was carried out December 17-18, 1991, in a printing shop containing 4 sheet-fed offset presses (2 2-color; 2 1-color; 16,000 sheets/day) and 3 spirit duplicators (24,000 pieces/day). Charcoal tube samples (pumps calibrated at 300 ml/min) were collected at twelve locations for 12 hourly periods. The tubes were analyzed for hexane equivalent concentrations by gas chromatography in our laboratories and, as a quality control, 48 paired samples were analyzed at a commercial lab. The agreement was very good ($r^2 = 0.969$) with the slope of the relationship being 0.929 for University vs. Commercial lab analysis. Each sample was also speciated for 14 identified compounds including n-hexane, benzene, toluene, and the xylenes. The average hexane equivalent concentration over the 12 hours at a workbench in the space was 75.5 mg/m^3 , 31% of which was toluene. Analysis of 10 of the cleaning solvents, blanket and plate washes indicated that 3 of these contained benzene. In addition to the hydrocarbon samples, 28 particulate samples were collected on polycarbonate filters (2 L/min for one hour), and were analyzed by proton induced x-ray emission spectroscopy (PIXE) for 14 elements including sulfur, chromium, nickel and lead. Source activities, including sheet counts, job set-up times, and cleaning periods, were also recorded. The volume of the space was 1494 m^3 with an air exchange rate of 15 hr^{-1} which included 34% makeup air from outside the building. There was no local exhaust.

The concentration and ventilation observations were used in conjunction with a completely mixed mass balance model for the interior space to estimate total emission rates of VOC and elements from all sources in the space. In addition the individual source activities were used to discriminate the contribution from each source. A chemical mass balance receptor model was also applied to the chemical pattern of elements and VOC to determine the contribution of each source to total emission. The results of these two determinations are compared. Successful application of mass balance models to determine emission rates from concentration data places the measurement information in a generalized form which can be applied to estimate workroom concentrations in other space and ventilation settings.

165

ESTIMATING THE CONTRIBUTION OF INDIVIDUAL WORK TASKS TO ROOM CONCENTRATION: METHOD APPLIED TO EMBALMING **Ben-**

nett, J.S., Feigley, C.E., Underhill, D. W., Department of Environmental Health Sciences, HESC, Rm 311, University of South Carolina, Columbia, SC; Stewart, P.A., Hayes, R., Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD 20892; Utterback, D.F., and Herrick, R.F. National Institute for Occupational Safety and Health, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, OH 45226.

Industrial hygiene control strategies should consider separately all contributions to the workroom contaminant concentration. Significant sources of a contaminant may be identified through measurement of its concentration during performance of specific work procedures. Continuous concentration measurements cannot be directly used to compare the emissions resulting from individual tasks because dilution and convection influence the measured concentration. The time-weighted average concentration gives even less information. Here a new approach for estimating emission rates from continuous concentration data was developed and applied to formaldehyde measurements collected during 25 embalmings. These were collected while controlling the ventilation rate, the concentration of embalming solution and the type of case (autopsied or intact body). The instantaneous emission rate, G, was estimated from the contaminant mass balance:

$$G = V \frac{dC}{dt} + QC$$

where V is the room volume, C is the contaminant concentration, Q is the dilution flow rate and t is time. The derivative was approximated by the Stirling interpolation polynomial. By graphing G versus t and noting the time the embalming procedures were performed, emissions were attributed to specific procedures. The embalming procedures with the highest generation rates were osmotic gel application, hardening compound application, aspiration of visera, closing of the abdominal cavity and drying compound application, which had peak rates (averaged for each occurrence) of 0.127, 0.083, 0.070, 0.069, and $0.055 \text{ ft}^3 \text{ HCHO/hr}$.

166

DETAILED WORK ANALYSIS FOR CONTROL OF EXPOSURE TO AIRBORNE CONTAMINANTS IN THE WORKPLACE **G. Rosén** and **I. Andersson**, National Institute of Occupational Health, S-171 84 Solna, Sweden.

Measures aimed to reduce worker exposure to airborne contaminants may often be expensive. Decisions on control measures must be based on expert knowledge of effects resulting from changes to different parts of the system. A method for work exposure analysis has been developed at the Division of Industrial Hygiene, Swedish National Institute of Occupational Health. This is based on the Picture Mix EXposure (PIMEX) method, which is a combined use of direct reading instrument and a video camera. The direct reading instrument monitors worker exposure in real time while the video camera records activities at the work place. The signal from the real time monitoring instrument is superimposed on the video film together with time information. The video film is analyzed in detail for different work activities and exposure associated with different activities. The use of a special computer software equipped with a frame grabber, which analyzes information on a data file at a resolution as low as 0.1 sec., has made this kind of analysis possible.

This method has been used in analyzing variations of exposures to dust in quarry and carpentry, organic solvents in spray painting operations, and styrene in glass fiber reinforced polyester plastics factories.

A detailed analysis of styrene exposure was carried out at a site where plans had been made to reduce worker exposure in manufacturing in a spray booth. The measures to be employed were focused on the phase of the work cycle where polyester was applied with a spray gun. The analysis revealed that this particular work phase contributed only 3% to the total worker exposure to polyester when manual rolling of the wet polyester and cutting of edges of the semihardened material explained 55 and 13%, respectively. PIMEX analysis indicated that financial and time investments for controlling particular the spraying phase, would be ineffective for control of the total worker exposure.

The detailed analysis of worker exposure by the PIMEX method can promote efficient and effective activities aimed to reduce health hazards in the work place and conserve financial resources by demonstration of effective control measures.

167

THE APPLICABILITY OF CONTINUOUS AREA MONITORING FOR EXPOSURE EVALUATION IN PETROCHEMICAL INDUSTRY **P. Kallionkoski** and **P. Ruokojarvi**, University of Kuopio, P.O. Box 1627, 70211 Kuopio, Finland; **R. Viinainen**, Neste Oy, P.O. Box 320, 01601 Porvoo, Finland.

The benzene plant and the cumene unit of the phenol plant of the main petrochemical complex of Finland are provided with stationary monitoring networks for benzene. The processes are located outdoors. They are exposed to benzene

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93 AIHCE

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Abstract Index by Session Topics

Platform Session Topics	Abstract Numbers
Aerosol Generation, Sampling & Characterization	231-236
Aerosol Deposition, Clearance & Health Effects	212-218
Agricultural Health & Safety	127-135
Air Sampling Instrument Performance	7-12
Applied Engineering	277-282
Asbestos Management	13-18
Bioaerosols—Sampling & Analysis	300-308
Bioaerosols: Indoor Contamination	102-110
Biological Monitoring Applications	145-152
Computer Applications	292-299
Confined Spaces	64-69
Dermal Monitoring/Exposure Assessment Strategies	82-92
Electromagnetic Fields:	
What Should We Be Telling Our Workers?	259-264
Ergonomics I	41-46
Ergonomics II	47-52
Ergonomics III	206-211
Exposure Assessment Strategies	163-174
Gas & Vapor Detection	309-317
General Management Issues	175-185
Hazardous Wastes I/Environmental Surveillance	136-144
Hazardous Waste II	153-162
Health & Safety Concerns of Emergency	
Response Workers	283-291
Healthcare Industries	332-337
Indoor Air Quality: Building Investigation Protocol	93-101
Indoor Air Quality: New Construction Issues	375-381
Industrial Hygiene General Practice I	53-63
Industrial Hygiene General Practice II	248-258
International Occupational Hygiene Issues	318-322
Ionizing/Nonionizing Radiation	265-270
Laboratory Health & Safety	367-374
Lead I	29-40
Lead II	186-191
Man-Made Mineral Fibers	192-199
Mining Safety & Health	353-358
Noise: Assessment & Control	70-81

Platform Session Topics	Abstract Numbers
Occupational Epidemiology	225-230
Particle Size Selective Sampling	346-352
Personal Protective Clothing & Equipment	1-6
Product Healthy & Safety	200-205
Respiratory Protection I	219-224
Respiratory Protection II	323-331
Risk Assessment/Cadmium/Applications	237-247
Sampling & Laboratory Analysis I	111-119
Sampling & Laboratory Analysis II	338-345
Total Quality Management	
Industrial Hygiene Issues	271-276
Toxicology	19-28
Ventilation I	120-126
Ventilation II	359-366

Poster Session Topics	Abstract Numbers
Aerosol Characterization	382-387
Air Pollution	388-390
Analytical Chemistry	395-407
Bioaerosols	408-411
Biological Monitoring	452-456
Blood-Borne Pathogens	457-460
Computer Applications	461-467
Ergonomics	468-478
Exposure Assessment Strategies	488-495
Gas & Vapor Detection	412-416
Hazardous Communication	496-498
Hazardous Waste	499-504
Indoor Air Quality	479-487
Industrial Hygiene General Practice	417-444
Lead	505-511
Noise	445-448
Product Health & Safety	512-515
Total Quality Management	516-518
Toxicology	449-451
Ventilation	519-522

Author Index page 115

2000901