chamber walls. Subsequent re-emission from the glass walls to the air adds to the airborne concentration until equilibrium is established between adsorption onto and desorption from the sink. At this point the airborne concentration levels off.

Adsorption and apparent degradation of the active ingredient on the chamber walls results in equilibrium airborne concentrations that are about a third of those predicted without these mechanisms. It is anticipated that glass is not a very efficient sink. Tests with typical residential interior surfaces could render significantly more active ingredient going to sinks for longer periods with subsequently more degradation and lower airborne concentrations in the test chambers and real rooms.

Conceptual details of the model's construction, the use and value of simulation software and a predicting performance advantage over previous models are presented.

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EVALUATION OF SOCIOECONOMIC FACTORS AFFECTING TIME SPENT IN INDOOR AND OUTDOOR MICROENVIRONMENTS BASED ON TEN TIME/ACTIVITY STUDIES. T.R. Johnson, J. Capel, and M. McCoy, International Technology Corporation, 3710 University Drive, Durham, NC 27514; W. Ollison, American Petroleum Institute, 1220 L Street, NW, Washington, DC 2000.

A number of computer-based exposure models have been developed which attempt to realistically simulate the movements of people through zones of varying air quality. Many of these models employ time/activity databases obtained from surveys in which subjects documented their activities in diaries. These surveys differ with respect to geographic location, local climate, diary recall approach (realtime versus retrospective), and demographic makeup of the sampled population. This paper presents results of a series of statistical analyses performed on ten time/activity databases to determine the significance of various predictive variables, with an emphasis on variables relating to gender, race, and income. The databases represent the activity patterns of residents of five cities (Cincinnati, OH; Denver, CO; Washington, DC; Los Angeles, CA; and Valdez, AK) and of the entire state of California. Results of the statistical analyses indicate that income, race, and gender significantly affect the average time spent in various indoor and outdoor microenvironments. For example, diary data obtained from a study of outdoor workers in Los Angeles indicate that subjects with incomes below $10,000 spent more time than the average subject in the indoors-residence and outdoors-roadside microenvironments (21 percent and 44 percent more time, respectively). This income group spent less time than the average subject in the indoors-other, outdoors-other, and motor vehicle microenvironments (64 percent, 73 percent, and 56 less time, respectively). These data also show that female subjects spent 30 percent less time in motor vehicles than male subjects. Such inter-group differences in time/activity patterns may significantly affect exposure to air pollution and should be considered explicitly in exposure modeling applications.

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MODELING STRATEGIES FOR INDOOR AIR EXPOSURE ASSESSMENT. M.D. Koontz and H.E. Rector, GEOMET Technologies, Inc., 20251 Century Boulevard, Germantown, MD 20874.

Exposure assessments have been historically limited by insufficient and inadequate data; this is especially true for the indoor environment. Indoor air quality

models offer the means to overcome some of these shortfalls by providing the means to: (1) understand existing data, (2) interpolate across data gaps, (3) extend available information to analogous scenarios, and (4) extrapolate to purely hypothetical conditions. Models for simulating indoor exposure are invariably based on mass-conservation principles that track the material balance for a defined airspace in terms of material gains and losses. Mass-balance relationships are specified through one or more differential equations where contaminant gain (transported input plus sources) and contaminant loss (transported output plus sinks) are stated as analytical functions or fixed constants. Dynamic submodels can be considered to incorporate important processes. Unlike many other areas of environmental modeling, however, indoor air models typically are not software products that can be purchased as "off-the-shelf" items. Rather, most existing software models are research tools that have been developed for specific purposes and are in a near-continual stage of development and refinement. This paper reviews the theoretical and practical framework for simulating indoor exposure scenarios and summarizes available software products. Among the modeling concepts and strategies to be discussed are alternative methods for characterizing mass balance parameters (including emissions, airflows and reversible/ irreversible sink effects) as well as potential advantages and pitfalls associated with the use of simplifying assumptions.

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ESTIMATION OF WORKROOM EMISSIONS FROM ELECTROPLATING. R.A.Wadden, P.A. Scheff, J.E.Franke, L.M.Conroy, Environmental and Occupational Health Sciences, University of Illinois at Chicago, P.O.Box 6998, Chicago, IL 60680.

Effective control of emissions from electroplating is necessary to maintain a healthy workplace. However, in many cases the emission rates are not well characterized. Based on intensive testing of 8 plating operations during production we have developed a number of methods for estimating emissions of chromium, nickel, copper, and sulfur. For each test area concentrations were determined from particulate samples collected on open face filters using calibrated personnel pumps. The samples were collected hourly at several locations in the vicinity of each source. The filters were analyzed using PIXE (proton induced x-ray emission spectroscopy). In each case, measurements of area concentrations were transformed to emission rates by using appropriate mass balance models in conjunction with measured ventilation rates. In addition source activities such as area plated, amp hours consumed, and total power usage were recorded simultaneously with concentration measurements. Comparison of the emission rates with source activities often allowed us to determine emission factors as well as the emission rates. For example, the emission factor for hard and decorative chrome electroplating for three processes varied between 0.08 and 1.47 mg Cr/amp·hr. These results were consistent with limited data available from the California Air Resources Board (0.02 - 3 mg Cr/amp·hr depending on control system). The methods provide a first estimate for determining workroom emissions when no other data are available, and are a useful way to extend field test measurements. For systems with local exhaust ventilation the approach also allows determination of mass-based collection efficiency.

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RAOULT'S LAW v HENRY'S LAW. CHOOSING ONE TO PREDICT EQUILIBRIUM VAPOR PRESSURES FOR COMPONENTS OF A LIQUID MIX-

TURE. I.C. Rock, Texas Occupational Health & Safety Institute, Texas A&M University, College Station, TX 77843-3133.

Industrial hygienists often need to estimate vapor concentrations resulting from liquid solutions under process conditions. Two tools available for this estimation problem are Raoult's Law and Henry's Law.

Raoult's Law describes the equilibrium conditions reached by ideal solutions. The equilibrium partial pressure of the vapor of the nth component of an ideal mixture is the product of the mole fraction of that component in the liquid phase and the equilibrium vapor pressure of that component over its pure liquid. The ideal solution assumption is violated by many real solutions. It is shown that Raoult's Law is appropriate for the solvent vapor in dilute solutions.

Henry's Law describes the equilibrium behavior of solutes in dilute solutions. The equilibrium partial pressure of the vapor of the nth solute in a dilute solution is the product of Henry's constant (empirically determined) and the equilibrium vapor pressure of that component as over its pure liquid. It is useful for all real solutions. The conditions necessary for its application are discussed and examples are provided of its utility in industrial hygiene situations.

In summary, both Raoult's Law and Henry's Law apply to real dilute solutions. Raoult's Law allows reasonable estimates of equilibrium solvent vapor concentrations and Henry's Law allows reasonable estimates of solute vapor concentrations at equilibrium. In solutions of molecules that behave ideally, Raoult's Law applies to all concentrations .

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CHARACTERIZATION OF SOURCE ACTIVITY AND EMISSION FACTORS FOR A COPPER PLATING LINE. S.A. Milz, Naval Hospital, Occupational Health/Preventive Medicine Department, NH064, Great Lakes, IL 60088; R.A. Wadden, J.E. Franke, P.A. Scheff, and L.M. Conroy, University of Illinois at Chicago, Environmental and Occupational Health Sciences, 2121 W. Taylor, M/C 922, Chicago, IL 60612.

Emission rates and emission factors were developed for copper and sulfur based on data collected during production of an eleven-tank copper plating line at a semi-conductor manufacturing plant. Hourly air samples for particulate matter were collected on polycarbonate filters over a two-day period at five locations around the line. The particulate matter on the filters was analyzed for elemental composition using Proton Induced X-Ray Emission Spectroscopy. In addition, source activity data were recorded during the entire twelve-hour sampling period. The observations included board code, rack size, number of boards, tank number, plating current, and temperature of the plating bath.

The collected hourly concentration data and ventilation rates were used with mass balance models to calculate hourly emission rates. The average copper emission rate was 487 μg/min. The average sulfur emission rate varied from 983 μg/min to 1232 μg/min depending on the mass balance model.

Source activity variables were averaged (rack size, current, temperature) or totaled (number of boards) for each of the twelve sampling hours. In addition, three other activity variables were calculated for each sampling hour. These calculated activity variables included the total square inches of boards entering the plating baths each hour, the total square inches of boards being plated each hour, and the total effective energy each hour, which was calculated by multiply-

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