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**OXYGEN AND CARBON DIOXIDE LEVELS DURING QUALITATIVE RESPIRATOR FIT TESTING.** E. Laferty, USAF, Hickam AFB, HI; R. McKay, University of Cincinnati, Cincinnati, OH.

When conducting some types of qualitative respirator fit testing, workers often comment regarding the air inside the enclosure being hot and uncomfortable. In other cases, the person inside the enclosure may not be able to tolerate the environment and terminate the test prematurely. This leads to the question: What are the actual environmental conditions inside the enclosure? This study was designed to quantify oxygen and carbon dioxide levels and other parameters that might lead to these comments when following Occupational Safety and Health Administration accepted protocols for qualitative fit testing using Sweetener or Bitrex. For this study, subjects performed a series of four respirator fit tests. Testing was conducted while wearing two types of respirators (N95 filtering facepiece and a full face). Each was tested quantitatively and qualitatively. Parameters measured included subjects' height, weight, age, oxygen and carbon dioxide levels, air temperature, heart rate, arterial oxygen saturation, and Borg Ratio Scale value on breathing exertion. Results from this study revealed that the mean level of $CO_2$ inside the N95 filtering facepiece during qualitative fit testing was 4.2% and the mean oxygen level was 15.5%. The significant rise in carbon dioxide and reduction in oxygen may be responsible for many of the subjective complaints observed with this method of fit testing. Professionals conducting respirator fit tests should be aware of the physiological burdens that may occur during the qualitative respirator fit test. Some groups may be especially sensitive to this test such as the elderly, pregnant women, persons with pulmonary and/or cardiac disease, or persons with psychological disorders such as anxiety, panic disorders, or claustrophobia.

## 112

**HOW FAR CAN ONE WALK WEARING A SCSR?** A. Johnson, W. Scott, S. Phelps, University of Maryland, College Park, MD.

Self-contained self-rescuers (SCSRs) are compact metal cases containing chemicals that can generate breathable oxygen during emergency egress in Immediately Dangerous to Life and Health (IDLH) atmospheres. They are routinely issued to miners for use during emergencies. SCSR oxygen generation can last a minimum of 60 min. SCSRs have a limited capacity to generate oxygen, and so users are instructed to walk at a vey measured pace in order that their needs for oxygen do not outstrip the rate of generation. When walking at the maximum rate allowed by the SCSR, how far can a wearer walk? Tests were conducted on a treadmill wherein subjects walked at a self-regulated pace at 0% grade. At the end of the test session, when the subject could no longer walk at even a minimal rate because of lack of oxygen, the speeds and times were multiplied and tallied to give total distance walked. This distance was consistently just over 4 mi in the 60 (plus) minutes. It might make sense to require multiple SCSRs for miners working over 4 mi from mine entrances. Also, the exothermic chemical reaction made the metal containers hot enough to burn the skin of wearers, and inhaled air temperature exceeded 50°C. Wearers need to be warned of these hazards.

## 113

**ESTIMATING SERVICE LIVES OF ORGANIC VAPOR RESPIRATOR CARTRIDGES FOR MULTIPLE VAPORS AT ALL HUMIDITIES.** G. Wood, Consultant, Los Alamos, NM; J. Snyder, NIOSH, Pittsburgh, PA.

A recently-published model for estimating service lives of organic vapor (OV) air-purifying respirator cartridges [Wood, *JOEH 1:*472–492 (2004)] has been extended to include multiple organic vapors at all humidities. Equilibriums among the OVs are calculated using Ideal Adsorbed Solution Theory, while the effects of adsorbed water are considered as due to micropore volume exclusion. Solubilities of OVs in water must also be taken into account. Adsorption kinetics include published effects of covapors and water vapor. The dynamics of adsorption and competition are incorporated using expanding zones, taking into account vapor and water displacements and rollups. A large number of measurements of breakthrough curves for OV mixtures at various humidities and for a single cartridge type have been done at NIOSH/NPPTL and by a contractor. The model, implemented as a spreadsheet and a computer program, has been tested against these data.

## 114

**CONSTANT FLOW OR BREATHER FLOW THROUGH A CANISTER: DOES IT INFLUENCE THE BREAKTHROUGH TIME?** L. Steenweg, M. Linders, S. van der Gijp, TNO-PML, Rijswijk, The Netherlands.

According to European standard EN 141, the capacity of canisters to be used for toxic industrial materials has to be tested at a constant flow of 30 litres per minute. According to the NIOSH requirements, canisters have to be tested at a constant flow of 64 litres per minute.

In actual use, however, the air flow pattern through a canister differs from constant flow: breathing results in a pulsating flow pattern. Air will pass the canister at variable speed during inhalation; this will result in much higher air flows through the canister. As a result, the breakthrough performance of the canister decreases dramatically. This means, in practice, that the canister can be used for short periods of time only; much shorter than the periods that are expected based on the outcome of tests with constant flow.

To establish the difference in breakthrough behaviour, TNO-PML has performed a research program in which ABEK-2 and NBC canisters were tested with 10 different toxic industrial materials under both breather flow and constant flow. All other parameters (influent concentrations, temperature, relative humidity, etc.) were kept the same.

In the presentation, the results will be presented and discussed, as well as the envisaged improvements/changes of standardisation.

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**EFFECT OF AEROSOL LOADING ON THE BREAKTHROUGH CHARACTERISTICS OF CHARCOAL CARTRIDGE.** C. Chen, C. Lin, National Taiwan University, Taipei, Taiwan Republic of China; S. Huang, C. Chen, Institute of Occupational Safety and Health, Taipei, Taiwan Republic of China; Y. Kuo, Chung Hwa College of Medical Technology, Tainan, Taiwan Republic of China.

Organic solvents are often used in the work environment. Exposure to organic vapors may lead to adverse health effects of respiratory tract, kidney, cardiovascular, and nerve system. Charcoal cartridges are commonly used to protect against a wide range of organic vapors. Although most of the charcoal beds have a filter installed upstream to protect the activated charcoal from particle contamination, the information on the effect of aerosol loading on the charcoal cartridge performance was limited.

In this work, the cartridges filled with 36.5 g of activated carbon were challenged with 3000 ppm cyclohexane, with the test flow fixed at 15 L/min and the relative humidity at 50%. The monodisperse solid (acrylic) and liquid (DOP) challenge aerosols were generated by using a powder disperser and a condensation monodisperse aerosol generator, respectively. A flame ionization detector was used to monitor the cyclohexane concentrations upstream and downstream of the cartridge. The aerosol penetration through the charcoal cartridge was measured by using a scanning mobility particle sizer ($< 0.7$ μm) and an aerodynamic particle sizer ($> 0.7$ μm).

The results showed that the aerosol penetration through the charcoal cartridge was up to 80% around the most penetrating size, even though the breakthrough time was longer than 30 minutes when challenged with 3000 ppm cyclohexane. The pressure drop across the charcoal bed decreased with time when challenged with cyclohexane, and this air resistance "regained" if the clean air was used to remove part of the absorbed cyclohexane. The breakthrough time of charcoal cartridge decreased with increasing aerosol concentration. Liquid aerosols showed stronger effect (than solid particles) on reducing the absorbing capability of the charcoal bed, apparently due to more surface area to cover up the activate site of the charcoal.

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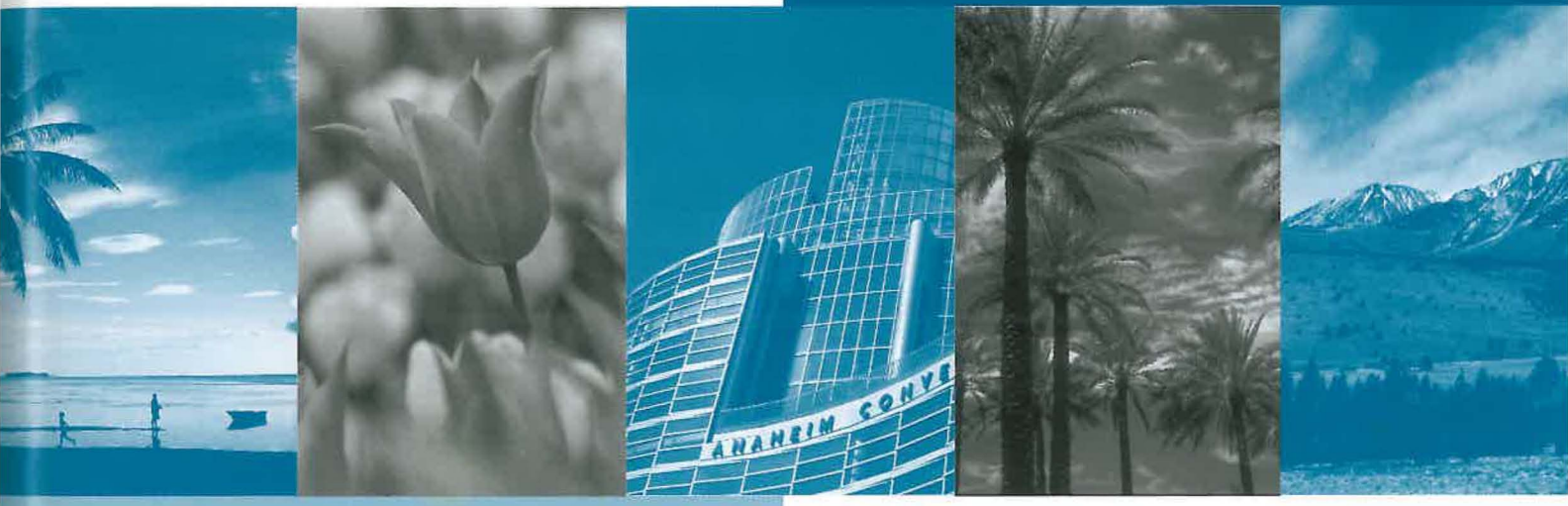


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