Particle size penetration of diesel particulate matter through respirator filter media

Kerrie Burton  
*University of Wollongong, kab843@uowmail.edu.au*

Jane L. Whitelaw  
*University of Wollongong, jwhitela@uow.edu.au*

Alison L. Jones  
*University of Wollongong, alisonj@uow.edu.au*

Publication Details  
Particle size penetration of diesel particulate matter through respirator filter media

Abstract
Abstract presented at the American Industrial Hygiene Conference & Exposition, May 30 - June 4 2015, Salt Lake City, Utah.

Keywords
media, penetration, diesel, particulate, matter, respirator, particle, filter, size

Disciplines
Education | Social and Behavioral Sciences

Publication Details

This conference paper is available at Research Online: http://ro.uow.edu.au/sspapers/1581
RH=80% was significantly higher than that at RH=20% for both aerosols and both MFS, which can be attributed to the effect of high RH on electric charges on the filter fibers. The most penetrating particle size (MPPS) was identified below 100 nm for both aerosol challenges. No consistent change in the MPPS was observed with the increase of RH. Respirator B provided lower protection levels; the total penetration was 2.1% to 8.6% for combustion particles and 1.4% to 5.7% for NaCl particles. The effects of challenge aerosol and RH followed the same trend as obtained for Respirator A. The MPPS was also observed in the particle size range below 100 nm.

**Conclusions:** The manikin-based testing with cyclic breathing showed that the filtration level of an N95 FFR obtained with NaCl particles may significantly underestimate its filtration efficiency against combustion aerosols. Higher relative humidity may reduce the filter performance.

**SR-116-04 Evaluation of the Effect of Head Strap Length on Facial Fit of N95 Filtering Facepiece Respirators**

M. Bergman, Z. Zhuang, A. Palmiero, D. Niezgoda, NIOSH/NPPTL, Pittsburgh, PA

**Objective:** A three-year study was performed to validate the scientific basis for the periodicity of fit testing by investigating changes in NIOSH-approved N95 filtering facepiece respirator (FFR) fit on a group of test subjects as a function of time. In this presentation, data from the periodicity of fit testing study is used to explore the relationship between head strap length and N95 FFR fit. The relationship of head strap length to N95 FFR fit has not been previously reported.

**Methods:** A group of 229 subjects was initially enrolled and tested every six months. During each visit, subjects performed a total of nine fit tests using three samples of the same FFR model. The facial dimensions of all subjects were also measured during each visit to determine changes over time that may affect respirator fit. Seven FFR models were included in the study. Inward leakage and filter penetration were measured for each donned respirator to determine face seal leakage (FSL). Unstretched head strap length was measured beginning on the second or third visit. For each respirator model, a linear regression was performed on geometric mean (GM) FSL of individual respirator samples using data from all visits (dependent variable) to the unstretched top and bottom strap lengths of those samples (independent variables).

**Results:** A total of 195 subjects completed the second visit and 134 subjects completed all seven visits. The data collected from all participating test subjects at each visit was used for this study. Among the seven FFR models, the mean top strap length ranged from 194.8 to 321.8 mm with relative percent standard deviation (%RSD) ranging from 0.31 to 5.18. The mean bottom strap length ranged from 194.6 to 299.5 mm with %RSD ranging from 0.42 to 5.11. For four of the seven respirator models, top and or bottom strap length was found to have a significant (P < 0.05) correlation with GM FSL.

**Conclusions:** Head strap lengths were found to be quite variable within some FFR models. Unstretched head strap length had some association with FFR fit. Further analysis of the data will be performed to explore the interaction of strap length with other factors such as weight changes and changes in facial dimensions to determine the effect on respirator fit. Future studies should be performed with respirators of controlled strap lengths to better understand the effect of length on respirator fit.

**SR-116-05 Particle Size Penetration of Diesel Particulate Matter through Respirator Filter Media**

K. Burton, J. Whitelaw, A. Jones, University of Wollongong, Wollongong, NSW,
Objective: Diesel engine emissions are known to cause adverse health impacts including lung cancer, cardiovascular and irritant effects. The diesel particulate component of the emissions is in the nanoparticle size range. Respiratory protection is commonly used to mitigate worker exposure. Current test methods to evaluate penetration through respirator filter media may not consider smaller size particles due to the diameter of the challenge aerosol and the detection limit for the instrument. The objective of this study was to determine the Most Penetrating Particle Size (MPPS) through a range of commonly used respirator filters in Australia, to evaluate whether MPPS is included in standard testing criteria for respirator filtering efficiency. Additionally the project evaluated penetration through the filter media using diesel particulate, rather than NaCl, as the challenge aerosol.

Methods: Emissions from a Perkins 4.4L diesel engine were fed into an experimental chamber. Penetration of these emissions was determined by sampling elemental carbon, using NIOSH Method 5040, before and after the respirator filter. A Scanning Mobility Particle Sizer with attached Condensation Particle Counter was used to measure penetration as a function of particle size.

Results: Initial results indicate that when challenged with DPM, the MPPS varied for each of the respirator models. The filtering efficiency at the MPPS appeared to meet the requirements for P2 certification in Australia or N/P/R95 NIOSH certification requirements.

Conclusions: Filtering efficiency in Australia is determined by challenging filter media with aerosolized sodium chloride and calculating penetration at designated flow rates. Current standard test requirements do not account for the differences in structure and chemical characteristics of DPM and sodium chloride nor do they include particle sizes below the instrument detection limit and diameter of the challenge aerosol. This study showed that the Most Penetrating Particle Size of diesel emissions through 3 commonly used respirator filters varies dependent on the filter and hence may not be included in filtering efficiency calculations. These findings will inform development of Australian and International Standards on the selection and evaluation of respiratory protection to ensure workers are protected against this common workplace carcinogen.

SR-116-06 Development of a New Data Acquisition System for Recording and Analyzing In-Facepiece Pressures during NIOSH Breathing Machine Tests

J. Parker, NIOSH, Pittsburgh, PA

Objective: This paper describes the development and testing of a new data acquisition system for recording and analyzing the in-facepiece pressure tracings when respirators are tested for various performance criteria with the NIOSH breathing machine. These tests are used for evaluating the performance of self-contained breathing apparatus (SCBA). The current system utilizes a combination strip-chart recorder and signal conditioning unit. Historical data has shown that when respirators are tested on breathing machines, it is often found that in-facepiece pressure sample tracings will include very short duration spikes below zero. The problem is how to determine if the negative spike(s) truly represent(s) a negative facepiece pressure, or not. This decision determines if a test passed or failed. NIOSH has always required that the spike must contain a certain minimum area that represents the combined duration and intensity of the spike in order to constitute a failure. This evaluation is currently performed qualitatively by examining the strip chart recording. Other researchers and scientists have accepted or rejected negative excursions based on duration only.

Methods: The new system uses a ±10 VDC, 16-Bit simultaneous sampling analog input device to capture the transducer outputs and to send these