SR-127-04

On Methods Suitable to Assess the Containment Efficiency of Fume Hoods and Safety Cabinets with Respect to Nanoparticles

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Objective: The increasing use of nanomaterials in laboratories brings concern regarding the containment efficiency of ventilation-based protective equipments, such as fume hoods and safety cabinets, in this size range of particles. Currently, no standard method of testing nanoparticles containment exists. The purpose of the present work is to evaluate and compare three different methods having the potential of being used as containment tests, namely a method based on particle counting, a method based on a particulate tracer, and a method based on a tracer gas.

Methods: The three different methods are assessed in a ventilated cleanroom, inside which a microbiological safety cabinet (MSC) is placed. Test pollutants (nanoaerosols of various types, an ultrafine fluorescent aerosol and a tracer gas) are generated inside the MSC and their concentrations are measured on several points outside the MSC and under different operating conditions (with or without manikin, and with moving-plate generated drafts).

Results: It is found that in the studied size range and operating conditions the containment is not size-dependant, nor dependant on particles chemical nature, which is explainable by the predominance of ventilation effects over particle-specific properties. The containment of nano-sized particles is also found always better than the containment of a tracer gas.

Conclusion: The three methods investigated are suitable to evaluate the containment efficiency of ventilated enclosures with respect to dispersed nanoparticles, i.e. either using a cleanroom and a counting method, or for in-situ testing, using fluorescent ultrafine particles as tracer, or a tracer gas (under specific conditions).

Podium Session 128 Protective Clothing and Equipment

Wednesday, May 22, 2013, 10:00 AM – 12:00 PM

SR-128-01

Permeation of Cyclohexanol through Disposable Nitrile Gloves

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Objective: The purpose of this study was to investigate the protectiveness of four types of disposable nitrile gloves against cyclohexanol.

Methods: Experiments involved a 1-inch permeation cell at 35°C and a water shaking bath with a speed of 8.53 cm/sec, using the American Society for Testing Materials (ASTM) F739-99 closed loop method. The products tested in triplicate were Kimberly Clark safeskin, blue, purple, and sterling nitrile disposable gloves. The challenge cell was filled with 10-mL of cyclohexanol and the collection cell was filled with 10-mL of water, the preferred solvent because of cyclohexanol's solubility and glove compatibility. The method blank comprised the glove and collection water only. The analytical method utilized an Agilent 6890N gas chromatograph with a mid-polar capillary column connected to an Agilent 5973 mass spectrometer used in the selected ion monitoring mode employing the internal standard method. The ions used for detection were m/z 57 for cyclohexanol and m/z 172 for 4-bromophenol.

Results: Cyclohexanol permeated all disposable nitrile glove products. The safeskin product had a normalized breakthrough time of 29±6 min and steady state permeation rate of 2.2±0.6 $\mu g/cm^2/min$, blue nitrile 26±4 min and steady state permeation rate of 12.1±1 $\mu g/cm^2/min$, purple nitrile 18±3 min and steady state permeation rate of 12.4±2 $\mu g/cm^2/min$, and sterling nitrile at 8±3 min and steady state permeation rate of 21.4±1 $\mu g/cm^2/min$.

Conclusions: The safeskin disposable glove was the most protective of the four that were tested in regards to normalized breakthrough time and steady state permeation rate. The

safekin, blue, and purple nitrile gloves would be rated as “Good” while the sterling nitrile gloves would receive a rating of “Poor” according to the chemical resistance rating system for disposable gloves by Kimberly Clark.

SR-128-02

Permeation of 2-Ethoxyethanol through Purple Disposable Nitrile Gloves

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Objective: The purpose of this study was to investigate the permeation of 2-ethoxyethanol (99% purity) through a disposable powderless, unlined, unsupported purple nitrile exam glove material. The goal was to investigate the protective capability and reliability of the gloves during occupational exposures.

Methods: Glove materials were conditioned for 24 h in a desiccator at a relative humidity of 52 ±1%. Four 1-inch diameter permeation cells (3 experimental cells with 2-ethoxyethanol as challenge and one air blank) were used with water as collection fluid in a protocol based on the American Society for Testing and Materials (ASTM) F 739 - 99a closed-loop permeation method. Aliquots of 0.1 mL were taken at permeation time intervals of 20 min, 1, 2, 4, 5, 6, and 8 h. The analytical method was based on gas chromatography-mass spectrometry (GC-MS) using the internal standard method (4-bromophenol as internal standard) and selected ion monitoring (m/z 59 and 172) and injection of 2-uL aliquots.

Results: The ASTM normalized breakthrough detection time corresponding to 0.25 ug/cm^2 occurred at <20 minutes. The permeation rate stabilized at 6.3 ± 0.61 ug/cm^2 from 1 through 8 hours. The material swelled noticeably into the collection chamber, but reverted to its original state on reconditioning.

Conclusions: These disposable purple nitrile exam gloves should not be used as personal protective equipment for exposure to 2-ethoxyethanol even for short period exposures.

CS-128-03

Surface and Skin Fiber Sampling Related to the use of a Cut-Resistant Sleeve

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Situation/Problem: NIOSH received a health hazard evaluation request from union representatives at a steel mill. They were concerned with skin and upper respiratory irritation, and safety and hygiene issues regarding the required use of cut resistant protective sleeves containing fiberglass, Kevlar®, and cellulose. Of particular concern was the potential for inhalation of fiberglass from the use of the protective sleeves after sleeves have been laundered.

Resolution: We collected surface samples using either Stick-To-It lift tape (SKC Inc., Eighty Four, Pennsylvania) or vacuuming with a polycarbonate filter from work surfaces, worker’s skin, and worker’s clothing, including the surface of new and laundered protective sleeves. We also collected bulk samples of new and laundered protective sleeves and other potential sources of fibers at the steel mill (i.e., insulation materials). These samples were analyzed by stereomicroscope and polarized light microscopy for identification of fiberglass, Kevlar®, and cellulose particles, as well as for particle morphology and size.

Results: All vacuum filter surface samples contained fiberglass and/or cellulose particles. All tape samples contained fiberglass, Kevlar®, and/or cellulose particles. The Kevlar® particles averaged 20 micrometers (µm) in width and the fiberglass particles averaged 10 µm in width; both had variable lengths. There were no differences in particle size or shape depending on whether the sample was collected from a laundered sleeve or a new sleeve. None of the Kevlar®, fiberglass, or cellulose particles seen in these surface samples had sharp edges. No fibers from insulation were found on surfaces or skin.

Lessons learned: We concluded that the fiberglass particles discovered on work surfaces did not pose an inhalation hazard. However, these particles may cause reversible upper airway irritation and reversible skin irritation for some individuals.

ABSTRACTS

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