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
S. QueHee, A. Mathews, UCLA, Los Angeles, CA.

Objective: The purpose of this study was to investigate the protective value 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 µg/cm²/min, blue nitrile 26±4 min and steady state permeation rate of 12.1±1 µg/cm²/min, purple nitrile 18±3 min and steady state permeation rate of 12.4±2 µg/cm²/min, and sterling nitrile at 8±3 min and steady state permeation rate of 21.4±1 µg/cm²/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 safeskin, 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
S. Banaee, UCLA, Arcadia, CA; S. Que Hee, UCLA, Los Angeles, CA.

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 µg/cm² occurred at <20 minutes. The permeation rate stabilized at 6.3 ± 0.61 µg/cm² 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
D. Ceballos, L. Tapp, D. Wiegand, NIOSH, Cincinnati, OH.

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.

SR-128-04
Cooling System to Alleviate Heat Stress in Hazmat Suits
G. Srinivas, TDA Research, Inc., Golden, CO.

Objective: When responding to a chemical spill or other hazardous cleanup operation, first responders must frequently wear a level A hazardous materials suit. The SCBA/impermeable suit provides contaminant free air and a barrier to the chemical hazard. Because the suits are sealed, they quickly get very hot and humid and within 20–30 minutes, first responders can experience heat stress. TDA Research, Inc. (TDA) is developing a lightweight, portable system that will cool and dehumidify the air circulated through the hazmat suit. Our objective is to build a system that alleviates heat stress for personnel and allow for more efficient working conditions.

Methods: We circulate (and recycle) cool, dry air (from the SCBA) over the first responders’ body with ducting to facilitate cooling by sweat evaporation. We use a desiccant to dry the air and a heat exchanger to transfer heat to the outside hazardous environment.

Results: We have successfully built and tested a heat exchanger that dries the air to about 15% RH and cools it to between 85 and 90°F for circulation. The cool, dry air is distributed to the hands, head, and feet within the hazmat suit with an internal duct system. We have also demonstrated that a full scale prototype can remove about 700 BTU/hr. (~200 W) of heat from a cooling suit. TDA is currently working with hazmat suit manufacturers to integrate the heat exchanger into the suit, as well as with physiologists to make the system more efficient and test with thermal manikins – prototype demonstration results will be presented.

Conclusions: TDA has successfully built and demonstrated a novel cooling system that will alleviate heat stress for first responders in hazmat suits.