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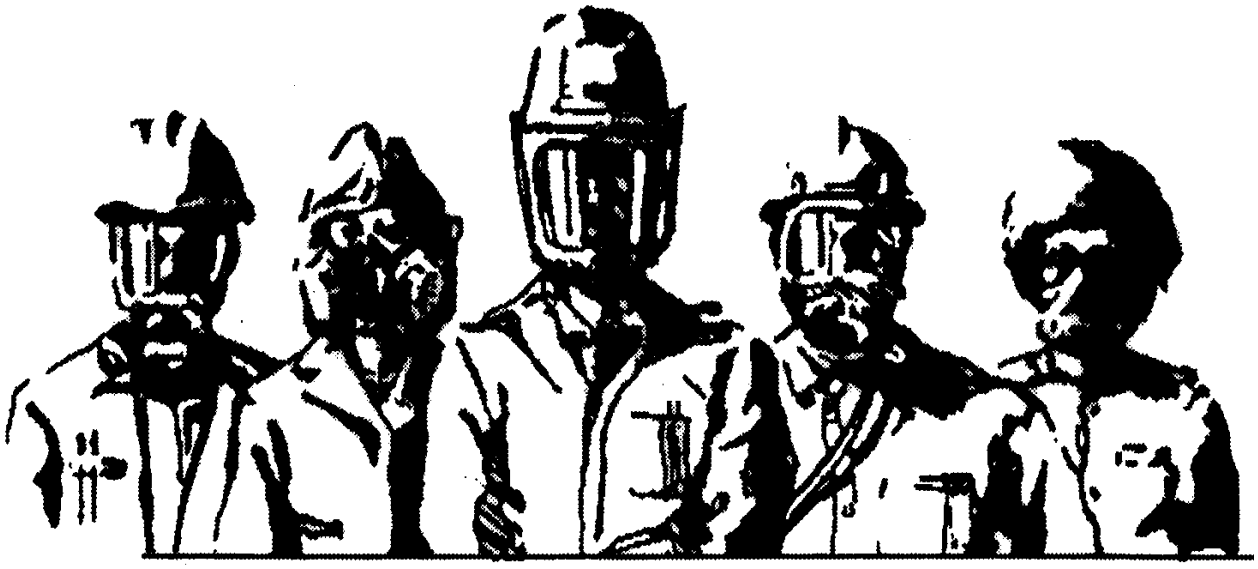

Performance Studies on Respiratory Protective Devices in the Workplace – Part II: Towards a unified approach

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ABSTRACT

The assigned protection factor (APF) is a fundamental parameter used when selecting adequate respiratory protective devices (RPD). Various methods have been used to arrive at current APFs, including workplace protection factor (WPF) studies. Many published papers report these results but as yet there is no common international protocol for conducting, analysing and reporting workplace performance studies. The protocols adopted vary according to the objectives of the study, and the protocol and objectives are not always clearly defined. The lack of a harmonised approach to workplace performance studies has partly been responsible for the huge differences in assigned protection factors that can be seen across the world. Part I of this paper discussed the issues surrounding the derivation of APFs and the need for a harmonised approach to future workplace studies. Part II discusses the key elements of workplace performance studies and makes recommendations for consideration with the aim of achieving a harmonised approach to WPF studies.

Keywords: Respiratory protective devices, assigned protection factors, workplace protection factors, performance

Low pressure drop respirator gas filters using adsorbent hollow fibres as an alternative to granular adsorbents

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ABSTRACT

Respirator users experience a physiological burden, one aspect of which is associated with breathing resistance from the filter. The current best practice of gas filters is to provide protection using 3adsorbent granule filled filters which, as the particle size decreases, have better adsorption kinetics, and hence longer breakthrough times. However this comes at the price of an increasing pressure drop and hence greater breathing resistance. In this paper, adsorbent hollow fibres for use in respirator filters are presented as a potential alternative to the conventional granular cartridges. A comparison of hollow fibre and granular filter modules was carried out using scanning electron microscopy and dynamic ammonia challenge (800 ppm, 1 L/min). In addition the pressure drop was measured at flow rates between 0.5-5 L/min, and using these data, pressure drops at higher flow rates were predicted. The hollow fibres were demonstrated to compare favourably to a granular module of equal volume in terms of pressure drop, adsorption kinetics and breakthrough loading, although improvements still need to be made to hollow fibre breakthrough time, which is slightly lower than an equal volume pellet module as a result of the lower density of the hollow fibre filters. The qualities of hollow fibres will provide several options for novel filter design.

Keywords: adsorption, hollow fibre, packed cartridge, low pressure drop, ammonia

Forces Generated by N95 Filtering Facepiece Respirator Straps

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ABSTRACT

The adequacy of the seal developed at the interface of a respirator and the user's face is an important factor in preventing inward leakage of contaminants into the user's breathing space. Restorative forces generated in response to the load produced by the elasticized straps of respirators during donning are responsible for the development of this seal, yet little data exist regarding the level of force developed by these tethering devices. Tensometer evaluations of six models of N95 filtering facepiece respirators indicated significant differences in forces generated by the tethering devices that were model dependent. Forces exerted on facial structures by N95 filtering facepiece respirators averaged <10 Newtons. Utilizing the Mooney-Rivlin hyper-elastic predictive model with vectors derived from three dimensional photogrammetry representations, force vector analyses were conducted on six models of N95 filtering facepiece respirator straps and indicated that this model can be useful in determining forces generated by these tethering devices. Tethering devices are integral to proper respirator function and data from this study may be useful in future research studies and for designers of protective facemasks that utilize similar tethering devices in determining minimal forces that are associated with passing quantitative respirator fit testing.

Keywords: N95 filtering facepiece respirators, straps, force vectors

BioProtect Tool: a Control Banding Method for Respirator Selection against Bioaerosols

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ABSTRACT

Selecting the right respirator to protect workers against occupational exposure to bioaerosols is complicated by the lack of occupational exposure limits, the limits of current sampling methods, the diversity of bioaerosols and the inconsistency among experts' recommendations. Thus, qualitative methods such as control banding offer a more practical alternative for risk assessment and management of bioaerosols. The objective of this project was to develop a control banding approach, the BioProtect Tool, for respirator selection against both infectious and non-infectious bioaerosols applicable to all workplaces. A committee including occupational hygienists, microbiologists and physicians, as well as experts in the fields of control banding, respiratory protection, ventilation and aerosol physics was formed to develop and validate the model. A 4 x 5 selection matrix was developed, with four biosafety risk groups and five exposure level bands. Each exposure level band is the sum of a control level band and a generation rate band. A minimum protection factor is assigned to each risk group-exposure level pair, allowing the user to identify an appropriate respirator. A validation of the model using nineteen case studies showed that the assigned protection factors obtained with the control banding approach matched or exceeded the assigned protection factors retrieved from the literature in fifteen cases out of nineteen. Comparison with the Canadian Standard Association's control banding model also showed that the control banding approach presented in this publication is more sensitive to slight changes in workplace conditions and tends to give more conservative results. Overall, the control banding approach developed is a simple and useful tool for assessing the risk of occupational exposure to infectious and non-infectious bioaerosols, providing recommendations for respirator selection and identifying activities that present the most risk. It could be easily integrated into the assessment and management of occupational risks wherever workers are exposed to bioaerosols.

Keywords: Control banding, bioaerosols, respiratory protection, risk assessment

Developing an Air Sampling System for Detecting Oxygen Leaks from the Facepiece of a Self-Contained Breathing Apparatus

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ABSTRACT

The goal of this work was to develop and validate an oxygen leak detection system for use with a closed circuit self-contained breathing apparatus (CC-SCBA). CC-SCBAs operate under a positive pressure closed loop, where carbon dioxide is removed from exhaled air while oxygen and other gases are recovered and recycled. There has been a long standing NIOSH prohibition against the use of such oxygen based closed circuit systems in the presence of high radiant heat or open flame due to concerns over possible user burn injury as a result of leaks in the vicinity of the facepiece. Past studies performed according to the NFPA 1981 standard have revealed that facepiece fit poses the biggest risk for a closed circuit respirator and will most likely be the location for a leak to occur. The system developed here was intended to detect leaks emanating from the facepiece seal using a plenum with sampling ports at intervals located along the periphery of the facepiece to pull air to an oxygen analyzer. Leaks were located at the neck, temple, and cheek of the facepiece and the changes in percent oxygen in the surrounding air were recorded for leak and no leak conditions. With this approach the oxygen leaks can be sensed directly and independently of size or location. It was found that the proposed system is capable of sampling from the vicinity of the facepiece; however its sensitivity in detecting leaks was not found to be adequate enough to definitively state if a leak had occurred due to large fluctuations in oxygen detected as a result of a low sample rate and a high dilution factor.

Keywords: closed circuit self-contained breathing apparatus, respirator fit, respiratory protection, oxygen leak