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EFFICIENCY EVALUATION OF N95 FILTERING FACEPIECE RESPIRATORS TO CAPTURE ULTRAFINE PARTICLES UNDER CYCLIC AND CONSTANT FLOWS

Ultra Fine Particles (UFP) (diameter of particle, Dp, <100 nm) can be found in most industrial workplaces, where their long term inhalation could result in serious detrimental impacts on health. In some situations, engineering and administrative controls are insufficient to adequately protect the workers from inhaling UFPs. Individual respiratory protection is then required, and N95 Filtering Facepiece Respirators (FFR) are the most widely used by industrial and healthcare workers. Previous study on the efficiency of the N95 filter using a constant flow and a polydispersed aerosol showed that the maximum particle penetration in these filters was obtained for a size of particles of less than 100 nm and that the penetration exceeded the threshold penetration of 5% for high airflow (>85 L/min). The present investigation of N95 FFRs efficiency evaluates the representativeness of these results by using a cyclic flow rate. A procedure to investigate the efficiency of N95 FFRs under cyclic and constant flows was developed for this study. The first objective was to investigate the individual impact of breathing frequency and inhalation flow rate on the efficiency of N95 FFRs. The experiments were performed for two Peak Inhalation Flows (PIFs) (135 and 360 L/min) and two breathing frequencies (24 and 42 Breaths Per Minute (BPM)) for a total of four cyclic flows. The second objective was to compare the efficiency of N95 FFRs under cyclic flows with the ones under constant flows equal to the cyclic flow minute volume, Mean Inhalation Flow (MIF) and PIF. Minute volume is defined as the average volume of inhaled air per one minute of breathing, while MIF is determined as the average volume of inhaled air per inhalation cycle. Peak Inhalation Flow (PIF) is the maximum flow obtained in any inhalation cycle. The selected constant and cyclic flows (with equivalent MIFs) were in the range of 42 to 360 L/min. Finally, the impact of particle loading time on N95 FFRs efficiencies was investigated under cyclic and constant flows for periods of up to six hours. A cyclic flow (with equivalent MIF rate of 170 L/min) and two constant flow rates of 85 and 170 L/min were selected. In all experiments, the filters were exposed to polydispersed NaCl particles ranging from 10 to 205 nm. The results showed that an increase in both PIF and breathing frequency could potentially raise the particle penetration through N95 FFRs. However the effect of PIF was observed to be much more important than the effect of the frequency. It was also shown that, among three constant flows equal to the cyclic flow PIF, MIF and minute volume, a constant flow equal to MIF can much better predict the initial penetration of N95 FFRs. Finally, particle loading had a significant impact on particle penetration through N95 FFRs, while the trend in penetration changes, in terms of loading time, highly depended on the levels of rRelative Humidity (RH). With low RH, the protection level increased with particle loading on the filter. Penetration of smaller particles (usually <100 nm) significantly dropped following a filter long-term exposure, and a distinct shift in the most penetrating particle size towards larger particles was also observed. With high RH, on the other hand, a reverse trend was observed, since particle penetration was generally increased with the loading time. In addition, this investigation showed that, in terms of loading time, a constant flow could not necessarily predict particle penetration during cyclic flows for long term exposure of the filters.

Biography

Ali Bahloul is a researcher at the IRSST since 2005, he has developed expertise in the field of industrial ventilation and indoor air quality. He is an associate professor at Montreal's School of Advanced Technology and Concordia University, as well as an adjunct professor at University of Montreal. His main research interest includes to anticipate, identify, evaluate and control exposure to chemical substances and biological agents.

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