PPF003: Poster presentation

Study on the Faceseal Leakage Characteristics of Self-Contained Breathing Apparatus

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Abstract

In pressure-demand self-contained breathing apparatuses (SCBAs), there is a special pressure regular and an exhalation valve on the mask working together to maintain positive back pressure in the facepiece. Thus, even in the event of a slight break of a sealing edge, there is a flow ex-filtrating the device, automatically preventing inward leakage. However, many laboratory studies reported that a momentary negative pressure may occur inside the facepiece under certain work conditions, which creates potential inward leakage. Therefore, the objective of this study was to investigate inward leakage in pressure-demand SCBAs by using a dynamic test system.

In order to characterize the inward leakage, pressure-demand SCBAs (Drager PSS 7000) were sealed onto a manikin's face with or without artificial leaks. The head form was connected to a homemade breathing simulator with adjustable tidal volume and breathing frequency. Breathing rates were chosen to span the breathing range of a human adult at different workloads: 10 - 25 times per minute with 0.5 - 2.5 L for tidal volumes, respectively. Stainless capillary tubes varying from 0.4 to 1.0 mm in diameter and 10 mm in length were used simulating the leaks. Springs of different elasticity were chosen to simulate different positive pressure on the exhalation valve. During the tests, pressure inside the facepiece was measured by a pressure transducer (Omega Model NO. PX2650-5BD5V), and signals are relayed to a data acquisition board (Adantech USB-4704) for data recording. Particle concentrations were measured using a condensation particle counter.

Results show that the probability of negative pressure occurs inside the facepiece increased by the respiratory flow rate, a surrogate of human activity level. Momentary (3.65 seconds per minute) negative pressure was observed inside SCBAs when the respiratory rate reached 25 times per minute and the tidal volume reached 2 l. Under the same condition, the fit factor was reduced from greater than 1000 to 35 for the capillary diameter of 1 mm. As the tidal volume exceeded 2 L, the negative pressure increased, as well as its duration. Whereas positive pressure could be applied on the exhalation valve to help reduce the occurrence of negative pressure, it increases resistance for exhalation. In conclusion, occurrence of negative pressure observed under the experimental conditions in this work could cause ambient contaminants to penetrate into the facepiece.