PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Dynamic Swatch Test Method For Assessing Liquid Aerosol Penetration In Chemical Warfare Protective Clothing

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Chemical warfare agents (CWAs) pose a threat not only in their gaseous form but also as liquid aerosols. Protective clothing is crucial for safeguarding soldiers against such hazards on the battlefield. The effectiveness of this clothing hinges on its ability to act as a barrier against these chemicals and biological agents. Therefore, it is essential to have a reliable methodology for testing the performance of chemical warfare protective clothing. This paper presents a dynamic swatch test method designed to simulate the penetration of liquid-phase aerosolized particles into protective clothing. The method involves a specialized test cell capable of dynamically shaping and rotating the fabric swatch, along with instrumentation for generating, sampling, and analyzing aerosol particles. This test cell is housed within a laboratory-sized recirculating wind tunnel, ensuring a controlled environment for testing. Notably, the test cell can rotate left and right, mimicking real-world mission conditions. Within the wind tunnel's test section, characterized by uniform average velocity distribution and low turbulence, di(2-ethylhexyl) sebacate particles serve as liquid aerosols, circulated at various wind speeds ranging from 1.0 to 5.0 m/s. A portable aerosol spectrometer captures aerosolized particles that breach the protective fabric, enabling the calculation of particle penetration as a function of particle size. Preliminary studies conducted on three woven textile swatches with varying physical properties indicate that higher wind speeds and increased fabric air permeability lead to greater penetration at an equivalent face velocity of 5 cm/s. Furthermore, penetration decreases for all fabrics when the fabric sample is rotated, highlighting the importance of considering fabric orientation in testing. The results demonstrate that the developed test system and methodology yield repeatable outcomes, providing valuable insights into the performance of chemical warfare protective clothing. By simulating real-world conditions and systematically evaluating fabric penetration, this method offers a reliable means of assessing the effectiveness of protective clothing against liquid aerosolized CWAs. Overall, this research contributes to enhancing the safety and security of military personnel operating in environments where chemical threats are present.

Journal name : Scientific Reports (Under revision)