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Proof Of Concept Respirator Lens Fog Test Chamber

Cody Kendig U.S. Army DEVCOM Chemical Biological Center

Lens fog is a common issue experienced by wearers of full-facepiece air-purifying respirators (APR) which can impede the wearer's ability to perform their job accurately and safely. Most commonly, this fog occurs when the wearer is working within a cold-weather environment, or in hot-humid environments. The temperature differential across the lens, and the high humidity environment contained within the facepiece lead to ideal conditions for condensation to begin to form. As fog forms within a respirator, the effective field of view decreases, leading to performance degradation for visually demanding tasks. As such, a common element of respirator certification programs is a standard test procedure that evaluates a respirators resistance to fogging effects.

In the case of the National Institute of Safety and Health (NIOSH) full-facepiece APR fog determination test procedure No. CET-APRS-STP-CBRN -0314, human subjects are required to don the respirator, enter a walk-in freezer, and conduct a series of visual acuity tests and exercises to the best of their ability. All measurements are subjective, qualitative, and reliant on the human test subject's opinions and observations.

The ultimate goal of the development of a proof of concept respirator lens fog test chamber was to eliminate the subjective human element, and provide a repeatable, objective measure of lens fogging. This would provide a method which could potentially be used to obtain consistent results for a respirator across individual laboratories without the need for the introduction of the human variable.

The test system consists of a temperature controlled freezer, containing a heated metal headform which is capable of simulated breathing of heated humidified air, and contains a camera mounted behind the right eye. The freezer contains a visual target set across from the head-mounted camera. To conduct a test, a respirator is donned upon this headform, and the internal camera takes images of the visual target as seen through the respirator lens at set intervals. Custom software compares these images to a set of calibration photos taken through a variable diopter lens set at known, diopter values to determine the magnitude of blurring caused by the fog buildup on the respirator lens. Additionally, this software compares the average pixel brightness of each image to a baseline photo through an unfogged lens as a secondary metric to characterize the fog buildup. An externally mounted camera is also utilized to determine the percentage of fog coverage present on the respirator lens throughout testing.

Data will be presented to demonstrate the efficacy of the prototype lens fogging test chamber utilizing commercially available respirators as the test assets. Data presented will focus on three measured metrics, blur, contrast change, and fog coverage.

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