The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research NIOSH

Total Inward Leakage (TIL) for Respiratory Protective Devices

NIOSH DATASET RD-1011-2019-1

AUGUST 16, 2019

Introduction

Total inward leakage (TIL) is an estimate of the performance of a respirator, which is measured as the leakage of contaminants through the filter media and through the faceseal interface and exhalation valve of respiratory protective devices under laboratory conditions. Several test agents have been used to measure TIL in different countries. There is a lack of consensus on the most appropriate test method to measure TIL. The International Organization for Standardization (ISO) developed a standard (ISO, 2014) on the comparison of TIL measurement using sodium chloride (NaCl) and corn oil aerosols, and sulfur hexafluoride gas. A comparison of the TIL values between different methods will enable the selection of a relatively suitable method for measuring TIL. NIOSH's National Personal Protective Technology Laboratory (NPPTL) investigated the TIL values for respirators worn by test subjects exposed to NaCl and corn oil aerosols in two aerosol chambers side-by-side. Four air-purifying respirator categories, made up of two models each, were fit tested, and then TIL was measured. TIL values for all eight respirator models were measured and compared.

Results showed that the geometric mean TIL values for corn oil aerosol were larger than those values for the NaCl aerosol for all respirator models tested in the study (Rengasamy et al. 2018). The net charge level for the aerosols in the test chambers showed that the corn oil aerosol was more neutrally charged compared to the positively charged NaCl aerosols. This suggested that charged NaCl aerosols are easily captured by the filter media to give lower TIL values compared to corn oil aerosol with relatively large TIL values. NPPTL also measured filter penetration for respirators with NaCl and corn oil aerosols of the test chambers. Results showed higher filter penetration values for corn oil aerosol than for NaCl aerosol, a trend similar to TIL measured for the two aerosols. Filter efficiency measurement showed lower TIL values for relatively higher efficiency respirator models. The results obtained in the study indicated the influence of filter penetration or filter efficiency on TIL. TIL measurement using test agents with different charge level, filter penetration and filter efficiency is likely to produce dissimilar results. Overall, the selection of a test agent that yields relatively higher TIL values representing a conservative estimate of respiratory protection would be a viable choice for TIL determination.

Download Data

The primary data pertaining to the determination of TIL using NaCl and corn oil aerosol test methods and comparison between the two results are available in excel and CSV formats. The data are presented in five tables. The data dictionary is available in PDF format.

- TIL Dataset [XLS – 16 KB]
- TIL Dataset [CSV – 4 KB]
- TIL Dictionary [PDF – 25 KB]

Data Collection Methods

TIL measurement: TIL values for corn oil and NaCl and corn oil aerosols was measured in two separate chambers. To measure TIL, each respirator model was tested by ten subjects as described in the ISO standard (ISO, 2014). TIL values for NaCl aerosol was corrected for lung deposition, and then compared with the TIL for corn oil aerosol.

Detailed descriptions of the methods are provided here. TIL-Methods.pdf [PDF – 22 KB]

Citations

Samy Rengasamy, Ziqing Zhuang, George Niezgoda, Gary Walbert, Robert Lawrence, Brenda Boutin, Judith Hudnall, William P. Monaghan, Michael Bergman, Colleen Miller, James Harris and Christopher Coffey: A comparison of total inward leakage measured using sodium chloride (NaCl) and corn oil aerosol methods for air-purifying respirators. Journal of Occupational Environmental Hygiene. 2018; 15: 616-627.

International Organization for Standardization (ISO): Respiratory protective devices – Methods of test and test equipment – Part 1: Determination of inward leakage (ISO Standard 16900-1) Geneva, Switzerland, ISO 2014.

Acknowledgements

When a publication makes use of this dataset, acknowledgement of the development of the dataset should be attributed to NIOSH NPPTL.

Contact

For further information, contact:

NIOSH/NPPTL
(412) 386-6111

Page last reviewed: September 4, 2019