Centers for Disease Control and Prevention

Promoting productive workplaces through safety and health research NIOSH

Respirator Exhalation Valve Research

Some types of respirators include an exhalation valve that opens to allow exhaled air to escape through the valve and closes to force inhaled air through the filter. In filtering facepiece respirators (FFRs) and elastomeric half mask respirators (EHMRs), exhalation valves typically include a membrane composed of natural rubber, silicone, or neoprene. This membrane sits atop a support structure and lies beneath a plastic cover.

Photo by Shutterstock

Respirators with exhalation valves are thought to provide more comfort and may be better suited for longer periods of use. The valve opens and closes based on the wearer's breathing pattern. During inhalations, the membrane closes against the support structure and blocks the opening, thereby not allowing airflow through the valve opening and thus protecting the wearer. During exhalations, when sufficient positive air pressure is achieved, the membrane lifts and the wearer's unfiltered breath exhausts (exits) from the valve, with only a portion of the exhaled breath from the wearer passing back through the filter media.

Because an exhalation valve can introduce unfiltered exhaled air into the surroundings, the CDC does not recommend the use of a respirator with an exhalation valve in certain healthcare situations, including but not limited to operating rooms, because the valve may allow contaminants to escape and reach others.

To examine the related knowledge gaps and critical research needs, NIOSH is conducting research to determine the potential for respirators with exhalation valves to contribute to source control—i.e., their ability to filter respiratory secretions to prevent disease transmission to others—as described below.

Source Control: Considerations for Respirators with Exhalation Valves

During the COVID-19 pandemic, medical professionals have expressed concern that healthcare personnel infected with SARS-CoV-2, the virus that causes COVID-19, may spread the disease from unfiltered exhaled air passing through their respirator's exhalation valve. While preliminary data suggests that the exhaust of particles through respirators with valves is less than or comparable to that of masks without valves (e.g., cloth masks, procedure masks), research gaps remain.

Importantly, the potential for infection from breath exhausted through the respirator's exhalation valve has not been fully studied. Therefore, NIOSH research is evaluating several areas associated with respiratory disease transmission.

Research Focus Areas

The use of EHMRs, FFRs, other NIOSH-approved respirators, and unregulated masks with exhalation valves as source control needs to be evaluated. Research is needed to understand respiratory droplet size and composition, transmission through the exhalation valve, changes in composition and viability in ambient air, deposition within the human body, and infectious dose for different types of cells.

To investigate these topics, NIOSH has a research portfolio to address respiratory droplet generation, emission through respirators and masks with and without exhalation valves, and transmission through the air. Key research questions currently being studied by NIOSH intramurally and through contracts are detailed below.

Source Generation

- What is the size and composition of human respiratory droplet emissions during various activities (e.g., talking, singing, coughing, and sneezing) and with different kinds of protective masks?
- How do human respiratory droplet emissions compare to mechanically generated aerosols that are typically used in scientific studies?

Source Control

- What percentage of exhaled particles flow through an FFR exhalation valve (i.e., “outward” filtration efficiency)?
- Which respirator mitigation strategies improve outward filtration efficiency?
- What percentage of exhaled particles flow through the exhalation valve (i.e., exhalation efficiency) for sinusoidal breathing patterns?
- Which size particles do not pass through the exhalation valve, and how does the size distribution change over distance with different respirators and respirator modification strategies?
- How does respirator fit affect exhalation efficiency?
- How effective is filtering exhalation exhaust from EHMRs and how do filters affect breathing with respect to exhalation resistance and CO_2 and O_2 concentrations?
- How are EHMRs being used in healthcare settings?

Airborne Mechanics

- After passing through an exhalation valve, what is the fate of dry particles and droplets with respect to distance and environmental conditions?