Civil + Mineral Engineering

Daneshazarian R, Nahian MR, Siegel J. 2025. An experimental study of respiratory dispersion in an operating room under positive and negative pressurization. *Journal of Building Engineering*, **102**, 112009.
DOI: 10.1016/j.jobe.2025.112009.

Abstract

Hospital operating rooms (ORs) are typically maintained at positive pressure, which can increase the risk of disease transmission to healthcare workers and to spaces outside of the OR when an infected patient is present. This study investigates the influence of operating room pressurization (positive and negative) and dynamic healthcare worker (HCW) activity on respiratory particle dispersion, addressing gaps in understanding airflow dynamics and infection control. Experiments were conducted in a full-scale OR to simulate conditions with a continuous respiratory aerosol source and a cough source, analyzing particle concentration under varying pressurization scenarios and with anteroom interactions. Key findings reveal that negative pressurization effectively reduces respiratory particle concentrations across the OR, with a ventilation efficiency of 78% compared to 59% under positive pressurization. The use of an anteroom reduced particle concentrations by 25% at the operating table and up to 31% in the anteroom. Movement of healthcare workers significantly influenced aerosol dispersion, with particle concentrations increasing by 17.8% at higher speeds (1.2 m/s) under positive pressure. Faster HCW movement increases particle spread, particularly under positive pressure. The inclusion of an anteroom further reduces particle migration to adjacent areas, emphasizing its importance in infection control strategies. The study's results highlight the effectiveness of negative pressure systems in mitigating airborne infectious disease transmission and demonstrate the value of anterooms in enhancing containment. These findings contribute to optimizing OR design and ventilation practices, providing evidence-based recommendations for safer healthcare environments, and delivers insights to inform future standards in building engineering for infection control.

Main Findings

1. Particle concentrations were consistently lower in the operating zone under negative pressure, even with continuous aerosol generation and staff activity
2. The presence of an anteroom improved containment regardless of pressurization, likely due to added volume for dilution and altered airflow pathways.
3. Particle size distribution showed that negative pressure was more effective at reducing larger and ultrafine particles
4. The combination of negative pressure and anteroom interaction provided the greatest reduction in particle migration to adjacent spaces.

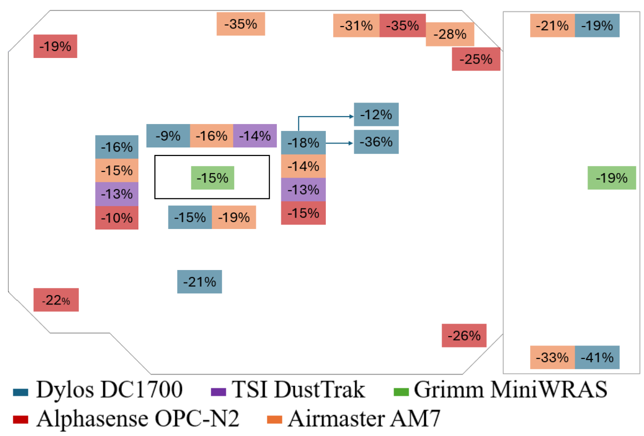

Figure 6c. Impact of negative pressure on the particle concentration under continuous source Case C

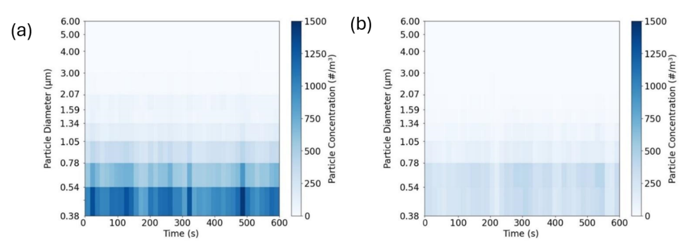

Figure 8. Particulate matter size distribution of continuous source under (a) positive pressure, and (b) negative pressure.

Support provided by: