Virus Control Aboard a Commuter Bus

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Introduction

Especially since the COVID-19 pandemic, a major health concern for public transportation users is exposure to viruses released by infectious passengers. Previous investigations of virus transport from an infectious passenger sitting in the middle of a transit bus with air exiting through the back grille have shown viruses spread to the back and front of the bus, due to the level of their concentration, there is an increased risk of infection to passengers sitting adjacent and behind the infectious person during transit when the passenger drop-off door is closed. However, at the bus stop when the drop-off door is opened, the exposure risk was only for passengers sitting in front of the infectious person. This previous study exemplified the importance of the bus ventilation system on exposure risk aboard a transit bus. The present investigation explores the possibility of using axial and vertical linear air exhaust slots placed on the side wall of the bus cabin for virus containment to reduce the risk of infection to passengers riding the bus.

Study Methods

Unsteady numerical simulations of virus spread aboard a transit bus with 37 passengers have been performed. The infectious passenger was sitting in an aisle seat in the middle of the bus releasing 1,267 viruses per minute (21.2 particles per second). The mouth velocity was 0.278 m/sec. (0.3 CFM). The virus was modeled as a 2.5 µm round carbon particle. Fresh air was injected through two linear ceiling slots spanning the length of the bus at a speed of 1 m/sec. The volume flow rate was 59.38 m3/min (2,097 CFM). The bus dimensions were taken from a standard transit bus used in Long Beach, California.

Two linear axial and vertical exhaust slots have been investigated. The axial slots were placed 20.32 cm above the floor with a width of 5.08 cm. There were two slots on each side of the bus covering the length of the bus adjacent to the seats. The vertical slots were placed between the windows, 66.04 cm above the floor. The slot length and width were respectively 30.48 and 5.08 cm. There were five slots on the left-hand side and seven slots on the right-hand side of the bus. The right-hand side includes the passenger drop-off doors. The pressure at the slots was -35 Pa. For each case, simulations were performed for the closed door during transit conditions and opened passenger drop-off door at bus stops.

> With a modified ventilation system, viruses could be locally contained with reduced risk of infection to other passengers.

Findings

Figure 1 shows typical results for virus distribution released from the infectious passenger after 60 seconds for the axial and vertical slots during transit (closed door) and after the passenger drop-off door was opened and then closed (opened door). Evaluating the comprehensive results show that for the axial slot, particles are contained to the adjacent and immediate front and back of the infectious passenger without spreading to the back of the bus or across the aisle for the transit period. The particles' concentration in these areas is according to the local mean velocity gradient and vorticity distribution. At the bus stop when the drop-off door is opened, particles disperse farther to the front of the bus but stay on the same side. After the door is closed, some particles are moving toward the rear of the infectious passenger, but the majority of the particles are concentrated in the front three rows of the infectious passenger.

With the vertical slots, during transit, particles' dispersion is limited, and the majority of the particles are concentrated around the infectious person. When the drop-off door is opened, particles move toward the entire back of the bus with reduced concentration, indicating a higher rate of mixing in this condition. With the reduced concentration, the risk of infection is reduced considerably.

An analysis using the Wells-Riley equation indicated a high risk of infection when the ventilation is off and the air is recirculating and a reduced risk of infection for both cases investigated.

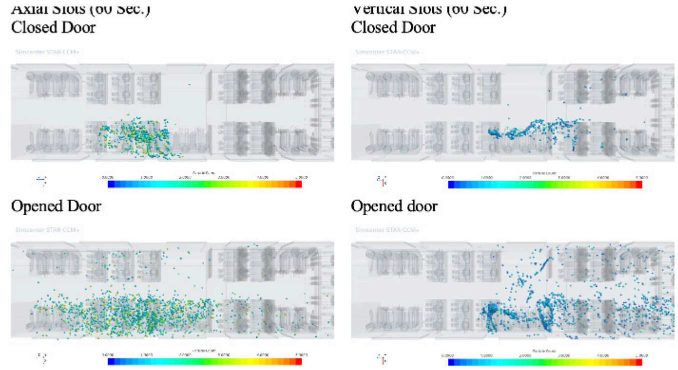

Figure 1. Virus Distribution after 60 Seconds

Policy Recommendations

A modified bus ventilation system with outside air injection could minimize the risk of the virus spreading from an infectious passenger, resulting in a reduced risk of infection and improved passenger health aboard a transit bus.

About the Authors

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To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/2248

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