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Indoor Airflow Patterns, Dispersion of Human Exhalation Flow and Risk of Airborne Cross-Infection between People in a Room

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In recent years, an interest in understanding the mechanisms of cross-infection between people in the same room has increased significantly. The SARS (Severe Acute Respiratory Syndrome) outbreak occurred in Asia in 2003 reopened the study of the airborne disease transmission as one of the most prevalent transmission routes.

Airborne cross-infection of diseases is caused by the transmission of pathogens, such as viruses or bacteria, between people and across environments. When a person is breathing, talking, sneezing or coughing, small particles, which may carry biological contaminants, are spread in the air. These tiny particles or droplet nuclei can follow the air flow pattern in the room and produce high contaminant concentration in different areas of the indoor environment. This fact can provoke a high exposure to exhaled contaminants and a risk of cross-infection to a susceptible person situated in the same room.

Abundant evidence shows that the air flow distribution systems play a crucial role in the dispersion of these human exhaled contaminants. However, there are many parameters that influence the cross-infection risk between people situated close to each other in a ventilated room, such as: relative position and separation distance between people, difference in height between them, level of activity, breathing function or process (breathing frequency, exhalation through the mouth or through the nose, coughing, sneezing) or air velocity and turbulence level in the micro-environment around the persons.

This thesis analyzes some of these parameters in the influence of cross-infection risk between two people in a room, which are simulated by two breathing thermal manikins. One of the manikins is considered the source of contaminants, which is exhaling contaminated air through the mouth. The influence of different ventilation strategies in the personal micro-environment, the direction of the human exhalation flow and the dispersion of exhaled contaminants has also been studied.

Several experimental tests in a full-scale test room have been carried out in order to study the cross-infection risk between two people in a room. Different ventilation strategies and different separation distances, and relative positions, between the manikins produce different levels of contaminant exposure to the susceptible person (target manikin). These results have been discussed and carefully analyzed within this thesis.

Keywords: human exhalation

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