Numerical study on the interpersonal exhaled droplet transport in a classroom

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Human expiratory droplets that carry microoganisms are capable of transmitting disease (Xu *et al*, 2015). The transport of human expiratory droplets in indoor in highly occupied indoor environment, like a classroom, may cause susceptible people get infection. A PRIMEQUAL program was proposed to study the environmental determinants of viral exposure by both experimental and numerical methods. This paper presents the simulation model and investigates the dispersion and deposition of the exhaled droplets in a classroom.

The geometry of the numerical model is shown in Figure 1, which is based on a full-scaled controlled classroom. Five "seated" cylinders (in grey), named MATEO in the measurement, are located with desks and seats to represent the students. MATEOs and four rectangular lamp boxes are the heat sources. Two ventilation diffusers are mounted on the ceiling, and the exhaust part (in purple) is below the door (in green). A jet source is adopted to represent a student's mouth during talking (Xie, 2008), which generates warm saturated moist airflow and monodispersed droplets.

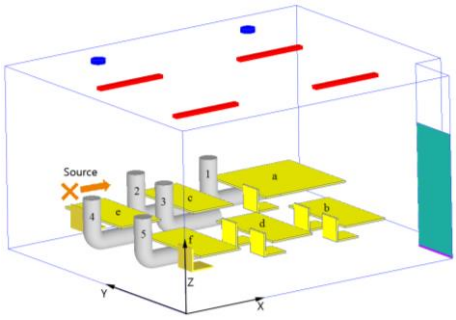

Figure 1 geometry

An Eulerian- Lagrangian approach is used to describe the airflow and the droplets (Xie, 2007; Zhang *et al*, 2012). Droplet evaporation is included and droplet residues are formed when the droplet diameter shrinks to its equilibrium diameter. The droplets are averaged packed into 3600 parcels. Discrete random walk (DRW) model is adopted to present the turbulent dispersion of the particles.

The results show that a well-mixed air pattern can be noticed except the local region of the source.

The droplets evaporate very fast in the air. Most of droplets turn into the residues in a short distance. Some droplets/residues are deposited very fast but other ones remain airborne for prolonged periods in the classroom. The total airborne period of the droplets and residues ranges from several seconds to over nine hundred seconds.

MATEO 2 has the largest exposure to the droplets/ residues. It also shows an exposure of almost 20% larger than the droplets/residues with an initial diameter of 40 μm, compared to that with an initial diameter of 22 μm, as shown in Figure 2.

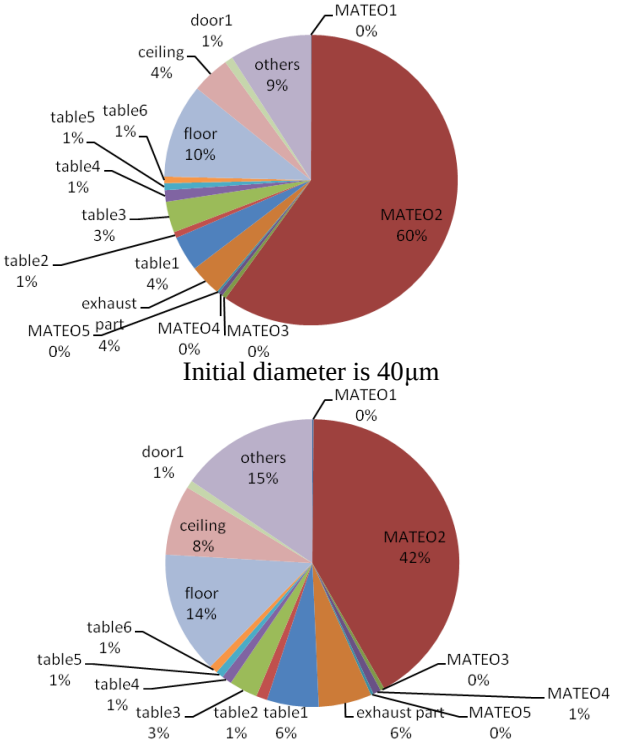

Figure 2 Deposition distribution of the particles

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