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Research Article

Indoor/Outdoor Airflow and Air Quality

Effects of near-wall heat source on particle deposition

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Abstract

Particle deposition in a chamber with a near-wall heat source is studied by CFD (computational fluid dynamics) modeling. The random walk model of Lagrangian approach is adopted to investigate deposition fractions and particle deposition numbers on different orientation surfaces of particles ranging from 2.5 μm to 10.0 μm by predicting the trajectories of 2000 particles with a density of 1400 kg/m^3. The effects of the heat source surface temperature and the gap between the heat source and the near wall on indoor particle deposition are studied. The results indicate that the heat source surface temperature and the gap between the heat source and the near wall affect particle deposition on surfaces. The impacts of these two factors on particle deposition on the floor, the ceiling, the non-near surrounding vertical walls and the near wall can be further influenced by the size of particles.

Keywords

Lagrangian approach,
computational fluid dynamics,
particle deposition,
Fluent

Article History

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1 Introduction

Nowadays, people spend most of their time in the indoor environment which makes that indoor air quality (IAQ) has received increasing attention. The presence of particles can influence the indoor air quality greatly. Many of indoor particles may have been brought by ventilation systems or emitted directly from indoor sources such as smoking, cooking, occupants and industrial materials. One fate of particles in indoor air is deposition onto surfaces. The process of deposition is very important because deposited particles may cause the material damage or artworks soiling (Nazaroff and Cass 1991). Besides, particle deposition may also lead to damage in electronic equipment (Weschler et al. 1996), or produce the disturbance in industry. On the other hand, particle deposition is a positive phenomenon from the perspective of altering the likelihood of human exposure, as a deposited particle cannot be inhaled unless resuspended. Once the deposition mechanism is carefully studied, particles could be encouraged to get attached as soon as possible to the closest possible surface and hence away from the breathing zone. Therefore, knowledge of particle deposition onto indoor surfaces is important for indoor air quality and indoor exposure studies.

Particle deposition indoors can be influenced by a variety of factors such as particle physical characteristics, indoor airflow and building surface coverings. In the literature, many factors have been studied (Chao et al. 2003; Howard-Reed et al. 2003; He et al. 2005; Schnell et al. 2006). Ventilation system determines the airflow pattern in the building which decides particle movement. Experiments were performed in an isolated room using four different airflow patterns by Thatcher et al. (2002), which revealed that increasing the mean air speed increased the deposition rate for all particle sizes studied by factors ranging from 1.3 to 2.4 with larger particles exhibiting greater effects than smaller particles. Zhao et al. (2004) studied the air movement and aerosol particle concentration and deposition in displacement and mixing ventilation rooms. They found that a displacement ventilated room had a lower particle deposition rate and larger escaped particle mass than the mixing one, while the average particle concentration of the displacement case was higher than the mixing case. Furthermore, the influence of wall surface characteristics on particle deposition has also received close attention (Lai et al. 2002; Lai and Nazaroff 2005). Abadie et al. (2001) presented the experimental

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