An experimental approach to measure particle deposition in large circular ventilation ducts

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This study was a part of the French project CleanAirNet, which aimed at producing new knowledge, models and techniques to help controlling the safety of the food products, through a better control of aerosol particle (bioaerosols) transport and deposition in the ventilation networks of the food industry. A small body of experimental literature has been reported on large ventilation ducts (Sippola, 2004). The purpose of this paper was to investigate particle deposition experiments in large circular ducts for fully developed turbulent flow.

An experimental setup (called MIDAS) was designed in a laboratory to validate a theoretically based model predicting particle deposition velocities for fully developed turbulent flow in an horizontal with circular cross-section (Ben Othmane, 2010).

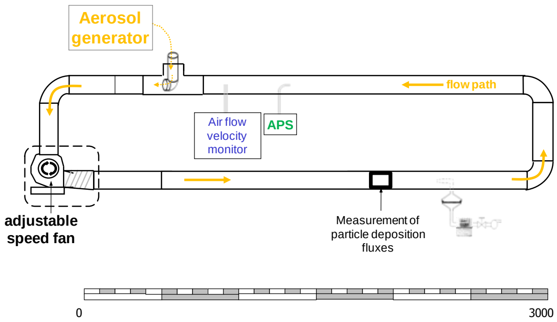

Figure 1. The experimental bench to investigate particle deposition velocity.

The experimental bench proposed in this study included a ventilation system, a monodisperse fluorescent aerosol generation system (VOAG, TSI), and direct-reading instruments to monitor the following parameters in real time: air-velocity, temperature, relative humidity, particle aerodynamic diameter (APS, TSI). The deposition of particles mass onto different surface orientations (with respect to gravity) was calculated by wiping the fluorescent particles and subsequently by measuring their concentrations by spectrofluorometry (FluoroMax, HORIBA). The particle mass deposited on filter was also determined by fluorescent techniques.

Experiments conducted at (5.0 ± 0.3) m/s in the circular duct system (160 mm in diameter, Reynolds number of 5.3×10^5) showed great stability for the generation of particles with nominal size of (0.92 ± 0.01) (2.12 ± 0.03), (3.47 ± 0.03) and (6.02 ± 0.11) µm; with trials lasted for 72, 4, 3 and 1 hour respectively.

The fluorescent technique allowed measuring deposited mass particle down to (4.8×10^{-11} ± 1.1×10^{-11}) kg. The deposition velocities obtained with 6 µm particles showed maximum uncertainty and variability of 35% and 26% respectively.

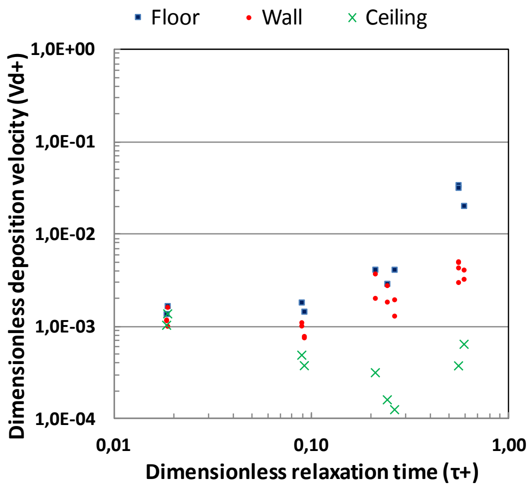

Figure 2. The influence of surface orientation in the circular duct, on dimensionless velocity.

The measured dimensionless deposition velocity showed the influence of the surface orientation (floor, wall and ceiling), in which a clear effect of the particle diameter is demonstrated. The experimental approach proposed in this study can be used to validate models on particle deposition in ventilation ducts from food factories, by considering large circular sections, turbulent flows, and thermal gradients for thermophoresis.

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Ben Othmane, M., Havet, M., Géhin, E. and Solliec, C. (2010) *Aerosol Sci. Technol.* **44**, 775-784.

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