



HAL
open science

Study of the resuspension phenomenon during airflow acceleration using Eulerian and Lagrangian approaches

Corentin Cazes, Félicie Theron, Lionel Fiabane, Dominique Heitz, Laurence Le Coq

► **To cite this version:**

Corentin Cazes, Félicie Theron, Lionel Fiabane, Dominique Heitz, Laurence Le Coq. Study of the resuspension phenomenon during airflow acceleration using Eulerian and Lagrangian approaches. European Aerosol Conference, EAC2023, Sep 2023, Malaga, Spain. hal-04385714

HAL Id: hal-04385714

<https://hal.inrae.fr/hal-04385714>

Submitted on 10 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Study of the resuspension phenomenon during airflow acceleration using Eulerian and Lagrangian approaches

C. Cazes^{1,2}, F. Theron¹, L. Fiabane², D. Heitz² and L. Le Coq²

¹IMT Atlantique, CNRS, GEPEA, Nantes, 44300, France

²INRAE, OPAALE, Rennes, 35000, France

Keywords: microparticle resuspension, accelerated airflow, time-resolved study, particle tracking velocimetry.

Associated conference topics: 5.7

Presenting author email: corentin.cazes@imt-atlantique.fr

Particle detachment from a surface and its subsequent entrainment within the flow describes the resuspension process. Understanding the phenomenon is essential in industrial applications: predicting airborne particulate contamination in HVAC systems (D'Alicandro *et al.*, 2021). This study involves monolayer deposits of isolated microparticles on a surface in a ventilation duct. It aims at studying the influence of the airflow pattern (an acceleration stage followed by a short steady-state period) properties on microparticle behaviour. For that purpose, the mean velocity and acceleration roles are investigated, and the evolution of the particle fraction remaining on the duct wall $F_{rem}(t) = N_p(t)/N_p(t_0)$ (with N_p the particle number) is analysed as a function of time. The experimental procedure involves filming microparticle deposits and monitoring airflow characteristics using constant temperature anemometry (Theron *et al.*, 2022). Centre and near-wall velocities and wall shear stress are monitored using hot-wire and glue-on hot-film probes, respectively.

Bronze particles were used for their spherical morphology. Two particle fractions with narrow size distributions characterised by d_{50} of 23.3 and 31.3 μm were tested to investigate the influence of the particle size on resuspension. The open return wind tunnel was 200 cm long with a rectangular section ($w \times h = 20 \times 4 \text{ cm}^2$). The test area, located 130 cm downstream of the entrance to ensure fully developed flow, was made of glass of low mean roughness. A CCD camera coupled with an x12 zoom lens composed the optical set-up. The window length was $2.0 \times 1.5 \text{ mm}^2$, corresponding to a $0.86 \mu\text{m}/\text{pixel}$ resolution. The airflow properties were the final velocity $\overline{u_{0,eq}} = 7.6\text{-}11.0 \text{ m}\cdot\text{s}^{-1}$ and the acceleration $\alpha = 0.3\text{-}2.1 \text{ m}\cdot\text{s}^{-2}$, representing ventilation systems operating conditions. The deposit frames were processed using an *in-house* particle detection algorithm (Cazes *et al.*, 2022), which gave deposit properties and particle numbers. Thus, one can compute the remaining particle fraction F_{rem} over time.

Another experimental rig was used, resembling the one described hereinabove to ensure flow similarity, to perform Particle Tracking Velocimetry (PTV), *i.e.*, measure particle trajectories and their velocity and acceleration. It used a Phantom VEO 440L camera and a

10 mm lens (Laowa) with a 2.8 opening. The frequency rate was 1.1 kHz with a $2560 \times 1600 \text{ pixels}^2$ resolution.

Results showed that most particles resuspended during the acceleration regime for all temporal airflow patterns. It emphasises that the phenomenon must be studied through time-resolved approaches. Based on a model fitting (Theron *et al.*, 2022), one can define a virtual start velocity $U_{0,s}$ which is the instantaneous mean centre velocity at the virtual start of the resuspension. Figure 1 shows the influence of $\overline{u_{0,eq}}$ and α on $F_{rem}(t)$. The particle fraction remaining and the virtual start velocity appear independent of the final velocity but increased with the acceleration parameters. The same tendency was seen for friction and near-wall velocities.

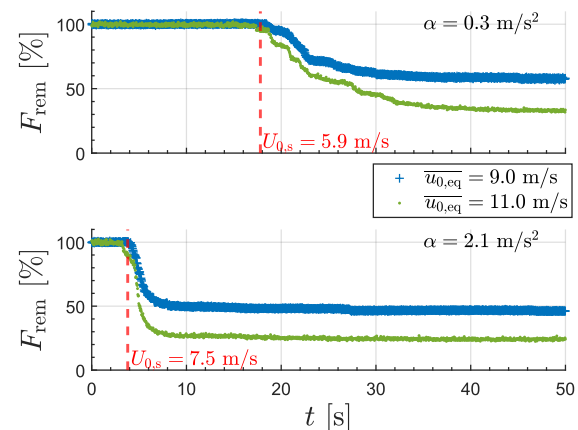


Figure 1. Remaining fraction F_{rem} as a function of time.

Finally, we investigated the particle trajectories at the resuspension start and their velocities using PTV. As a result, we propose to link the physical phenomena responsible for the resuspension with the appearance of turbulence in the near-wall region.

This work is financially supported by the French Ministry of the Armed Forces - Defence Innovation Agency and the Pays de la Loire Region, France.

Cazes, C., Fiabane, L., Theron, F., Le Coq, L. and Heitz, D. (2022) *International Aerosol Conference (IAC2022)*, Athens.

D'Alicandro, A.C., Massarotti, N. and Mauro, A. (2021) *J. Aerosol Sci.* **158**, 105823.

Theron, F., Debba, D., Le Coq, L. (2022) *Aerosol Sci. Technol.* (11)**56**, 1033-1046.