Experimental and Modeling Study of the Filtering Capacity of Green Wall Species

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Abstract

Air pollution caused by particulate matter (PM) is one of the most severe issues in urban environments. Urban green infrastructure (UGI), in particular green walls, have been proven to be capable of capturing PM via deposition on leaves. This phenomenon was assessed by numerical simulations and validated with wind tunnel experiments. The wind tunnel consisted of a closed circuit air duct system in which air movement was created by a controllable inline duct fan which can induce air flow velocities varying from 2.0 to 4.4 m.s-1 for an empty reactor. One duct section could be removed so that plant material could be placed in the wind tunnel. COMSOL Multiphysics® simulation software was used to visualise particle trajectories and calculate transmission probabilities.

The flow velocity and pressure were computed using a stationary study, while the particle trajectories were computed using a separate time dependent study. The fluid flow was modelled with the k-ω turbulence model (CFD module), because it is opted for internal flow problems involving high Reynolds numbers (ReD ≈ 2e-4 in the wind tunnel) and strong streamline curvature. The plant section was simplified as a uniform, porous medium. The flow throughout this porous medium was modelled with the Brinkman Equations interface, with values of porosity and permeability obtained with measurements. In a time dependent study, particle transport was modelled with the Particle Tracing module. Release conditions were set to mimic the wind tunnel experiments. It was assumed that the drag force was the dominant force and that it follows Stokes' law, since Rer was smaller than one.

Finally, wind tunnel experiments were performed to validate the multiphysics model. For this, PM, generated with an ethylene burner, was directed to the air duct system. The collection efficiency of the empty wind tunnel as well as the wind tunnel filled with plant material was determined. Different plant species, used as green wall species, were selected to cover different plant morphologies. Experiments are still running, hence conclusions about model agreement with the experimental data cannot be made. It is expected that PM capture will be different for different plant species.

Figures used in the abstract

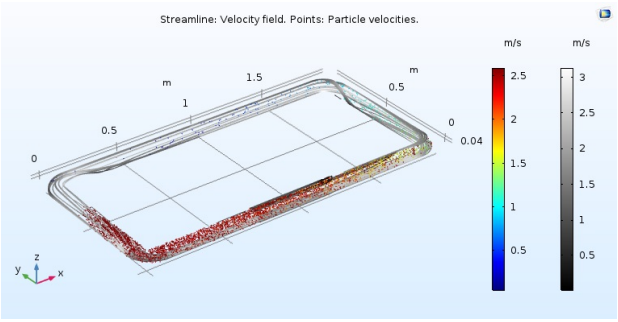

Figure 1: Visual presentation of the flow field (streamlines) and particle trajectories (points) in the wind tunnel.