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A numerical set-up for the simulation of infection probability from SARS-CoV-2 in public transport vehicles

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The outbreak of SARS-CoV-2 has shown the importance of indoor air quality control and flow pattern studies. In this sense, Computational Fluid Dynamics (CFD) simulations have always been a powerful tool to study air movement and contaminant transport. In the case of HVAC installations, CFD can help understand the flow patterns and propose new alternatives to improve the air quality, which would result in a reduction of new infections.

The numerical method is built on the basis of the turbulent fluid solver *buoyantBoussinesqPimpleFoam*, present on the open-source platform *OpenFOAM*. The solver integrates the transport of a scalar quantity called air-age used to measure indoor air quality. In the simulations, $\kappa-\varepsilon$ RANS turbulence modelling is employed, together with a particular strategy to represent the air flow from air outlets in order to reduce the calculation time.

In this work, an original methodology is introduced to determine susceptibility to infection by airborne transmission of the virus. This is done by running multiple simulations of the contaminant transport for a stationary flow, placing the main source of contaminant in a different location and studying its effect on the rest of the users of the vehicle. A convection-diffusion equation with variable source term is employed to model contaminant transport [1,2]. Realistic parameters for the contaminant generation and inhalation rate, as well as for its diffusion in the air, are employed [3]. Once the contaminant concentration distribution is resolved, an integration over time is performed to obtain the probability of infection in each susceptible location using the CFD integrated form of the Wells-Riley model [1,2].

This numerical method allows the study of air quality and the diffusion of contaminants in means of transport (or other closed places) in which air conditioning and/or purification systems are active. The simulations allow to choose the operating parameters (position of the vents, air speed, recirculation rate, positioning of the seats) that minimize the risk of infection for the users of the service.

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