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# The Bio-E-RATEs (Bioaerosols Emission Rates Analysis Through Experiments): an experimental bench for the characterisation of viable airborne respiratory particles emission rate.

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Viable airborne particles refer to particles that contain one or more living organisms (bacteria, fungi, pollen, viruses, fragments from living things...). These particles are known to be one of the main transmission routes of airborne infectious diseases in indoor environments. It seems therefore very important to physically characterize the sources of emission of such particles to better predict their transmission in indoor environments. With the outbreak of new diseases such as COVID-19, the study of the transmission of human exhaled respiratory particles became a growing subject in the literature. Indeed, humans generate respiratory particles when breathing, speaking, singing, sneezing, or coughing (Bourouiba et al., 2014).

The main objective of our work is to use the Bio-E-RATEs (Bio Aerosol Emission Rates Analysis Through Experiments): a new experimental chamber (with a controlled atmosphere) to evaluate the emission rate of airborne viable respiratory particles. This clean air aerated chamber has a rectangular parallelepiped shape, with an internal volume of about 5 m<sup>3</sup> and a floor surface area of 2.5 m<sup>2</sup>. It was pre-sized to be able to contain up to five people performing various indoor activities inside it. In the Bio-E-RATEs, the emission rate is evaluated following the methodology developed by (Géhin et al., 2008). It can be used to evaluate the mean emission rates by analysing the concentration kinetics in a clean chamber with a controlled atmosphere. In this work, a Biotrak (TSI) 9510-BD is used to measure the (viable and non-viable) particles concentration inside the chamber with a diameter ranging from 0.5 µm to 10 µm. The methodology used for the emission rate evaluation was validated in the Bio-E-RATEs following the same experimental procedure presented in the IAC 2022 (Ait Ali Yahia et al., 2022) where an artificial aerosol (PSL and ammonium sulphate) with a known emission rate is generated in the chamber.

In this work, we present a preliminary study of the physical characterization of respiratory particles emitted by human volunteers in the Bio-E-RATEs. The experimental protocol is as follows: the volunteer enters a decompression chamber where he/she wears a clean room gear together with an FFP2 mask. During this time the zero particles concentration in the clean room is monitored with the Biotrak (figure 1). After ten minutes, the volunteer enters the clean room and closes the door separating it from the decompression room. When the

volunteer enters the room, an increase in the concentration in the room is observed (figure 1). This increase is explained by the remaining particles coming from the decompression room. After 15 minutes, the volunteer removes the mask and remains static in the room while breathing for 20 minutes. During this time, an increase in the particles concentration in the room is observed (figure 1). Afterwards, the volunteer exits the room where the particles concentration decreases following an exponential law (figure 1). The decreasing part of the curve is used to evaluate the euration rate which considers the aeration flow and the particles deposition inside the chamber. The increasing part of the curve observed after the volunteer removed the mask is used to calculate the average emission rate during the generation (Géhin et al., 2008).

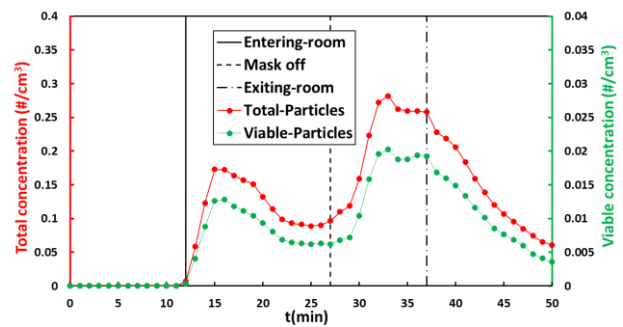


Figure 1. example of the time evolution of the total and viable particles concentration in the Bio-E-RATEs.

The average particles respiratory emission rates of ten volunteers were evaluated following this methodology. The results were found to be in good agreements with the literature (Alsved et al., 2020) with an average value equal to  $1110 \pm 440$  Particles.s<sup>-1</sup>. The average viable respiratory particles emission rate was found to be equal to  $100 \pm 30$  Particles.s<sup>-1</sup>.

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