Control of airborne disease transmission in classrooms through the integration of individual chair personalized exhaust units

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With the fast spread of the COVID-19 pandemic across the globe, the need for implementing fast and effective ventilation solutions in the indoor environment became increasingly important. One of the most critical indoor environments that could benefit from such solutions is the academic sector (schools, universities). In the latter, classrooms constitute confined spaces with high occupant density and the risk of disease transmission between students is very high. In this work, a new ventilation design that can be easily retrofitted into existing classrooms is suggested. The latter consists of a downward piston flow from the ceiling and personalized exhaust units integrated in the students' chairs. The exhaust units suck the students' thermal plume entraining the students' contaminants before the latter spread in the classroom. On the other hand, the downward ceiling piston flow assists the exhaust units by suppressing the development of the thermal plume in the occupied space. Such a system allows for effective purging of the contaminants right at their source of generation and could decrease the risk of cross-infection between the students. This study will be conducted by developing a 3D CFD model of an occupied classroom space equipped with the chair exhaust units and the piston flow. The latter was validated experimentally in a representative climatic chamber equipped with a breathing infected thermal manikin generating Serratia Marcescens bacteria similar to SARS-CoV2. A case study was conducted on the validated model to optimize the system in terms of chair exhaust design, suction flow rate, ventilation air change hour and occupant density.