

Effect of energy renovation on indoor air quality of a French school building

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Abstract

Indoor air quality (IAQ) and thermal comfort issues in schools are of particular public concern because children represent a vulnerable population group to air pollution. In fact, their respiratory and immune systems are still developing and a long-term exposure to indoor air pollutants might have a significant impact on their health and scholarly. This study focuses on the effect of the energy renovation of two classrooms which consists of the implementation of a dual flow ventilation system with high efficiency filters (F7). The classrooms are located in an alpine valley (France) known for its high level of atmospheric pollution. To do this, carbon dioxide (CO₂), temperature (T), relative humidity (RH) and PM_{2.5} were monitored continuously over twice two-month periods before and after the renovation in winter 2018 and 2020, respectively. In addition, the ventilation airflows were measured and a daily questionnaire that report the information on general condition in the classroom were recorded day-to-day. The results of these campaigns indicate that before the renovation, the two rooms were confined, estimated by IAQ index such as ICONE index which are equal to 2. The CO₂ concentration reached to 4790 ppmv due to a very low air exchange rate 0.05 h⁻¹. During the high PM_{2.5} levels episodes observed in outdoor air, the low air exchange rate limited the transport of PM_{2.5} from the outside to the inside of the classrooms. As a result, the percentages of concentration exceedance compared to WHO recommendations were 23% and 17%, in class 1 and class 2 respectively, while it reached 68% in outdoor air.

After the renovation, the ventilation airflow was higher than before renovation and reached to 2.46 h⁻¹. As consequence, a drastic reduction of the confinement was measured with ICONE index of class 2 reaching to 0. The CO₂ concentrations are remained low with a maximum value of 1150 ppmv. Rather the high air renewal generates a significant inflow of outdoor particulate pollution which the indoor PM_{2.5} concentrations range were 20-80 µg.m⁻³ during the outdoor air pollution episodes. However, the indoor concentrations were all the time lower than those observed outside with indoor/outdoor concentration ratio about 0.5. It can be assumed that the filtration of the supply air allowed to limit the entrance of the particles. However, this figure should be taken with caution because

of the complex physic associated with particle behaviours (e.g. sedimentation, resuspension, etc). In addition, it is interesting to note that a dysfunction of the ventilation system led to a situation close to that before renovation, both with regard to the rate of ventilation airflow, as well as the concentrations of CO₂ and PM_{2.5}.

Keywords: Indoor air quality, energy renovation, school, ventilation, filtration, thermal comfort, PM_{2.5}, ventilation airflow

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