Contribution ID: **133** Type: **Poster**

Lessons learned by Covid-19 pandemic mitigation measures to improve ultrafine particles exposure in a university dining hall

Particulate matter (PM) has been recognized as leading health risk factors worldwide, contributing to adverse effects for exposed people in life and work environments. During the Covid-19 pandemic period, it has been shown how environmental factors, including ultrafine particles (UFPs) and PM concentrations, may play an important role in SARS-CoV-2 differential distribution and transmission. In particular, the literature highlighted the contribution of chronic exposure to air pollution on the pandemic spread and the close correlation between Covid-19 and airborne PM2.5.

The main aim of the present study is to investigate the effects on improving UFPs exposure of the mechanical ventilation system equipped with plasma-based filter technology, installed as Covid-19 mitigation measure in the dining hall of a university site.

An experimental campaign was conducted in May 2021 to assess the impact of the mechanical ventilation system on UFPs concentration levels related to the activities carried out in the canteen, by high frequency (1 Hz) real-time measurements of particle number concentration (PNC) and particle average diameter (Davg). Furthermore, concentrations of indoor pollutants such as PM, total volatile organic compounds (TVOCs) and CO2 have been monitored by low-cost sensors to evaluate the indoor air quality for the users (workers and students), as possible indicator of indoor air quality improvement and Covid-19 risk mitigation. Measurements were performed in three working days: in day 1 electrostatic UFP filters were activated on all the fan coils; in day 2 the filter option was turned off and measurements continued also during the night until the morning of day 3. The places were frequented by students, teachers and staff personnel for meals on two different shifts (lunch and dinner). The kitchen and canteen service workers have access to the site even before and after two shifts for preparation and recovery/cleaning operations. Progressive anonymous data counting of users' access during the lunch and dinner shifts were allowed.

Indoor PNC (Dp < 700 nm) levels resulted mainly influenced by outdoor particles level, meals preparation, recovery/cleaning activities and users'turnout in the dining hall. In particular, PNC increase and great variability in the indoor measurement points were strictly related to the dining activities, reaching the maximum average PNC level of 30,000 part/cm3 (st. dev. 16,900 part/cm3) during the dinner time of day 1. Davg (Dp < 300 nm) increase has been highlighted during the lunch and dinner times, mostly in day 2 than in day 1, passing from 22 nm during the nighttime to 48 nm during the post dinner recovery activities in day 2. By the comparison between PM1 low-cost sensor response and high-resolution (1 Hz) PNC and Davg data in the same sampling point, the general trend alignment between PNC and PM1 was respected, both instruments highlighting peaks in correspondence to the lunch and dinner activities. Low Davg values correspond to higher PNC compared to PM1, while high Davg values reflect lower PNC compared to PM1. This behavior is consistent with the major contribution given by smaller particles in terms of PNC as compared to the PM1. By the comparison of PNC levels between day 1 and day 2 it has been observed that the use of plasma-based filter technology produced a reduction of average PNC (Dp < 700 nm) estimated up to a maximum of 3 times, in the tested conditions of use, providing an effective mitigation of UFPs concentrations particularly during the periods of access to the dining hall by the users. As expected, the number of persons present inside the dining hall was correlated to the CO2 levels (Pearson r = 0,81) and TVOCs resulted upper during the cleaning activities for meals preparation compared to the other time slots.

Although the findings of the present study are subject to some limitations, strictly related to the short period available for measurements, the obtained results confirm the useful contribution of mechanical ventilation

systems with plasma-based filters technology, to improve the UFP levels in indoor environments. They were successfully used in addiction to the general Covid-19 containment measures such as physical distancing, prevention of crowding and cleaning/sanitization procedures to guarantee the safe use of the university dining hall during the pandemic period. This kind of systems could be generally adopted also after the pandemic emergency, to improve indoor air quality and UFPs exposure levels during the current activity and use in the dining hall.

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