Investigation of Cooking-Generated Oil Smoke Impact on Indoor Air Quality and Ventilation Optimization Using CFD

Chih Yen Huang[1*], Guan Yu Lin[1]

[1]*Department of Environment Science and Engineering, No. 1727, Section 4, Taiwan Boulevard, Xitun District, Taichung City 407224, Taiwan.*

Abstract

Cooking activities are a major source of inhalable suspended particulate matter (particle diameter <10 µm). Among them, respirable particles (diameter <4 µm) can penetrate deep into the alveolar region and are associated with adverse impacts on indoor air quality, cardiopulmonary health, and cancer risk. This study investigates the impact of cooking-generated oil smoke on indoor air quality and aims to identify optimal ventilation strategies for residential environments. Experiments will be conducted in a laboratory at Tunghai University in Taiwan, focusing on cooking processes that produce high concentrations of oil smoke. A slant-back range hood with a deep canopy, commonly used in Taiwanese households, was employed to simulate typical residential ventilation conditions. Measurements include particle concentrations and airflow characteristics to evaluate the temporal variation and spatial distribution of pollutants. Experimental results indicate that under natural ventilation combined with range hood operation, the high openness of the space allowed pollutant concentrations to return to background levels within approximately two minutes after cooking. However, during the cooking process, significant particle concentration peaks were observed in the human breathing zone, with PM_1 reaching 180 µg/m^3 and $PM_{2.5}$ reaching 183 µg/m^3, indicating a potential short-term exposure risk. Further simulations using ANSYS Fluent will be conducted to model the concentration distribution and compare with experimental data to validate feasibility and accuracy.

Keywords: Inhalable aerosol; Indoor air quality; Numerical simulation; Thermal comfort