2· 項目簡介

(*項目所屬科學技術領域、主要研究內容、發現點、科學價值、同行引用及評價等內容。*)

Air pollution affects inhabitants of cities and visitors who expect to enjoy high-end hotel amenities and a variety of historical, cultural, and outdoor activities. The project aimed at exploring (i) the chemical and physical characteristics of air pollutants emitted directly from commercial and residential activities such as cooking in the built environment, and (ii) air pollutants emitted indirectly from commercial and residential activities through the use of secondary energy i.e. electricity.

In the study of the chemical and physical characteristics of air pollutants emitted directly from commercial and residential activities, we focused on the emission of cooking fumes because it attracted numerous environmental complaints in Macao SAR and Hong Kong SAR. In addition, research evidence showed that cooking operations are a major source of organic aerosol emissions comprising up to around 20 percent of the primary fine organic carbon particle emissions in cities (Rogge et al., 1991; To et al., 2007). A review study from the International Agency for Research on Cancer of the World Health Organization (IARC, 2010) indicated that emissions from high-temperature frying are classified to Group 2A - probably carcinogenic to humans. The risk of causing cancer increases when ultrafine particles are emitted from cooking sources at high temperature. In our study, we confirmed that a wide range of organic compounds including n-alkanes (AHs), polycyclic aromatic hydrocarbons (PAHs), fatty acids (FAs) and aromatic amines (AAs) were found at the exhausts of restaurants (To et al., 2007). The highest concentration of these compounds measured was 0.65microgram•m-3 for PAHs (carcinogenic compounds), 6.09microgram•m-3 for AAs (carcinogenic compounds), and 17.32microgram•m-3 for AHs (less toxic compounds). We then determined the size distributions of the aerosols emitted from cooking operations and provided a mathematical model that explains the lognormal distribution of the aerosols (Yeung and To, 2008). Our findings showed that the normalized number concentration of sub-micrometer aerosols increases rapidly when cooking temperature increases. We also explored the effect of fuels on cooking fume emissions. The measurement results indicated that gas cooking produced higher concentrations of PM10, TVOC and extractable organic material than electric cooking for stir frying, pan frying and deep frying in the domestic kitchens but inclusive results were obtained for deep frying, griddle frying and char-broiling in the commercial kitchens (To and Yeung, 2011). Our research findings (To et al., 2007; Yeung and To, 2008) were included in the IARC Monograph 95 (IARC, 2010). One of our papers (To et al., 2007) was also used as an important reference in the US Centers for Disease Control and Prevention (CDC) in assessing the health hazard of workers in commercial kitchens (Gaughan et al., 2009).

In the study of air pollutants emissions due to the use of secondary energy i.e. electricity in cities, we first investigated the modeling of electricity consumption based on a city's economic and demographic structure (Lai et al., 2008; 2011). After that, we employed a holistic approach – life cycle analysis that determined air pollutants including greenhouse gases (GHG) such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) due to the production, transportation, refining of primary energy sources and combustion of fuels in power plants (To et al., 2011). We defined the scope of fuel life cycle analysis and identified that fuel life cycle emissions would be 786 g CO2-equivalent per kWh electricity consumed in Macao in considering all up-stream indirect emissions and the contribution of indirectly emissions due to the imported electricity. We used the fuel life cycle approach in studying GHG emissions for electricity consumption in Hong Kong and considered the indirect emissions due to the imported electricity from the Daya Bay Nuclear Power Plant (To et al., 2012). We also reported the effect of energy mix on GHG emissions in Hong Kong. All papers (Lai et al., 2008, 2011, To et al., 2011, 2012) were published in top SCI journals including ENERGY and ENVIRONMENTAL POLLUTION (with impact factors greater than 3.6; top 10 percent in their SCI categories).

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