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Chemical Analysis of Particulate Matter ($PM_{2.5}$) and Volatile Organic Compound Contaminants

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Abstract : The main objective of this research was to measure particulate matter ($PM_{2.5}$) and Volatile Organic Compound (VOCs) as two classes of air pollutants, at Prince George (PG) neighborhood in warm and cold seasons. To fulfill this objective, analytical protocols were developed for accurate sampling and measurement of the targeted air pollutants. $PM_{2.5}$ samples were analyzed for their chemical composition (i.e., toxic trace elements) in order to assess their potential source of emission. The City of Prince George, widely known as the capital of northern British Columbia (BC), Canada, has been dealing with air pollution challenges for a long time. The city has several local industries including pulp mills, a refinery, and a couple of asphalt plants that are the primary contributors of industrial VOCs. In this research project, which is the first study of this kind in this region it measures physical and chemical properties of particulate air pollutants ($PM_{2.5}$) at the city neighborhood. Furthermore, this study quantifies the percentage of VOCs at the city air samples. One of the outcomes of this project is updated data about $PM_{2.5}$ and VOCs inventory in the selected neighborhoods. For examining $PM_{2.5}$ chemical composition, an elemental analysis methodology was developed to measure major trace elements including but not limited to mercury and lead. The toxicity of inhaled particulates depends on both their physical and chemical properties; thus, an understanding of aerosol properties is essential for the evaluation of such hazards, and the treatment of such respiratory and other related diseases. Mixed cellulose ester (MCE) filters were selected for this research as a suitable filter for $PM_{2.5}$ air sampling. Chemical analyses were conducted using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for elemental analysis. VOCs measurement of the air samples was performed using a Gas Chromatography-Flame Ionization Detector (GC-FID) and Gas Chromatography-Mass Spectrometry (GC-MS) allowing for quantitative measurement of VOC molecules in sub-ppb levels. In this study, sorbent tube (Anasorb CSC, Coconut Charcoal), 6 x 70-mm size, 2 sections, 50/100 mg sorbent, 20/40 mesh was used for VOCs air sampling followed by using solvent extraction and solid-phase micro extraction (SPME) techniques to prepare samples for measuring by a GC-MS/FID instrument. Air sampling for both $PM_{2.5}$ and VOC were conducted in summer and winter seasons for comparison. Average concentrations of $PM_{2.5}$ are very different between wildfire and daily samples. At wildfire time average of concentration is 83.0 $\mu g/m^3$ and daily samples are 23.7 $\mu g/m^3$. Also, higher concentrations of iron, nickel and manganese found at all samples and mercury element is found in some samples. It is able to stay too high doses negative effects.

Keywords : air pollutants, chemical analysis, particulate matter ($PM_{2.5}$), volatile organic compound, VOCs
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