Source Apportionment Study with PMF Model and Health Risk Assessment of Volatile Organic Compounds (VOCs) at Atmospheric Fine Particulate Matters (PM$_{2.5}$) in Dhaka, Bangladesh

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An investigation on volatile organic compounds (VOCs) in the fine particulate matter (PM$_{2.5}$) has been carried out from February 2017 to January 2018 in Dhaka, Bangladesh. PM$_{2.5}$ samples were collected with a low volume sampler Environtech (Model APM 550) on Quartz filter paper for about 24 hours. Gas Chromatography (GC-2010 plus Gas Chromatograph, AOC-20i, Shimadzu) coupled with Flame Ionization Detector (GC-FID), Electron Captured Detector (GC-ECD) and Flame Photometric Detector (GC-FPD) were used to measure the concentration of the VOCs. Source apportionment with Positive Matrix Factorization (PMF) model, air mass trajectory analysis with HYSPLIT Model, and health risk assessment were done. The average PM$_{2.5}$ mass concentration in Dhaka was 254.8 μgm^{-3} with ranging from 155.6 to 478.3 μgm^{-3}. The strong seasonal variations were observed. Average PM$_{2.5}$ mass concentration obtained during winter was 323.9 μgm^{-3} and during monsoon period was 196.7 μgm^{-3}. The results showed that the range of individual VOCs concentrations varied between 79.1 μgm^{-3} to below the detection limit (BDL). The average concentration of Benzene, Toluene, Xylene, Ethylbenzene, 1,2,4-Trimethylbenzene, Ethyl methylbenzene, Chloroform, Carbon tetrachloride, _p_-Dichlorobenzene, Methylene chloride, Hexane, _d_-Limonene, Pentane, Nonane, Decane were 25.9, 18.1, 22.5, 21.6, 14.9, 26.8, 15.0, 13.6, 10.6, 16.0, 21.7, 8.83, 12.0, 14.8, and 12.5 μgm^{-3}, respectively. Air mass analysis indicate during winter season most of air masses come from Indo Gangetic plain (IGP) and during monsoon period come from ocean. The concentrations of VOCs were higher during the winter season while in monsoon their concentrations were found to be the lowest. Five main groups of sources of VOCs were identified with PMF model. These included gasoline exhaust, diesel exhaust, coal and wood burning, industry and other sources. The consequence of VOCs emission towards human health has been estimated in terms of non-cancer and cancer risk in population due to their inhalation exposure. Cancer and noncancer risks were assessed using conventional approaches, Hazard Quotient (HQ) and Lifetime Cancer Risk (LCR), USEPA. Cancer risk for Benzene, Chloroform, Methylene Chloride and Carbon tetrachloride was calculated to be 3.09×10^{-4}, 4.99×10^{-4}, 9.16×10^{-4}, 3.66×10^{-4}, respectively based on cancer potency factor, which are higher than the acceptable value. HQ for Toluene, Xylene, Hexane, _d_-Limonene are less than 1, whereas Ethylbenzene, 1,2,4-TMB, _p_-Dichlorobenzene have HQ values greater than 1. In order to improve the air quality in Dhaka and reduce the health risk of air pollutants related diseases, it is urgent to implement the control measure for the emission of volatile organic compounds.

Key words: Volatile Organic Compound; Particulate Matters (PM$_{2.5}$); PMF; Health risk assessment.