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ORIGINAL ARTICLE

Principle component analysis of flue gas exhaust and health risk estimates for the population around a functional incinerator in the vicinity of Rawalpindi Pakistan

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KEYWORDS

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Abstract In this investigation, a long term monitoring of flue gas (FG) was performed, which was emerging from a point incinerator, situated in the vicinity of Rawalpindi city of Pakistan. It was aimed to analyze and correlate the spread of particulate matter, and that of exhaust gases in the surrounding residential areas. The study spanned three consecutive years of investigation. The principal component (PCA) and cluster analysis revealed two distinct groups of gasses from the exhaust i.e., C_xH_x, H_2S, SO_2 and CO and NO_x, NO, NO_2, and CO_2 in PC 1 and 2, respectively. The distribution of Particulate matter 10 (PM_{10}) remained constant over the period of three years. The concentration of PM_{10} remained higher than USEPA safe limits on all the sampling sites. PM_{10} on most of the sites correlated with the flue gasses emerging from the point source. The results indicate the influence of the flue gas exhaust on the surrounding environment, and a probable association with the public health.

Abbreviations: CO, carbon monoxide; FG, flue gas; O3, ozone; SO2, sulphur dioxide; PM, particulate matter.

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1. Introduction

The incinerator is a major point source contributing to widespread air pollution. The major pollutants in flue gas emissions of incinerators include CO, SO_2, NO_x, CO_2 and particulate matter (PM). According to Ahmad et al. (2011), many large cities around the world harbor massive air pollutants, which

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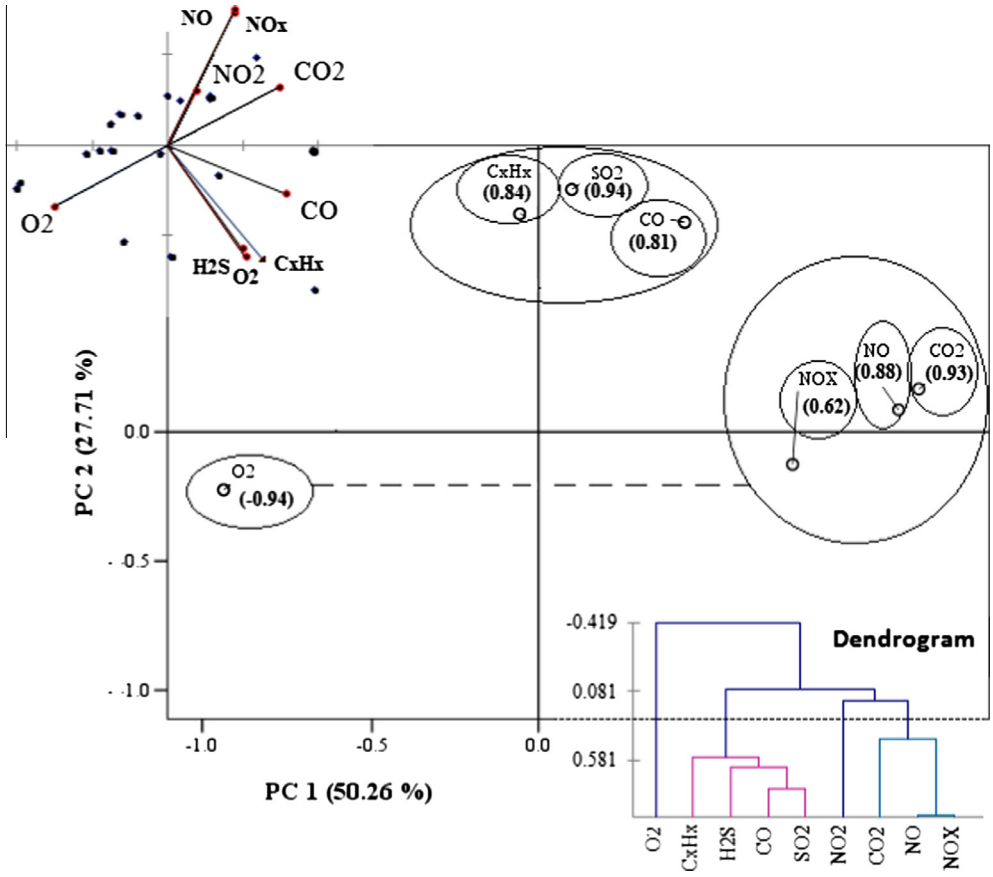

Figure 1 Principle component and cluster analysis of flue gas exhaust.

Table 1 Year wise average flue gas emission record of exhaust (ppm) from the incineration point source.

Years of observation		CO	CO_2	C_xH_x	H_2S	NO	NO_2	NO_x	SO_2
2009	Mean ± Std	248.3 ± 45	3.7 ± 1.4	0.3 ± 0.1	3.4 ± 0.7	18.7 ± 10	2.9 ± 1.0	21.6 ± 13.8	9.57 ± 0.3
	Min	18	2.2	0.2	1	5	1	5	1.1
	Max	745	5.8	0.5	18	34	14	48	28
2010	Mean ± Std	419.5 ± 43.9	3.6 ± 2.1	0.6 ± 0.1	3.3 ± 0.78	17.9 ± 4.9	0.4 ± 0.07	38.3 ± 6.23	7.47 ± 2.2
	Min	68	0.4	0.1	1	1	0.1	1	4.3
	Max	1490	6.2	1.4	25	45	0.8	212	12.3
2011	Mean ± Std	188.3 ± 22.1	4.6 ± 0.5	0.4 ± 0.2	1.0 ± 0.01	21.7 ± 9	1.5 ± 0.01	34.8 ± 9.9	6.9 ± 1.9
	Min	165	4.1	0.2	1	20	1	15	3.3
	Max	210	5	0.5	3	23	3	50	11.9
Total	Mean ± Std	302.1 ± 36	3.9 ± 1.6	0.4 ± 0.04	2.4 ± 0.62	19.2 ± 3.8	1.3 ± 0.8	32.4 ± 4.9	10.3 ± 2.6
	Min	18	0.4	0.2	1	1	1	1	1.1
	Max	1490	6.2	1.4	25	45	14	212	28

demand continuous monitoring of these pollutants in order to make better policies for their control. These issues have gained attention owing to their adverse effects on human health and ecological systems (Ghauri et al., 2007).

Incinerators are used for thermal decomposition of organic and inorganic solid wastes, although they release large concentrations of air pollutants. The incineration process is no doubt an effective way of solid waste management, but at the same time, it is also a source of air pollution, therefore, the process of incineration remains a highly controversial topic. A large amount of solid waste is generated in Pakistan, which is managed improperly. In Rawalpindi city, a few hospitals, have incinerators but, they are not functional. To combat the issue, a three-chambered incinerator was initiated in the vicinity of Morgah, in order to meet the requirements of waste management. This incinerator also provides a better waste management option for the hazardous hospital waste. A number of studies have been conducted in Pakistan to assess the air pollution from different sources, but there are scarce studies on comprehensive analysis of any FG exhaust. This study aims at monitoring air pollutants from point source, to adopt effective strategies for controlling air pollutants in addition to availing the benefits of solid waste incineration practice.

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