یازدهمین کنگره ملی سراسری
فناوریهای نوین در حوزه توسعه پایدار ایران
11th National Congress of
the New Technologies in Sustainable Development of Iran
senaconf.ir

Investigation of analysis of heavy metals and airborne particles in Tehran

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Abstract:

Anthropogenic activities have drastically changed the biochemical cycles of heavy metals (HM) resulting in an elevated presence and availability of these elements in ecosystems and the urban environment. Six stations were selected for air sample collection for analysis .The method of field sampling is given according to manufacturer's instructions booklet. Air quality with respect to SO_2, NO_2 and PM-10 has been determined in each site. Maximum concentrations of Zinc, lead, cadmium, copper and nickel were recorded at station four while minimum concentrations of lead, and zinc, were observed at station two. Maximum concentrations of chromium and Iron were observed at station three and minimum copper was recorded at station three. Maximum concentrations of manganese were recorded in station two and three and minimum concentrations of chromium were observed in station one and two. Levels of pollutant in residential areas and industrial areas were lower than the National Ambient Air quality Sources and EPA.

Key word: Ambient air, heavy metal, air pollution

Introduction

Global industrialization, developmental and agricultural activities have an effect on environmental pollution and the global ecosystem. Growing industrialization and environmental pollution from advance technology have started to affect human health (Yagdik, *et al.,* 2000).

Air pollution is aesthetically offensive and can be a genuine hazard to humans and vegetation (Nria, 1979). Agricultural crops are exposed to high concentrations of various air pollutants. Its visible effect on the foliage reduces growth and yield and causes premature death of the plant. The development and severity of the pollutant affected not only on the concentration of the particular pollutant, but also on a number of other factors. These include the length of exposure to the pollutant, the plant species and its stage of development as well as the environmental factors conducive to a build-up of the pollutant and to the preconditioning of the plant, which make it either susceptible or resistant.

The environmental pollution in some areas of Iran is alarmingly high. Pollution of the environment with toxic metals has increased dramatically since the onset of the industrial revolution (Jain, 1986) .Soil pollution by heavy metals, such as cadmium, lead, chromium, and copper, etc. is a severe problem. Although heavy metals are naturally present in soil. Contamination from local sources is mostly industry (mainly non-ferrous industries, but also power plants and iron, steel and chemical industries), agriculture (irrigation with polluted waters, sewage sludge and fertilizer especially phosphates, contaminated manure and pesticide containing heavy metals), waste incineration, combustion of fossil fuels and road traffic. Long-range transport of atmospheric pollutants adds to the metals in the natural environment (European Environmental Agency, 1995). In recent years, it has been shown that lead levels in soil and vegetation have increased considerably due to traffic pollution, especially from usage of leaded petrol and exhaust combustion (Cabrera *et al.,* 1999). Heavy metals are found generally at trace level in soil and vegetation. However, these have a toxic effect on organisms at high concentration. Heavy metal toxicity has an inhibitory effect on plant growth, enzymatic activity, stomata function, photosynthetic activity, accumulation of other nutrient elements and also damages the root system (Vidal *et al.,* 1999).

Tehran

The metropolitan area is surrounded at the north and east side by the Alborz Mountains, one of the highest mountain ranges in Iran with its peaks above 5,000 m. Average elevation of the city itself is about 1,300 m, increasing towards the North and the posh quarters encroaching the mountain slopes. The city (Municipality of Tehran) covers an area of approximately 22 km North-South and about 35 km East-West - embedded in a 60 by 60 km primary model domain. The city area proper is divided into 22 municipality areas or districts.

The climate is mild-continental, with hot summers (mid to high thirties) and moderately cold winters (just below zero), average annual precipitation in this semi-arid zone around 200 mm, with rainfall mostly between November and April. Predominant winds are westerly as well as, with lower frequency, NNE and SE.

Approximately each site vehicular passes in the range of 6500-20000 daily around Tehran (Table2). Data collected on the basis of registered vehicles on the police high way station and some un-registered data given by local authority.

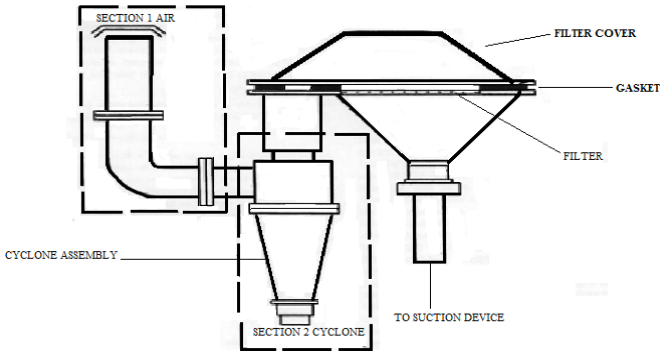
Table1: Vehicles passing from each station per day

No	Name of station	Number of vehicles
1	Saidi high way (shahid beheshty complex)	7000
2	Saidi high way(shah Tareeh)	6500
3	Tehran-Qom high way(Turouz abad)	20000
4	Tehran-Qom high way (Jalil Abad)	18000
5	Tehran-Varamin high way(near Amin Abad road)	15000
6	Tehran -Varamin high way(Firooz Abad)	14000

Material and method

Six stations(6 stations and every station 3 samples 5m, 10m, 15m and opposite site) were selected for air sample collection for analysis point of view in table-1. The areas selected for collection from various locations to cover industrial, commercial and residential zones.A type of sampler is shown in Fig 1 . The method of field sampling is given according to manufacturer's instructions booklet. (CPCB, 1999-2000) The collected filters samples were sieved into coarse and fine fractions. Well-mixed samples of 2 gram each were taken in 250 mL glass beakers and digested with 8 mL of aqua regia on a sand bath for 2 hours. After evaporation to near dryness, the samples were dissolved with 10 mL of 2 % nitric acid, filtered and then diluted to 50 mL with distilled water. Heavy metal concentrations of each fraction were analyzed by Atomic Absorption Spectrophotometer. Quality assurance was guaranteed through double determinations and use of blanks for correction of background and other sources of error.

Fig.1: A typical Schematic Air Sampler (High Volume Sampler)



Calculation

Calculation of volume of air sampled: (CPCB, 2003-04)

$V = Qt$

Where

V = volume of air sampled, in m^3;

Q = average flow rate, in m^3/min; and

t = total sampling time, in min.

Calculation of PM-10 in ambient air

PM-10(as µg/m^3) = (W_1-W_2)*10^6/ V

Where

PM_{10}= mass concentration of particulate matter less than **10** micron diameter, in ***µg***/m^3;

W_1 = initial of filter, in g;
W_2 = final weight of filter, in g;
V = volume of air sampled, in m^3; and
10^6 = conversion of g to µg.

Result

Air pollution is one of the major problems in Tehran. According to the World Bank report the annual damage due to air pollution in Iran was about 7 billion(Jitendra *et al.*,1997) Also, people die in Tehran due to air pollution and related maladies.

Sources of Emissions

Air pollution emissions in Tehran falls into two major groups, the stationary (industrial, commercial, residential) and mobile (traffic) sources; the share of mobile sources (as a total tonnage) is 89%. Vehicles are the main emissions source in the city. CO (Carbon Monoxide) and PM-10 (Particulate Matter) are the two main pollutants in Tehran. For the latter, beside the combustion sources and in particular traffic, wind entrainment from soils including the desert areas south of the city, must also be considered as important sources.

Ambient Air Quality

Air quality with respect to SO2, NO2 and PM-10 has been determined in each site. Levels of SO2, NO2 and PM-10 were observed during March and April depicted in table 3. Levels of pollutant in residential areas and industrial areas were lower than the NAAQS (National Ambient Air quality Sources).

Table 3: Meteorological and test description in Tehran

Test Description	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Date of Sampling	20.10. 10	22.10. 10	28.10.10	04.11.10	6.11.10	10.11. 10
Time of Sampling	8:00am 4:00pm	8:00am 4:00pm	8:00am 4:00pm	8:00am 4:00pm	8:00am4 :00pm	8:00am 4:00pm
Ambient Temperature (° C)	22	17	19	23	38	36
Relative Humidity (%)	38	40	45	42	44	30

Table 4: Analysis result of ambient air Tehran

	Particulate Matter µg/m^3	Sulphur dioxide ppm	Oxides of Nitrogen ppm
Station 1	79	72	27
Station 2	83	27	38
Station 3	33	62	25
Station 4	66	21	88
Station 5	47	28	56
Station 6	49	30	23

Levels of pollutant in all stations were lower than the standard .High concentration of SO_2 was observed at station one while minimum concentration was recorded at station four. Maximum concentration of particle matter was observed at station two also minimum concentration of particle matter was showed at station three and NOx was maximum in station four while minimum NO_x was recorded at station six. Levels of SO2, NO2 and PM-10 are observed during March and April depicted in table 3, 4.

A primary pathway for human health exposure to heavy metals is inhalation of air particulates containing heavy metals. Air particulate samples were analyzed in six stations in Tehran -Iran .The results of the heavy metals pollution are presented in table 5.

Maximum concentrations of Zinc, lead, cadmium, copper and nickel were recorded at station four while minimum concentrations of lead, and zinc, were observed at station two. Maximum concentrations of chromium and Iron were observed at station three and minimum copper was recorded at station three. Maximum concentrations of manganese were recorded in station two and three and minimum concentrations of chromium were observed in station one and two.

Table 5: Concentration of heavy metal (mg/kg) in ambient air along highways Tehran

No station	Zn	Cr	Pb	Cd	Mn	Fe	Cu	Ni
Station 1	10.24	0.00	0.36	0.008	0.003	0.40	10.63	0.14
Station 2	5.49	0.00	0.24	0.009	0.004	0.33	6.72	0.28
Station 3	15.5	0.05	0.30	0.005	0.004	0.41	3.55	0.31
Station 4	16.07	0.03	0.40	0.015	0.003	0.29	12.13	0.34

Station 5	10.85	0.001	0.33	0.007	0.003	0.31	5.31	0.32
Station 6	14.88	0.003	0.34	0.001	0.002	0.35	8.32	0.27

Discussion

Air pollution around Tehran has considered for present study. In Tehran 20,000 vehicles passing from station three and minimum in station two 6500 per day. Data was collected from police records.

Air quality of SO2, NO2 and PM-10 was collected from all stations in Tehran. It was observed that in Tehran region station two has 83 $\mu g/m^3$PM-10 particulate matters, 72 ppm SO2 in station one and NO2, 88 ppm in station four. The pattern of air pollution was not uniform.

Focus of present work is on concentration of heavy metals in ambient air quality. Tehran has not uniform pattern of heavy metal concentration in ambient air quality. Zn, Pb, Cd, Cu and Ni were higher in station four and Cr, Fe and Mn were higher in station three. Data was linked to heavy traffic in station four -20,000 vehicles/per day and 18,000 vehicles/per day in station three.

The World Health Organization (WHO) ambient air quality health guidelines were available for a few metals; arsenic, cadmium, chromium (VI), lead, manganese, mercury, nickel and vanadium (WHO, 1987). On these guidelines all the levels are reported in mg/kg Cd level 0.005, Cr, 0.008 which are classified as carcinogens and Pb 0.05, Mn 0.15. In present study Cd level was 0.015 mg/kg in station four. Cr level in Tehran 0.05 in station three; Pb level was 0.40 mg/kg in station four in Tehran. Mn level in Tehran were 0.04 mg/kg in station two and station three. The result showed Station three and four in Tehran were highly polluted due to transportation of vehicles.

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