Volume 10 – No.4 April 2001
REPRINT pp. 405-408

INVESTIGATION OF HEAVY METAL POLLUTION OF TRAFFIC IN KEMALPASA-TURKEY

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SUMMARY

Trace metal concentrations of the soil samples of Kemalpasa-Turkey region traffic were investigated to determine Pb, Ni, Cd, Mn, and Zn content by flame atomic absorption spectrometer. The concentration of Pb, Ni, Cd, Mn, and Zn were found at all places in the range of 13-375, 30-145, 1.1-5.8, 218-348, and 27-108 μg/g, respectively. A good correlation was found between the number of cars or total number of vehicle and the metal contents.

KEYWORDS: Pollution, Trace Metals, Soil, Traffic

INTRODUCTION

The trace element contents of soil samples have been investigated for various purposes such as agricultural studies and different pollution studies [1-4]. Soil samples are among important materials to be tested during investigations of environmental pollution originating from traffic. Traffic is one of the sources of emission of toxic heavy metals such as Pb, Ni, Cd, Mn and Zn. The largest part of environmental lead in cities originates from exhausts of motor vehicles in traffic. Lead is added to gasoline as the organic tetraalkyllead additives: tetramethyllead, tetraetyllead, and mixed alkyls triethylmethyllead; diethyldimethyllead and etyltrimethyl-lead [5]. Motor oils also contain nickel in trace levels [6].

The source of nickel in the street dust has been reported as corrosion of the metallic part of the cars in the traffic [7,8]. The source of manganese from traffic has been reported as tyre-wear [7]. Cadmium and zinc exist in accumulators of motor vehicles or in carburettors, as alloys [9]. They are released as combustion products. Kemalpasa is located in west Anatolia. It is 15 km away from Izmir. It has a surface area of 190 km^2 and had a population of 43400 in 1995. The city which is famous for its cherry and olive gardens, is the second largest industrial region of Turkey with 43 food and 167 industrial factories.

There are no publications so far about the determination of trace elements originating from traffic pollution of Kemalpasa-Turkey. In this study, the level of the heavy metals in soil samples collected from ten stations in Kemalpasa-Turkey were determined by flame atomic absorption spectrometry (FAAS). The relationship between metal contents and traffic intensity was calculated.

EXPERIMENTAL

Sampling: A total of nine street dust samples were collected from low and high density traffic roads in Kemalpasa during the period of April to June, 2000. Sampling was performed according to detailed guidelines mentioned by Somer and Aydin [1], which consisted of soil dust collected from both sides of a 10-15 m length of the road. They were dried at 60 ^oC and sieved through a 170 mesh sieve. Samples were then taken by the coning and quartering methods.

Preparation to the analysis: The soil samples were dried at 110 ^oC for 3h and ground to pass through 200 mesh sieve and homogenized for analysis. 1.0 g of soil samples were digested in 15 mL concentrated hydrochloric acid and 5 mL of concentrated nitric acid at room temperature, then heated to 95 ^oC. After the evolution of NO_2 fumes had ceased, the mixture was evaporated nearly to dryness on a sandbath and mixed with 20 mL solution containing 1%(v/v) HCl and 1%(v/v) HNO_3. Then, the resulting mixture was filtered through a Gouche crucible and the insoluble fraction of silicates was determined. The clear solution was used for an FAAS measurement after dilution to 50 mL [10,11].

Measuring condition:
All the samples were analyzed by Perkin Elmer Model 3110 Flame Atomic Absorption spectrophotometer. Atomization was performed by Acetylene/Air flame with a flow rate of 2.5 L/h for Acetylene and 6 L/h for air. Two types of sources from Cathedon and Perkin-Elmer were employed to excite the elements.

Preparation of standard solutions:
All the standard solutions were prepared from analytical grade compounds of Merck Company. For each element, six standard solutions of different concentrations in the linear range were prepared in 2M HNO_3, the optimum linear concentration range for the measurement [12].
The calibration curves were prepared for each of the elements investigated. The least square fitting was employed to get the best line in the linear range of the calibration lines.

RESULTS AND DISCUSSION

Before starting sample analysis the accuracy and precision of digestion procedure were tested to determine recoveries of the metal ions. Sample was analyzed both with and without spiked standard containing a mixture of the examined metals of different amounts. The results are shown in Table 1.

The procedure given in experimental was applied to the sample collected from Kirazli Kahve Square Station. No losses of Pb, Ni, Cd, Mn, and Zn was found during the digestion due to the high recovery rates of ≥96%. A preliminary test involving seven replicate digestions on one soil sample for these metals produced relative standard deviations of about 4-11%. Using the procedure, the heavy metal contents under investigation in soil samples were determined and the results are presented in Table 2.

TABLE 1 - Analytical performance of digestion

Metal	Recovery, %	Relative standard deviation, (s/x)*
Pb	99	0.054
Ni	97	0.038
Cd	96	0.098
Zn	98	0.105
Mn	97	0.045

*N=7

TABLE 2 - Heavy metal concentrations in surface soil of different traffic volume location in Kemalpasa-Turkey (April-June 2000)

Location	No. of vehicles 07.00-19.00h	No. of cars 07.00-19.00h	Concentration. x±t*s/ÖN. mg/g				
			Pb	Ni	Cd	Zn	Mn
1. Nift Mountain	0	0	13.2±0.6	29.8±1.3	1.08±0.10	26.7±3.0	217.5±9.1
2. Emniyet Square	5021	2541	115.9±6.0	74.4±2.8	1.18±0.08	51.8±5.3	260.2±14.5
3. Kirazli Kahve Square	5701	3624	151.1±9.2	66.8±2.6	4.07±0.39	51.6±5.1	332.7±12.4
4. Izmir Road (Olmuksa)	9034	3806	172.8±7.3	87.4±3.8	2.00±0.14	40.6±3.5	313.4±13.1
5. Akdeniz Kimya Cross	8975	4522	375.2±16.1	101.3±4.8	4.65±0.22	105.3±8.4	271.8±14.3
6. Izmir Road (Omya Maden.)	9123	3300	146.0±8.3	114.2±5.4	2.81±0.31	83.2±7.6	320.1±13.2
7. Ankara Road	10927	6733	302.1±18.4	144.7±7.4	5.84±0.76	108.1±10.6	332.9±12.2
8. Ansica Road	5231	2800	143.1±5.6	77.4±3.2	2.67±0.34	33.7±4.0	310.2±13.6
9. Sütcüler Road	4956	3690	152.1±8.8	125.8±4.8	2.73±0.25	46.2±4.0	348.3±14.8
10. Meyhane Bogazi Square	8790	3608	164.4±7.4	57.9±2.5	3.26±0.36	34.7±4.2	277.1±13.5

*Uncertainty at 95% confidence level (N=6)

TABLE 3 - Correlation between vehicle types and metal concentrations

Vehicle types	Correlation coefficient, r				
	Pb	**Ni**	**Cd**	**Zn**	**Mn**
Cars	0.837	0.806	0.858	0.725	0.664
All vehicles	0.763	0.661	0.677	0.666	0.508

TABLE 4 - Coefficient correlation data between metal concentrations

	Pb	**Ni**	**Cd**	**Zn**	**Mn**
Pb	1.000				
Ni	0.641	1.000			
Cd	0.825	0.602	1.000		
Zn	0.825	0.728	0.752	1.000	
Mn	0.320	0.724	0.499	0.268	1.000

Nift Mountain was selected as the control station due to having zero traffic volume. If the heavy metal concentrations in the roadside soil dusts were compared with the metal contents in the location 1, it is seen that the metal concentrations of the dusts are higher than the control samples. This shows that traffic volume has a strong influence on the metal pollution of the roadside soil dusts. The highest vehicle number (911 vehicles/h) is at Ankara Road Station. The highest metal concentrations were found in this station. The concentrations of Pb, Ni, Cd, Mn, and Zn were found at all places in the range 13-375 μg/g, 30-145 μg/g, 1.1-5.8 μg/g, 218-348 μg/g, and 27-108 μg/g, respectively.

There was a good correlation between the number of cars and the metal contents (Table 3). According to statistical calculations, at the 95% confidence level, the correlations between the investigated metal contents and the number of cars or total vehicles number is significant [13]. As it was expected, the good correlations have been observed in Pb concentrations, because of leaded petrol used in the vehicles.

Cadmium and zinc concentrations were obtained 1.1 and 27 μg/g, respectively, at the location 1 where the traffic volume was zero. The mean value of Cadmium and zinc in soils world-wide, is <1 μg/g and 15-25 μg/g, respectively [3].

This shows that Cd and Zn pollution is not only of traffic origin. Soil is a chemically, physically and biologically complex system, whose constituents are constantly undergoing changes due to weather conditions, geographical location and human activities such as traffic, industrial activity and agricultural [14,15]. Soils in industrialised areas and motorways that have high traffic volume have become contaminated with traces of heavy metals [1,16-18]. Cadmium especially is used in the electroplating industry, mining industry, dye productions, pipe and iron plating industries and agricultural applications in Kemalpasa and in this way cadmium id emitted to the environment. A similar results was found by Yalcin et al. and Bereket et al. [2,9].

The heavy metal values of soil samples in Kemalpasa were approximately similar to other studies on urban soil samples [19,20].

A linear regression correlation test was performed to investigate correlations between metal concentrations of our present samples. The values of the correlations' coefficients between metal concentrations in the soil samples from Kemalpasa are given in Table 4 (p=0.95). Our present correlation data have shown good agreement with the results found by Tatsumi et al. [21].

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Received for publication: August 1, 2000
Accepted for publication: March 15, 2001

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FEB Vol.10/ No 4/2001 – pages 405 - 408