Toxic and Trace Metals (Pb, Cd, Zn, Cu, Mn, Ni, Co and Cr) in Dust, Dustfall/Soil

[1]F. U. KHAN, [1]A.U. RAHMAN, [1]A. JAN AND [2]M. RIAZ
[1]*Materials Science Division (M. S. D.)*
P.C.S.I.R. Laboratories, Jamrud Road, Peshawar, Pakistan
[2]*Medicinal Botanical Center*
P.C.S.I.R. Laboratories, Jamrud Road, Peshawar Pakistan

(Received 22nd April, 2002, revised 25th October, 2003)

Summary: Metals (Pb, Cd, Zn, Cu, Mn, Ni, Co and Cr etc) emitted into the urban air from different sources (coal and petroleum burning, municipal incinerators, automobile exhaust, refuse burning, pesticide use in agricultural, diverse industrial manufacturing process etc.) and being an ultimate sink for al types pollutants, the soil pollution are receiving increasing attention as potentially important pollutants. To assess health hazard and other problems posed by metal component, information is needed on their concentrations, particle size and chemical forms. So the toxic and trace metals concentration in dust, dustfall (aerosols), soil is reviewed.

Introduction

The term dust is very comprehensive. It may be of many kinds e. g. street dust, house dust, indoor dust, out door dust, road dust etc. Generally dust may be defined as those particles having diameter between 0.1 and 1000 microns [1]. Dust is a typical air pollutant. It is easily noticeable on trees, buildings even by necked eyes where there is no rainfall to wash them away. It indicates the degree and kind of air pollution in a city. Dust often contains elevated concentrations of toxic metals [2]. In some instances these may represent a significant pollutant source especially when storm water runoff and removes a large part of them and their associated metals [3]. It has now been well established that aerosols and deposited dusts found in urban areas are substantially enriched in many toxic trace metals by comparison with those found in non-urban areas [4]. People who reside in urban locations are exposed to lager amounts of potentially hazardous elements than their counter-parts. Street dusts are relatively complex materials, the composition of which is seldom constant. This is because of changes during weathering, the relatively short residence time in the environment. It is also the material that is now recognized a significant source of heavy metals in the urban environment and it has also been suggested that street dusts can be an important source of metal intake for young children due to inadvertent ingestion of the dust [5].

Rapid industrialization and urbanization without environmental control has resulted in heavy metal contamination of communities. Human being, animals and plants take these metals through air, water and food. The nuisance caused by dustfall and grit is a common feature in urban areas of arid zones, since they are faced with combination of industrial, construction and transportation activities [6]. It cases a variety of diseases in human body [7]. It retards the growth of roadside plants by affecting photosynthesis and degrades chlorophyll contents and carbohydrates in plants [8]. It has been reported that plants are more sensitive to pollution than animals or human being. Injury to vegetation caused by heavy metals has also been well documented because of many botanical and chemical investigations during the past hundred years [9]. Painted surfaces are very susceptible to particulate damage before the paint is dry [10]. Dustfall also contribute to the chemical decay of marble, limestone, dolomite stone work and concrete structure [11].

A number of materials in urban areas contribute to street dust. The elemental composition, patterns of distribution and possible sources of street dust are not common to all urban environment but vary according to the peculiarities of each city. Among them road traffic (automobile), industrial activities and weathered materials are the important sources of trace metal pollution [12] Addition to this particular circumstances can also intermittently raise trace metal concentrations in street dust. The elements Pb, Cu, Zn and Cd have been identified as coming from weathered materials [13-15] It has been reported that use of lead based paints for redecoration of old houses has marked affect on Pb concentration

Table -1: Concentration of Heavy and Toxic Metals in Dust/Dustfall and Aerosol in Different Cities and Countries

Country	Location/city	Sample	Unit	Pb	Cd	Zn	Cu	Ni	Mn	Co	Cr	Analytical Technique	Ref
Poland	Lecz-Wlodawa	Dustfall	G/m²m.	13.7	5.6	46.4	10.1	1.6	13.2	-	3.1	AAS, ICP, AES	31
U. K.	Lancaster	Street dust	µg/g	1880	4.6	534	143	35	-	9.1	29	AAS	32
USA	Illinois	Street dust	µg/g	1000	1.6	32	-	250	35	6.8	210		33
Saudi Arabia	Riyadh	Falling dust	µg/g	66.8	3.8	142	36.5	26.0	319	20.6	-		34
India	Noamundi	Aerosol	µg/m³	0.79	0.04	16	0.09	0.17	0.15	0.11	-		35
Nigeria	Hauts	Sediments	mg/kg	4-295	.13-8.6	27-323	5-102	11-149	276-748	6-41	23-167		36
Nigeria	Various sites	Dust	µg/g	4-243	02-1.7	12-48	-	1.0-3.3	-	-	0.73-2.6	AAS	37
Saudi Arabia	Riyadh	Indoor dust	µg/g	639	2.0	547	271	53	-	-	69.0	AAS	38
Saudi Arabia	Riyadh	Outdoor dust	µg/g	1762	2.5	443	939	44	-	-	35.1		38
Czeck	Tehice	Aerosol	µg/m³	85	-	100	6.6	2.3	11	-	2.2		39
Pakistan	Abbotabad	Dustfall	Mg/kg	446	52	931	283	-	533	-	-	AAS	40
Pakistan	Islamabad	Dustfall	µg/g	22.7	-	8.3	19.2	5.6	-	-	-	AAS	41
Pakistan	Peshawar	Dustfall	µg/g	525	-	763- ?	-	358	637	54	83	AAS	42
Pakistan	Peshawar	Roadside dust	µg/g	80.4	3.2	-	49.6	-	-	-	-	AAS	43
Pakistan	Karachi	Street dust	Mg/g	810-4527	0.2-4.5	112-2215	46-315	72-481	-	-	-	AAS	44
USA	Chicago	Aerosol	µg/m³	3.5	-	0.9	0.2	0.07	0.04	-	-	ES	45
USA	Cincinnati	Aerosol	µg/m³	2.1	-	3.0	0.4	0.06	0.31	-	-	ES	"
USA	Denver	Aerosol	µg/m³	3.0	-	0.4	0.4	0.06	0.03	-	-	ES	"
USA	Philadelphia	Aerosol	µg/m³	1.9	-	0.6	0.1	0.06	0.1	-	-	ES	"
USA	St. Louis	Aerosol	µg/m³	1.9	-	0.3	0.2	0.06	0.04	-	-	ES	"
USA	Washington	Aerosol	µg/m³	1.8	-	0.9	0.6	0.06	0.03	-	-	ES	"
Bahrain	Bahrain	Street dust	µg/g	697	72	151	-	125		-	144	AAS	46
Bahrain	Bahrain	House dust	µg/g	360	37	64	-	113		-	183	AAS	"
Hong Kong	Hong Kong	Surface dust	mg/g	302	2.6	1517	201	-	-	-	-	AAS	47
Poland	Polish town	Aerosol	µg/m³	-	-	.48-3.1	.04-0.46	.07-.79	-	-	.002-.06		48
Greece	Various sites	Dust	µg/g	65-259	1.8-4.3	75-241	-	-	52.2	-	-		49
England	Lancaster	Street dust	µg/g	2540	2.78	458	199	-	-	-	-	FAAS, SV	50
France	Paris	Street dust	g/kg	0.9-6.1	-	1.5-4.6	0.1-1.7	-	-	-	-		51
Equador	Cuenca	Dust	Mg/kg	293	0.36	509	-	-	-	-	-		52
Malaysia	Kaulampur	Dust	µg/g	2466	2.96	344	-	-	-	-	-		53
Jamica	Kingston	Dust	µg/g	909	0.8	0.8	-	-	-	-	-		54
Egypt	Various sites	Dust	µg/g	52-1850	0.23-0.42	-	-	-	-	-	-		55
Hong Kong	Various sites	Dust	µg/g	1080	1.08	-	-	-	-	-	-		56
Netherlands	Near smelter	Dust	µg/g	761	1.43	-	-	-	-	-	-		57
Germany	N. R Westphalia	Dust	µg/m² day	113	1.3	-	-	-	-	-	-		58
W. Germany	Hettstedt	House dust	µg/m² day	1.14	0.024	-	-	-	-	-	-		59
Mexico	Chihuahua	Dust	µg/g	277	10	-	-	-	-	-	-		60
Mexico	Monterrey	Dust	µg/g	467	11	-	-	-	-	-	-		"
Mexico	Torreon	Dust	µg/g	2448	112	-	-	-	-	-	-		"
Canada	Halifax	Dust	µg/g	674-1519	-	-	-	-	-	-	-		61
Kuwait	Salmich	Dust	µg/g	136	-	-	-	-	-	-	-		62
Scotland	Glagow	Dust	µg/g	308	-	-	-	-	-	-	-		63
Taiwan	Taipei	Dust	µg/g	196	-	-		-	-	-	-		64
W. Germany	W. Berlin	Dust	µg/g	8-2943	-	-	-	-	-	-	-		65
Saudi Arabia	Jeddah	Street dust	ppm	745	-	-	-	-	-	-	-		66
U. K.	Birmingham	Street dust	ppm	1630	-	-	-	-	-	-	-		67
U. K.	Manchester	Street dust	ppm	970		-	-	-	-	-	-		"
Belgium	Belgium	Street dust	ppm	2255	-	-	-	-		-	-		68
Malta	Malta	Street dust	ppm	1825	-	-	-	-	-	-	-		69
USA	Av. of 77 cities	Street dust	ppm	240-1500	-	-	-	-	-	-	-		70
Albania	Various sites	Soil	mg/kg	172	14	2495	1107	-	3579	476	3685		71
Pakistan	Peshawar	Soil	mg/kg	1.19	0.06	17.39	7.0	26.61	5.71	2.41	2.06	AAS	72
Pakistan	Abbotabad	Soil	mg/kg	11.41	1.60	42.57	38.5	-	142.29	-	-	AAS	40
Pakistan	Lahore	Soil	mg/kg	640	70	300	-	-	-	-	-	AAS	73
Pakistan	Islamabad	Soil	mg/kg	15.61	-	59	22.5	-	-	-	-	AAS	74
USA	California	Near smelter	7900	140	2900	-	-	-	-	-	-	AAS, SV	50
England	Lancaster	Soil	mg/kg	807	1.42	340	104	-	-	-	-	AAS, SV	"
Hong Kong	Hong Kong	Soil	mg/kg	195	2.3	237	-	-	-	-	-		56
USA	Grand Rapids	Surface soil	mg/kg	17.9	0.41	21.1	8.0	-	5.4	2.3	3.2	AAS	75

AAS Atomic Absorption Spectrophotometery
SV Striping Voltametery
FAAS Flamé Atomic Absorption Spectrophotometery
SV Striping Voltametery
ICP Inductively Coupled Plasma
AES Atomic Emission Spectrophotmetery
ES Emission Spectrograph

[16]. Davis et al has stated that nature of road surface is another factor regarding the concentration of heavy metal [17]. The concentrations of elements Pb, Cu, Zn tend to increase from the pavement, to the gutter, to the center of the road. The variation is probably because of size fraction of the dust particles, the smallest occurring in the road way and dilution of the Pb particles, further away from the road surface by materials such as soil [18]. Elements originating from automobiles are lead, cadmium, copper, zinc, iron, chromium and nickel [19]. Lead comes from Pb in Petrol, where as the other elements come from wear and tear on the car, such as Zn and Cd from tire wear [19]. As stated earlier that rapid industrializa-tion, urbanization, coal and petrol burning refuse burning automobile exhaust, diverse industrial manufacturing process, pesticide use in agriculture; soil pollution and metals emitted in to the atmosphere have received increased attention. Being an ultimate sink for all types of industrial waste, almost all industrial wastes are dumped into the soil where they retained relatively strongly either on inorganic or organic colloids. So to assess health hazard posed by metals component and evaluating the potential effects on crop productivity and toxicity to human being and animals, there have been considerable number of studies on the concentration of heavy metals and street dust, and soil. The vast majority have been

carried out in developed countries with long histories of industrialization and (crucially in the case of lead), extensive road building and the use of leaded gasoline as well as in developing countries [20 – 30]. In this paper concentration of heavy and toxic metals in aerosols/dustfall, dust and soil in different countries/cities are reviewed.

The most commonly used sampling methods were Nuclepore membrane filters, vacuuming the road dust, gravity method, general sweeping of the road surface etc. Atomic Absorption Spectrophotometric (AAS), Inductively Coupled Plasma (ICP), Atomic Emission Spectrophotometric (AES), Flame Atomic Absorption Spectrophotometric (FAAS), Striping Voltametric (SV), Emission Spectrograph (ES) analytical techniques were used for the determination of metals.

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