

Chemical Investigation of the Air Quality in Work Place Environment of Selected Industries

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Summary: Samples of air from the work place environments of selected industries were collected. These samples were analysed for carbon monoxide (CO), sulphur dioxide (SO₂) and heavy metals like, Lead(Pb), Copper(Cu), Chromium (Cr), Cadmium (Cd), Zinc (Zn) and Iron (Fe), by standard methods. The results are presented and discussed. The level of these elements varied in the range of 0.79-1.43, 0.07-0.5, 0.22-130, 0.001, 3.7-25, 93.60 and 24.6- 59 µg/m³ for Pb, Cr, Cu, Cd, Zn and Fe respectively in the air samples of various industries investigated.

Introduction

Air pollution may result from natural processes or anthropogenic. The natural air pollution may result from forest fires, decomposition of plants and animals, soil erosion, pollen and mold spores, ocean spray, volatile hydrocarbons emitted by vegetation and ozone from electrical storms and the stratosphere. The major routes of anthropogenic air pollution are industrial emissions, vehicular emissions and burning of fossil fuels.

Air pollutants are present in the atmosphere in concentrations that disturb the dynamic equilibrium in the atmosphere and thereby affect man and his environment. Global air pollution (90%) is contributed by the primary pollutants like carbon monoxide, oxides of nitrogen (NO_x), oxides of sulphur (SO_x), hydrocarbons (HC) and particulates. These air pollutants have various toxic effects on man, Vegetation, livestock and materials [1-8].

For the analysis of CO, NO_x, SO_x and heavy metals like, Pb, Cr, Cu, Cd Zn and Fe in air samples, extensive literature is available [9-19].

Results and Discussion

The results of the chemical investigation of air samples collected from the work place environments of selected industries are given in Table 1 and 2.

From the Table-1, it can be seen that the work place environment of the industries studied contain a higher concentration of suspended dust than the

Table-1: Analysis of air samples of CO(g), SO₂ (g) and suspended dust

Industry	Date of Sampling	Time of Sampling (hrs)	Suspended dust (mg/m ³)	CO(g) (mg/m ³)	SO ₂ (g) (mg/m ³)
Paper and Board Mills	23.10.94	1240	0.8851	11.4	-
Match Factory 1	13.10.94	1200	2.05	7.15	0.12
Match Factory 2	21.11.94	1300	1.09	5.72	0.43
S. Absorbing Cotton Industry	12.12.94	1330	21.99	11.43	0.135
Steel Industry	27.1.95	1130	1.333	9.143	3.15

Table-2: Analysis of air samples for heavy metals

Industry	Heavy metals (µg/m ³)					
	Pb	Cr	Cu	Cd	Zn	Fe
Paper and Board Mills	0.8	-	0.5	-	18.7	57.0
Match Factory-1	0.79	0.5	130	-	8.1	59.0
Match Factory-2	1.4	0.32	1.3	-	7.9	325
S. Absorbing Cotton Industry	0.21	0.07	0.22	-	3.7	30.0
Steel Industry	0.93	0.31	0.38	0.001	93.6	25.0
National Environmental Quality Standards						
Pb	=				1.5 µg/m ³	
Cr	=				1 µg/m ³	
Cu	=				-	
Cd	=				10-20 µg/m ³	
Zn	=				-	
Fe	=				-	

national ambient air quality standard (0.075 mg/m³). The concentration of suspended dust is highest in S. absorbing cotton industry. The workers of this industry are thus exposed to hazardous effects of suspended dust.

Table-1 also shows a higher concentration of CO in paper and board mills and S. absorbing cotton- industry, than the national ambient air

quality standard for CO (10mg/m^3). Rest of the industries shows CO concentration in the permissible limit. As is clear from the Table-1, the concentration of SO_2 studied in all of these industries, is higher than the national permissible limit (0.08mg/m^3). The workers of these industries are also exposed to the hazardous effect of SO_2 .

The results of the air samples for Pb, Cr, Cu, Cd, Zn and Fe are given in Table-2. The concentration of Pb, Zn, Cr and Cd is highest in steel industry, that of Cu is higher in match factory-2. The concentration of Pb is higher in Match factory-2 and steel industry than the national ambient air quality standard for Pb (0.0015mg/m^3). Rest of the industries have Pb level in permissible limits.

Experimental

Apparatus and instruments

Desaga gas sampler GS312, West Germany made, High volume dust sampler, American made, Lamotte Axial Reader equipment, phillips flame Atomic absorption spectrophotometer PU-1900X and milton Roy digital spectronic 20D, were used during this work.

Chemical and reagents

All reagents were of analytical reagent grade (Merck) and deionized, distilled water was used throughout.

Solutions for SO_2 determination

(a) Absorption solution

27.2 g of mercury(II) chloride and 11.7g of sodium chloride were dissolved in 1000 mL water.

(b) Formaldehyde solution

5 mL of a 35% formaldehyde solution were pipetted into a few hundred mL of water and were filled up to 1000 mL with water.

(c) Pararosaniline solution

40 mg of pararosaniline were dissolved in 6 mL of concentrated HCl and were filled then upto 100 ml with water.

d) Calibration solutions

1.54 g of sodium metabisulphite were dissolved in 1000 mL of distilled water. 5mL of this

solution were diluted upto 500 mL with the absorption solution. 5mL of this solution were diluted to 50 mL with the absorption solution. This solution was then used for the calibration curve.

Sampling

For CO and SO_2 gases samples of air were collected, using desaga gas sampler and impinger bottles as follows:

CO

Poured 10 mL of carbon monoxide absorbing solution into impinger bottle. Connected impinging apparatus to intake of air sampling pump. Collected air at a rate of 1.0 L per minute for 30 minutes or until a measurable amount of CO was absorbed. (A measurable amount of CO was indicated by the development of yellow color in the absorbing reagent).

SO_2

Poured 20 mL of SO_2 absorption solution into each impinger bottle. These bottles were connected with the desaga pump. The air flow was adjusted to 1 L per minute. About 200 L of air, were sampled at one time.

Suspended dust

Conditioned dust filters for 24 hours in a desiccator. Weighed the filters immediately, after taking them out of the desiccator. Inserted the filters into the high vol-sampler. Adjusted the flow to 40 cubic feet per minute. Noted the total operation time after sampling. Took the loaded filters out, dried for 24 hours inside the desiccator. Weighed the filters immediately after taking them out of the desiccator. Subtracted weight of the unloaded filters from the loaded filters, to obtain weight of dust.

Calculations

$40\text{ cu ft} \times \frac{\text{sampling time in minutes}}{60} = \text{total volume of air (cu ft)}$

$\frac{\text{Total volume of air (cu ft)}}{35.1} = \text{total volume of air (m}^3\text{)}$

$\frac{\text{Wt. of dust on dry filter}}{\text{total volume of air (m}^3\text{)}} = \text{mg/m}^3\text{ susp. dust}$

$\frac{\text{total filtes (mg)}}{\text{total volume of air (m}^3\text{)}} = \text{mg/m}^3$

*Procedure for analysis**CO*

After the sampling period was completed poured contents of impinging apparatus into a clean test tube. Placed the tube into axial reader to match test sample to the index of color standard to obtain the concentration of CO.

SO₂

After having finished sampling, 10 mL of absorbing solution containing SO₂, were mixed with 1 mL pararosaniline solution, and 1 mL of formaldehyde solution. Stored that solution for 3 minutes in a dark place. Measured the photometric absorption at 550 nm using spectronic 20 D.

Calibration curve

0.1, 2, 4, 6, 8 and 10 mL of calibration solution were filled up with the absorber solution to 10 mL. Added 1 mL of pararosaniline solution and 1 mL of formaldehyde solution, to each solution. Stored in a dark place for 30 minutes. Measured the photometric absorption at 550 nm of each solution. Put the readings onto graphic paper (Absorption against contents of SO₂). 1 mL of the calibration solution contains 1 µg SO₂. Found the contents of SO₂ in the sample collected using the calibration curve.

Calculations

$$\text{Conc. of SO}_2 = 20 \text{ mL} \times a \times 1000 / X \text{ } \mu\text{g SO}_2/\text{m}^3.$$

a = Contents of SO₂ according to graph in µg/mL.

X = Volume of air drawn through impinger bottles in L.

To give final result, the contents of SO₂ in both impinger bottles were added.

Heavy metals in dust samples

Took 0.2 g of suspended dust into a test tube. Added 2 mL of acids mixture (20% perchloric acid + 80% HNO₃), placed on a hot plate at 110°C and heated to dryness. Added 2 mL HCl and warmed for 5 minutes on a water bath at 90°C. Added 8 ml H₂O and heated for 20 minutes. Allowed to cool and

settle. Read for Pb, Cr, Cd, Cu, Zn and Fe on AAS, using the standard operating parameters [20].

Conclusion

All of the industries, studied release a higher concentration of suspended dust than the permissible level. Paper and Board mills and S. absorbing cotton industry release a higher concentration of CO to the work place environment. SO₂ concentration in the work place environment of all of the industries studied is higher than the permissible limits. Pb is also found in higher concentration in Match Industries, than the national ambient air quality standard. This situation may lead to hazardous results if not checked properly in time.

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