

Effect of Cement Kiln Dust on Some Properties of Soil

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ABSTRACT

The paper present on the physic-chemical analysis of soil samples collected from five different areas of Shree cement factories. Physical and chemical parameters like pH value, organic carbon, water holding capacity, moisture content and heavy metals. Soil was found to be alkaline type and having decreasing pH, organic carbon and heavy metals with the increase of distance. While water holding capacity and moisture content were increases with the increase of distance.

Keywords: Cement Kiln Dust, Heavy Metals, Organic Carbon, Soil pH

I. INTRODUCTION

The cement industry also plays an important role in the imbalances of the environment and produces air pollution hazards Stern¹. It also causes the pollution in soil where cement industries are located. The particles of cement dust can enter into soil in the form of dry, humid or occult deposits and can alter its physical-chemical properties Ahiamadjie *et al.*²

In this paper report the study of soil parameters of pH, organic carbon, water holding capacity, soil moisture content and heavy metals of Shree cement industrial area in Ajmer city (Rajasthan) India.

II MATERIAL AND METHODS

2.1 Soil analysis

The samples of cement kiln dust polluted soil were collected within 2 km periphery of Shree Cement Plant, Andheri Devri near Beawar, Ajmer.

Soil sample from 3 different depths (surface, 20 and 30 cm) were collected from the study sites during rainy seasons. The samples were carefully labeled and were brought to the laboratory in the polythene bags. A part of soil sample was analyzed immediately for moisture content and remaining was spread out in large enamel trays for air drying.

After air drying the bigger lumps were broken in a mortar and passed through 2 mm sieve, mixed thoroughly and stored in well labeled polythene bags for further analysis.

2.2 Determination of soil pH

The pH of the soil samples was measured by addition of enough distilled water to soil samples in a soil: water ratio of 1: 2 (20 g soil in 40 ml water). For measurement of pH, a digital pH meter was used.

2.3 Estimation of water holding capacity

The soil samples was powered and dried in an oven at 105⁰ C for 24 h. The weight of the circular soil cylinder (internal diameter of 5.4 cm and a height of 12.7 cm respectively) was noted initially (W₀) and a circular filter paper (what man no. 1) was placed inside the perforated bottom of the cylinder. The cylinder was filled with the dried soil and again the second weight of the cylinder was noted (W₁).

The cylinder was placed in a petridish of 10 cm diameter containing water, for about 12 h to enable the water that enters the cylinder and saturate the soil. The cylinder was taken out, wiped on the outer surface and the final weight (W₂) was noted.

$$\text{WHC (\%)} = \frac{(W_2 - W_0) - (W_1 - W_0)}{(W_1 - W_0)} \times 100$$

W₀= Weight of the empty cylinder (g)

W₁= Weight of the cylinder with the dried soil (g)

W₂= Weight of the cylinder with the saturated soil (g)

2.4 Determination of soil moisture content (%) -

The soil sample were collected and the initial weight (I) was noted. The soil was dried and weight was noted (F). The moisture percentage was calculated using the formula as follows:-

$$\text{Moisture content (\%)} = \frac{I - F}{I} \times 100$$

Where,

I= initial weight of the soil sample (g)

F= final weight of the dried soil sample (g)

2.5 Determination of Organic carbon [Walkey and Black's 1934, rapid titration method]

1 gm of accurately weighted soil was transferred to 500 ml erlenmayer flask. To this 10 ml of Potassium dichromate was added followed by 20 ml of concentrated Sulphuric acid. The flask was swirled for one minute and was kept it

for about 30 minute for digestion to take place. Then 200 ml of water, 10 ml of 85% Phosphoric acid and 1 ml of diphenylamine indicator (0.5 g of diphenylamine dissolved in mixture of 100 ml concentrated Sulphuric acid and 20 ml water) solution, were added and titrated with Ferrous sulphate from the burette until the solution turned purple or blue. The titration was continued slowly until the colour changed to bright green to which 0.5 ml of 1N Potassium dichromate was added and completion of titration was achieved by adding Ferrous sulphate drop by drop until the last trace of blue colour disappeared. The amount of Carbon oxidized was expressed as a percentage of the soil using the formula-

$$\frac{V_1 - V_2}{W} \times 0.003 \times 100$$

Where,

V_1 = volume of 1N Potassium dichromate solution (ml)

V_2 = volume of 1N ferrous sulphate (ml)

W = Weight of the soil taken (g)

Total Organic carbon = oxidisable organic carbon $\times$ 1.33

% Organic matter = oxidisable Organic carbon $\times$ 2

2.6 Determination of Heavy metals

Heavy metal was also analyzed in cement kiln dust polluted soil with AAS method at the Indian beauru of mines (IBM) Parbatpura, Ajmer.

III. RESULTS

The types of soil available in Rajasthan are mostly sandy, saline, alkaline and chalky (calcareous) clay, loamy, black lava soil and nitrogenous soils are also found. Four districts of Dausa, Tonk, Jaipur and Ajmer are watered by river of banas and its tributaries and thus the fertile soil sustains mixed xerophytic and mesophytic vegetation.

Soil characteristics- The physico-chemical characteristics of the soils of investigated area are presented in tables 1 and 2.

- i. **Soil pH-** Data of the pH analysis of different soil samples are given in table. It is varied from 7.00 to 9.00 at study area. Hence soil was found to be alkaline type and having decreasing pH with the increase of distance. Soil pH level is higher (9.00) in upper surface of 1 km distance at cement factory.

- ii. **Organic carbon** – Result shown in table. The data clearly showed gradual decrease in organic carbon content from 1.25 to 0.75 in the soil in accordance to distance from the cement factory. Organic carbon % was higher (1.50) in upper surface of 1km distance at cement factory.
- iii. **Water holding capacity and moisture content**- The results are shown in table water holding capacity (21.5 to 43.14) and moisture content (3.36 to 8.19) were increase with increase distance from factory.
- iv. **Heavy metal content in soil**- the concentration of Zn, Cr, Pb and Ni in sampled soils from cement factory site is shown in table. The highest and lowest metal concentrations were recorded at the cement factory sites, respectively. The highest concentration of Zn (156 ppm), Pb (110 ppm), Cr (131 ppm) and Ni (39 ppm) in soil was obtained in upper surface at cement factory.

IV. DISCUSSION

The effect of such deposition affects the growth and biochemical characteristics of field crops have also been widely studied Prasad & Inamdar³ and Prasad *et al.*⁴ The deposition of cement kiln dust in large quantities around cement factories cause changes in soils physical and chemical properties Asubiojo⁵ & Saralabai⁶.

Parthasarathy *et al.*⁷ observed the physical properties of soil exposed to cement kiln dust fall out and observed a decrease in water holding capacity and pore space and an increase in thermal conductivity and specific heat. Amos *et al.*⁸ analyzed that the cement dust which high calcium has impacted the soils by increased soil pH, calcium carbonate, total base saturation and pH dependent cation exchange capacity (CEC). Similar observations were reported by Vyas⁹ in a study assessing some soil physico-chemical characteristics of unpolluted and cement dust polluted soil samples. It is apparent from the data pH, organic carbon; Calcium and Magnesium concentration, specific conductivity was higher in polluted soils over those of control ones. However, nitrate level and water holding capacity were lower in the polluted samples.

Khamparia *et al.*¹⁰ observed samples were indicated that due to effect of cement dust pollution, The content of heavy metal like lead and cadmium increased in soil. Due to the deposition of cement kiln dust emerging out of the cement plant, in the surrounding of the cement plants effected the concentration of various plant nutrients content accumulation of heavy metal in soil. It also affected the physico-chemical properties of the soil. The accumulation of heavy metals may be hazardous to the soil, animal, plant. The significant effects were concentrated within the distance of 1km from the cement plant. Physicochemical characteristics determined were soil metals content (Fe, Cd, Cu, Pb, Ni and Zn). The levels of all the metals except Zn were higher within the factory than in the control, Cr, Fe, Pb and Ni were significantly higher in all localities than in control. Stanley *et al.*¹¹ similar results were observed by Holban *et al.*¹² analyzed parameters for soil were cadmium, copper, chromium, nickel, lead, zinc, manganese and petroleum products content. The concentration level of heavy metals in soil has indicated that the cement industry together with the traffic emission were mainly responsible for metal pollution in that respective area. Micheal *et al.*¹³ the samples were obtained at random distances round the factory and were analyzed by atomic absorption

sepectrophotometer. It was found that zinc; copper and lead have the highest level in areas close to the cement factory in site 1, 2 and 3 while the concentration of cadmium remained low.

V. CONCLUSION

Cement dust, in reason of its physic-chemical properties, could be considered as a major air pollutant in the locality where cement plants are situated. The presence of high quantity of alkaline and heavy metals in cement dust can affect not only soil but also human and plants life.

VI. ACKNOWLEDGEMENT

Authors are thankful to Principal, S.P.C. Govt. College, and Dr. Anshuma Kumar, Head, Department of Botany for providing Laboratory facility for work and Guide, Dr. Suman Parihar for her critical suggestions and proper guidance during the study and UGC for financial assistance.

Table-1. Physico-chemical characteristics of soil at various sites and depths (rainy season) at shree cement Ltd. Beawar (Ajmer)

S.NO.	sites	depths	W.H.C. (%)	Moisture content (%)	Soil pH	Organic carbon (%)
1.	Near factory area	surface	21.5	3.36	8.70	1.25
		20 cms	28.1	4.70	8.50	1.15
		30 cms	30.0	4.90	8.49	1.9
2.	½ km	surface	20.1	3.30	8.32	1.21
		20 cms	25.5	4.45	7.96	1.13
		30 cms	28.2	4.60	7.59	1.04
3.	1 km	surface	17.8	2.50	9.00	1.50



		20 cms	22.5	4.30	8.01	1.20
		30 cms	24.1	4.50	8.00	0.97
	2 km	surface	20.50	3.03	8.03	1.30
		20 cms	29.5	4.49	7.93	1.18
		30 cms	32.5	4.78	7.92	0.99
	3 km	surface	27.83	3.65	7.49	1.12
		20 cms	35.38	7.75	7.38	1.08
		30 cms	43.14	8.19	7.00	0.75

Table-2. Heavy metal content (ppm) in soil-

S.NO.	Sites	Depths	Pb (ppm)	Ni (ppm)	Cr (ppm)	Zn (ppm)
1.	Near factory area	surface	110	39	131	156
		20 cms	54	06	40	72
2.	½ km	surface	62	29	52	113
		20 cms	40	11	51	76
3.	1 km	surface	51	08	29	131
		20 cms	38	12	44	77

4.	2 km	surface	60	21	38	112
		20 cms	34	19	49	65
5.	3 km	surface	104	20	Trace	106
		20 cms	51	27	32	81

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