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TO STUDY THE LEACHING BEHAVIOR OF COAL ASH

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ABSTRACT

The coal is the main source of Thermal power plant and co ash is the waste product of that thermal power plant. The present paper deals the leaching characteristics of coal ash and soil residues from Eklahare thermal power plant coal ash pond, Maharashtra, India. These coal ash consist of various toxic elements. These elements have greater tendency to leach out from the solid phase and display subsequent enrichment in conc. from coal to bottom ash. When coal ash comes in contact with water, the alkaline elements present on its surface will dissolved rapidly and move into solution. When this solution percolate through ground water and create a problems like ground water contaminants and land pollution. This study is useful to overcome such a problem. The aim of this work is to study the ground water contaminants due to disposal of coal ash in surface water source which disrupts the aquatic life, whereas toxic metals leached from coal ash can contaminate soil, ground water and surface water. Therefor it is important to predict the leaching behavior of residues to prevent the environmental effect.

Keywords: Coal ash, Soil, Leachate, Column leach test, AAS.

I.INTRODUCTION

Coal is a main source of energy in thermal power plant and its consumption is predicted to increase in the future in order to meet the continuous demand for electric power generation. Due the fast growing rate of industrialization the use of coal also increases to generate the electricity, coal combustion waste products have become significant sources of environmental pollution due to their leachable toxic behavior of elements. Fly ash and bottom as from coal thermal power plants are known to contain several toxic elements, which can leach out from the ash and contaminate soils, surface water and groundwater. Therefore, these elements may become a hazard to the environment because of their contribution to the formation of toxic compounds, if the ash is not utilized or disposed of properly. This contamination could affect to health, environmental and land-use problems.

Coal-based thermal power plants all over the world face serious problems of handling and disposal of the ash produced. The high ash content (35–45%) of the coal in India makes this problem more serious. At present, about 75 thermal power stations produce nearly 100 million tonnes of coal ash per annum. Safe disposal of the ash without adversely affecting the environment and the large storage area required are major concerns. Hence

attempt the utilization of fly ash rather than disposed it. The coal ash can be utilized in various engineering applications such as construction of embankments, as a backfill material, as a sub-base material, etc. For this, an in-depth understanding of the physical and chemical properties, and engineering and leaching behavior are required. In India, at present, the major portion of coal ash goes to disposes instead of utilized. The utilization rate (13%) is far below the global utilization rate (25%) [21]. Due to minute particle size and presence of potentially toxic elements. Some heavy metals leach out of the ash Coals and contaminate the soil, surface and ground water.

The present study was undertaken to evaluate the leaching behavior around eklahare thermal power plant coal ash pond. For this purpose, long term leaching study was conducted to understand leaching pattern with respect to trace toxic elements by column leach test. Leachates from the column set up were also regularly monitored weekly and determine the relationship between leaching behavior with the properties of soil and coal ash.

II. MATERIALS AND METHODS

Eklahare Thermal Power Station (ETPS) is a coal fired power plant having 5 generation units which was selected as the study area. The coal which is used is import from Mahanandi, Orrisa. It has the installed capacity of 880 mw.It is located around 474 hectare area and it is operated by Maharashtra State Power Generation Company (Mahagenco).The test for determination of physical properties, p^H value and engineering properties coal ash and different soil sample around eklahare thermal power plant in accordance with the relevant standard. Chemical analysis of coal also done with the relevant standard. The following tests also conducted in the study:-

1) Specific Gravity Test (ASTM D854-06)
2) Grain Size Distribution Analysis (ASTM D422-63)
3) Field density by core cutter method (ASTM D6938-15)
4) Permeability by varying head method(ASTM D2434-68)
5) Chemical Analysis (ASTM C618-93)

Table 1. Chemical composition of coal ash

Sr. No.	Constituent	Coal ash (%)
1.	Silica (SiO2)	67.40
2.	Alumina (Al2O3)	19.44
3.	Iron Oxide (Fe2O3)	8.5
4.	Calcium Oxide (CaO)	2.7
5.	Magnesium Oxide (MgO)	0.45
6.	Sulphur (SO3)	0.30
7.	Loss of Ignition	3.46

Table 2. Physical properties of sample

Sr. No.	Properties	Coal Ash	Soil
1.	Specific Gravity	2.16	2.24
2.	Field density	1.66 g/cc	1.4 g/cc
3.	Permeability	1.78 x 10^{-5} cm/s	1.46 x 10^{-5} cm/s
4.	Grain size distribution Sand % Silt % Clay %	 72 28 NIL	 55.4 42.8 12

III. EXPERIMENTAL PROCEDURE FOR LEACHING TEST

Column leach test:- The column leach test is the more realistic analysis of metal leaching from coal ash soil mixtures. The test set up more closely studied the field behavior compared to any other test. Column leach test are conducted with continuous percolation of water causing a constant increase in L:S ratio. The coal ash was set in the bottom of a plastic pipe and water penetrates by gravity and the pressure of 150 mm or 180 mm head water. Diameter of the pipe was 28 mm or 56 mm. run the leaching experiment using columns with different p^h values like acidic or basic .Columns made of 50 ml were set up on ring stand. The column leaching apparatus; two different layers of contaminated soils and coal ash of different height ratios are taken.

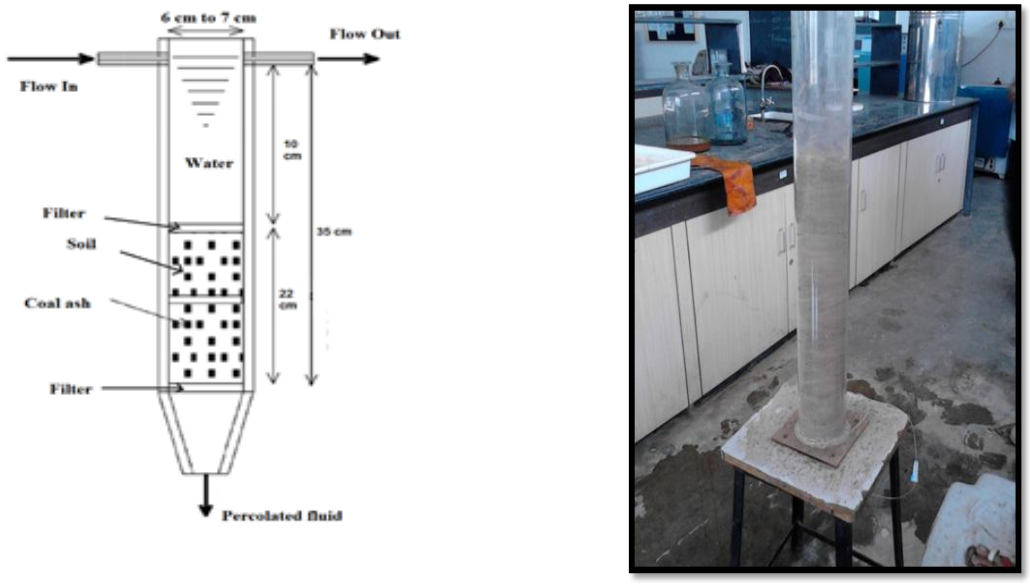

Fig. 1- Cross section of column leach test

The two layers of gravel insert between each two layer which is act as filtration medium. Water is poured from an overhead tank at a particular flow rate to the inlet of the soil column for a certain ponding depth over the contaminated sample of coal ash. Subsequent infiltration causes leaching and the leachates are collected from

the bottom of the column. Total height of column has 3 different parts as; H1: Height of the ash layer. H2: Height of the contaminated soil layer. H: Height of the water layer above the soil layer which may be termed as ponding depth.(M.K.Tiwari 2015) collect the leachate and perform heavy metal analysis with the help of atomic absorption spectrophotometer.

IV. OBSERVATIONS

Table 2. Heavy metal concentration leached during First week of the month

Metal	FA-1	FA-2	FA-3	FA-4	FA-5
Zn	ND	1.62	1.4	0.28	ND
Ni	ND	ND	ND	ND	ND
Cu	1.8	1.3	4.0	2.0	2.38
Fe	ND	ND	ND	0.25	1.3
Pb	1.8	ND	ND	0.3	ND
Mn	0.4	0.12	ND	ND	0.15
Mg	11.30	8.95	3.00	2.90	6.60
Cd	ND	ND	ND	ND	ND

Concentration in mg/kg ash, (FA1, FA2, FA3, FA4 FA5 –column leach set upsND- Not detected)

Table 3. Heavy metal concentration leached during Second week of the month

Metal	FA-1	FA-2	FA-3	FA-4	FA-5
Zn	1.45	1.93	2.43	1.28	0.58
Ni	3.3	0.53	2.18	1.05	0.43
Cu	7.75	5.25	11.75	23.25	8.75
Fe	1.95	2.23	2.33	2.03	1.15
Pb	1.2	ND	ND	1.48	ND
Mn	45.26	135.74	140.28	65.77	25.22
Mg	215.32	160.21	280.45	255.14	128.64
Cd	ND	ND	ND	ND	ND

Concentration in mg/kg ash, (FA1, FA2, FA3, FA4 FA5 –column leach set ups ND- Not detected)

Table 4. Heavy metal concentration leached during Third week of the month

Metal	FA-1	FA-2	FA-3	FA-4	FA-5
Zn	0.39	0.52	0.56	0.38	0.21
Ni	0.11	0.14	0.32	0.18	0.03
Cu	0.14	009	0.18	0.72	0.18
Fe	0.5	0.52	0.57	0.53	0.26
Pb	0.004	0.002	0.052	0.007	ND
Mn	0.066	0.25	0.26	0.22	0.151
Mg	0.262	0.202	0.544	0.481	0.183
Cd	0.04	ND	0.008	0.002	ND

Concentration in mg/kg ash, (FA1, FA2, FA3, FA4 FA5 –column leach set ups ND- Not detected)

Table 5. Heavy metal concentration leached during Fourth week of the month

Metal	FA-1	FA-2	FA-3	FA-4	FA-5
Zn	2.4	ND	0.91	0.75	0.67
Ni	ND	ND	0.75	0.45	0.40
Cu	6.8	3.0	0.52	0.57	5.7
Fe	2.1	ND	3.7	ND	1.86
Pb	ND	0.037	ND	2.3	ND
Mn	ND	3.2	2.4	1.9	1.9
Mg	3.45	10.80	19.69	14.93	14.93
Cd	ND	ND	ND	ND	ND

Concentration in mg/kg ash, (FA1, FA2, FA3, FA4 FA5 –column leach set ups ND- Not detected)

V. DISCUSSION OF RESULTS

Leaching behavior is important to predicting the environmental impact of heavy metal analysis of coal ash associated with the disposal of coal ash in to pond. In these study the leachability of heavy metal was determined from the coal ash and soil sample around Eklahare thermal power plant. During these studies, leaching behavior of various heavy metal like Zn, Ni, Cu, Fe, Pb, Mn, Mg and Cd from leachate was studied from the column leach test. The following graphs shows the concentration of heavy metal of various samples taking at the interval of eight days was studied.

Table1. shown Mg and Cu show solubility with water and leached in higher concentration in all samples of coal ash and Soil. The leached Cu concentrations were low in comparison with Mg, this is probably because Cu is

precipitated as their insoluble hydroxides. The Pb is leached out in only two samples to a similar extent, but below permissible limits. Mn is leached only one samples but shows very low concentration.

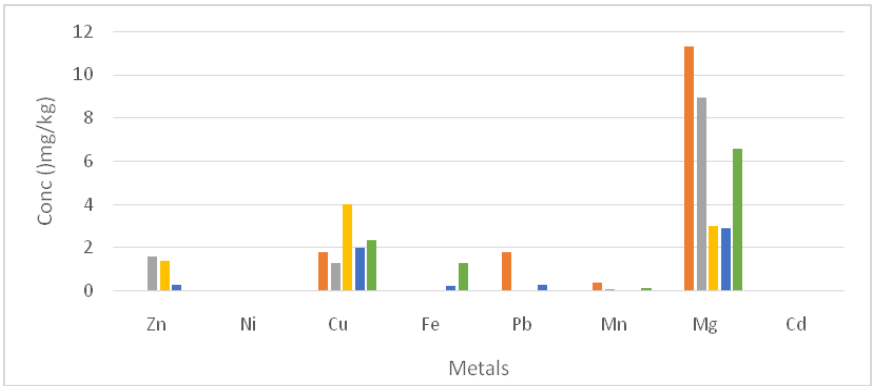

Fig 2. Graphical representation of conc. of metal in first week

Table 2. shown Mg, Mn, and Cu show solubility in weakly acidic medium and were leached at higher amounts in all samples. Cd was insoluble and does not leach out from these samples. Zn, Ni, Fe, and Pb also leached but at very low concentrations.

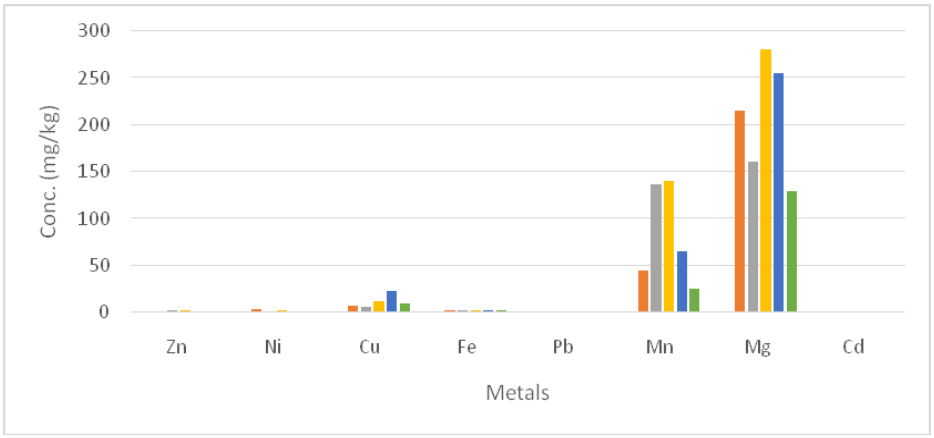

Fig 3. Graphical representation of conc. of metal in second week

Table 3.Shown Mg, Mn, Fe and Zn were leached to a large extent. Cu and Ni were leached to medium level while Pb, and Cd were extracted to lower level in comparison with other heavy metals.

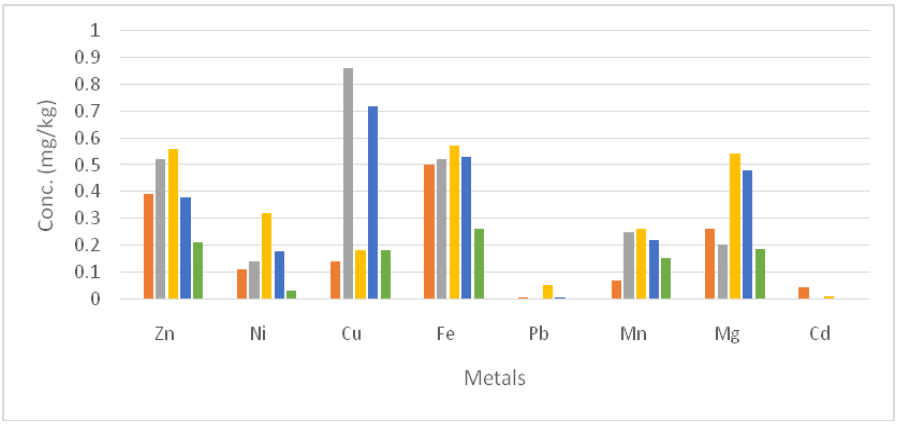

Fig 4. Graphical representation of conc. of metal in third week

Table 4. Shown the concentration of Mg ,Cu and Fe is highly leached. Mn, Zn and Ni leached to a medium level. Cd was insoluble and does not leach out from these samples. Cd gives a small concentration in only one sample.

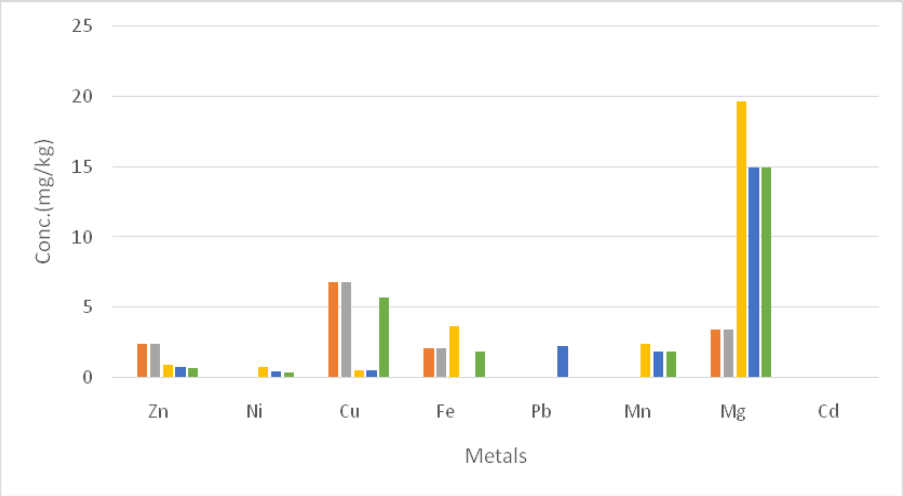

Fig 5. Graphical representation of conc. of metal in last week

VI. CONCLUSION

- As the overall concern for the environment and the need for the safe disposal of fly ash, a strategic approach evolving potential remedial methodologies to mitigate leaching of toxic minerals is designed for ash storage ponds.
- The chemical composition of the soil and fly ash is a key factor in determining leaching behavior by influencing metal availability and speciation.
- From the selected soil sample clay content more up to 42.8% hence, soil is impervious type of soil. As per the analysis result 1.14 x 10-5. For such a type of soil it is expected comparatively low leachate percolation.
- On the basis of the study the leaching concentration of various metals were studied. The concentration of the various metal near the ash pond at the surrounding are within the permissible limit of Indian standard IS 10500.
- The Coal ash samples from Eklahare Thermal Power Plant were found to be environmentally safe for disposal and can be engineered for their bulk utilization in industry and agriculture.

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