Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 8, August -2017

# TO STUDY THE LEACHING BEHAVIOR OF COAL ASH

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**Abstract** — *Coal-based power generation produces over 750 Mt of coal ash per year globally, but under 50% of world production is utilized. Large amounts of fly ash are either stored temporarily in stockpiles, disposed of in ash landfills or lagooned. Coal ash is viewed as a major potential source of release of many environmentally sensitive elements to the environment. This coal fly ash and demonstrates that a large number of elements are tightly bound to fly ash and may not be easily released to the environment, regardless of the nature of the ash. This review provides an extensive look at the extent to which major and trace elements are leached from coal fly ash. It also gives an insight into the factors underlying the leach ability of elements and addresses the causes of the mobility. The mode of occurrence of a given element in the parent coal was found to play an important role in the leaching behavior of fly ash. The amount of calcium in fly ash exerts a dominant influence on the pH of the ash–water system. The mobility of most elements contained in ash is markedly pH sensitive. The alkalinity of fly ash attenuates the release of a large number of elements of concern such as Cd, Co, Cu, Hg, Ni, Pb, Sn or Zn among others, but at the same time, it enhances the release of oxyanionic species such as As, B, Cr, Mo, Sb, Se, V and W. The precipitation of secondary phases such as ettringite may capture and bind several pollutants such ash As, B, Cr, Sb, Se and V.*

***Keywords****- Coal ash, Soil, Leachate***,** Chemical constituents, power plant

## 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. attempt the utilization of fly ash rather than disposed it. The coal ash can be utilized in various engineering application ssuch 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%) 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 leachingbehavior 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, pH 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

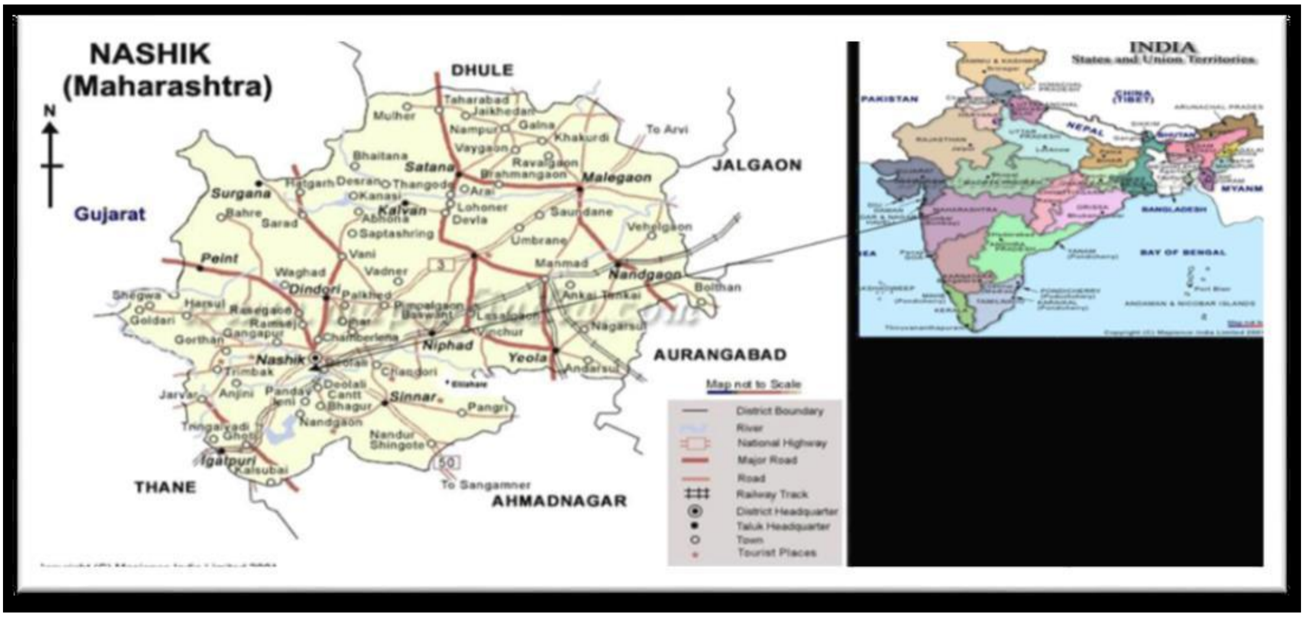


**Photo No.:- 1 Location detail of NETPP**

**Table No:-1 Physical properties of Soil and Coal ash**

| Sr No | Description | Soil sample | Coal ash sample |
|---|---|---|---|
| 1 | Specific gravity | 2.48 | 2.07 |
| 2 | Field density | 1.66g/cc | 1.4 g/cc |
| 3 | Permeability (H/m | 1.14 x 10-5 | 1.785 x 10-5 |

## III. EXPERIMENTAL PROCEDURE FOR LEACHING TEST

### 1.Column Leachate Test

This test method is a standard laboratory procedure for generating aqueous leachate from materials using a column apparatus. It provides a leachate suitable for organic analysis of semi volatile and non-volatile compounds as well as inorganic analyses. The column apparatus is designed and constructed of materials chosen to enhance the leaching of low concentrations of semi volatile and non-volatile organic constituent as well as to maximize the leaching of metallic species from the solid. Analysis of column effluent provides information on the leaching characteristics of material under the conditions used in the test This test method provides for the passage of an aqueous fluid through materials of known mass in a saturated up-flow mode. It is intended that the sample used in the procedure be physically, chemically, and biologically representative of the material.

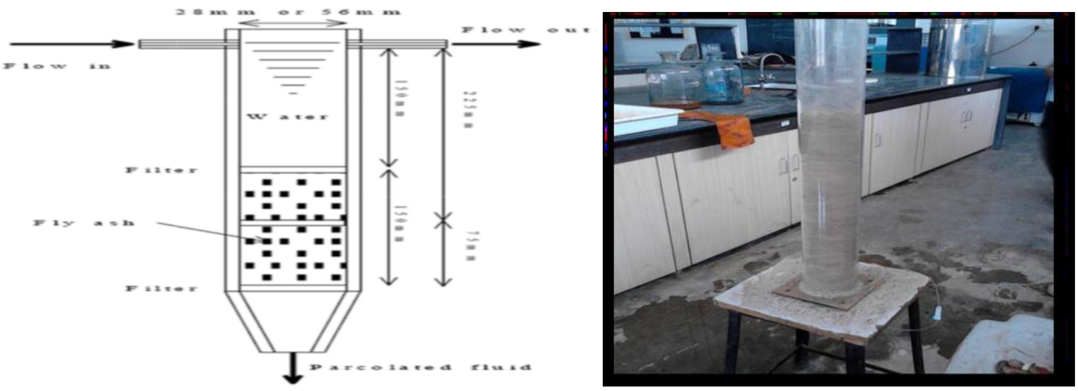


**Fig. 1- Cross section of column leach test**

 

## 2. Heavy Metal Analysis by Atomic absorption spectrophotometer

The high absorption of toxic elements presents in fly ash in the kind of hard metals. Cd, Cr,As, Ni, Pb and Zn are the metals enriched in fly ash, others have intermediate enrichment like Al, Fe, Mn, Mg, Si and V and Ca, Co, Cu, K, have equal amount in the fly ash (Annon, 2002). In the present study relative abundance of total heavy metals in fly ash was planted in order of As, Cu, Cd, Pb and Cr after collection of leachate from column set up using atomic absorption spectrophotometer. Atomic Absorption Spectrometry (AAS) is an analytical technique that measures the concentrations of elements. Atomic absorption spectroscopy can be used to analyze the concentration of over 62 different metals in a solution and is so sensitive that it can measure down to parts per billion of a gram in a sample. The technique makes use of the wavelengths of light specifically absorbed by an element. They correspond to the energies needed to promote electrons from one energy level to another, higher, energy level. Atoms of different elements absorb characteristic wavelengths of light. Analyzing a sample to see if it contains a particular element means using light from that element. For example with lead, a lamp containing lead emits light from excited lead atoms that produce the right mix of wavelengths to be absorbed by any lead atoms from the sample. In AAS, the sample is atomized – i.e converted into ground state free atoms in the vapors state and a beam of electromagnetic radiation emitted from excited lead atoms is passed through the vaporized sample. Some of the radiation is absorbed by the lead atoms in the sample.

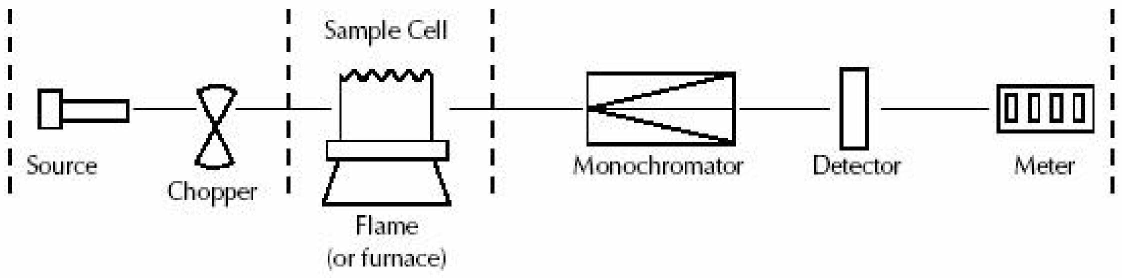


**Fig.2 Mechanism of AAS**

An atomic spectrophotometer consists of light source, a sample compartment and a detector. In this method, light from the source is directed through the sample to a detector. The source of light is lamp whose cathode is composed of the element being measured. Each element required a different lamp.

## 3.Physical Test conducted on soil sample and Coal ash sample

- Specific Gravity
- Grain size distribution
- Field density by core cutter method
- Permeability Test

## 4. Test Conducted On Leachate

- pH
- Turbidity
- Total Hardness
- Chlorides
- Alkalinity
- Total dissolved solids

 

## IV DISCUSSION OF RESULTS

**Table No2. Result of physical properties of coal ash and soil sample**

| Sr. No. | Description | Soil sample | Coal ash sample |
|---|---|---|---|
| 1 | Specific gravity | 2.48 | 2.07 |
| 2 | Sieve analysis<br>Gravel Content<br>Sand content<br>Silt<br>Clay | -<br>-<br>86.6%<br>2%<br>11.2% | -<br>-<br>90.8% (Coal ash)<br>2%<br>7.2% |
| 3 | Field density | 1.66g/cc | 1.4 g/cc |
| 4 | Permeability | 1.14 x 10-5 | 1.785 x 10-5 |

The following tables shows that soil consist of 88.6 % sand and 11.2 % of clay and 2% silt. Coal ash consist of 90.8% ash, 2% silt and 7.2% clay. The ratio of the particle surface area to the volume occupied by the particles, the average particle size, and internal pore structures in the material all control the surface area. Smaller particle sizes produce larger surface area, allowing for increased contact between the solid material and the leaching fluid, resulting in increased contact between the leaching fluid andleachable constituents.

**Leaching Parameters (experimental evidence)**

Most experimental evidence relating to the leaching behavior of leachate obtained from column leach tests. Different types of leaching tests usually gives different results that reflect some aspects of the leaching behavior**.**

**Table No.3 Parameters of (Acidic) leachate collected between 1st jan 30th jan**

| Table No.4.2 Parameters of (Acidic) leachate collected between 1st jan 30th jan Sr.No. | Parameter Sample taken after nth days | **PH** | **Alkalinity (mg/lit)** | **EC (µS/cm) x10³** | **Turbidity (NTU)** x10-1 | **Hardness (mg/lit) x102** | **Chloride (mg/lit) x102** | **TDS** (mg/l) **x103** |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/1/2016 | 3.05 | 102 | 2.88 | 34.87 | 49.221 | 34.52 | 1.02 |
| 2. | 10/1/2016 | 3.84 | 98 | 2.46 | 24.25 | 46.835 | 32.81 | 0.98 |
| 3. | 15/01/2016 | 3.71 | 87.02 | 2.47 | 23.86 | 36.474 | 31.76 | 0.84 |
| 4. | 20/01/2016 | 4.08 | 73.47 | 1.68 | 22 | 3.40 | 27.645 | 0.76 |
| 5. | 25/01/2016 | 4.32 | 54 | 1.27 | 21.07 | 2.79 | 23.732 | 0.35 |
| 6. | 30/1/2016 | 4.55 | 28.25 | 0.72 | 21.05 | 2.38 | 17.376 | 0.21 |

 

**Table No.4 Parameters of (Neutral) leachate collected between 1st jan 30th jan**

| Sr.No. | Parameter Sample taken after nth days | **PH** | **Alkalinity (mg/lit) x101** | **EC (µS/cm) x10³** | **Turbidity (NTU) x10-1** | **Hardness (mg/lit) x102** | **Chloride (mg/lit) x102** | **TDS (mg/l) x103** |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/1/2016 | 6.19 | 22.0 | 3.67 | 31.47 | 11.24 | 94.62 | 1.56 |
| 2. | 10/1/2016 | 6.28 | 20.8 | 3.47 | 28.54 | 10.750 | 84.26 | 1.09 |
| 3. | 15/01/2016 | 6.87 | 19.3 | 2.56 | 28.04 | 9.351 | 72.83 | 0.98 |
| 4. | 20/01/2016 | 7.46 | 16.0 | 2.23 | 25.71 | 8.62 | 32.52 | 0.94 |
| 5. | 25/01/2016 | 7.82 | 17.8 | 1.62 | 16.02 | 5.34 | 12.01 | 0.67 |
| 6. | 30/1/2016 | 8.23 | 17.3 | 1.17 | 15.32 | 5.29 | 11.5 | 0.7 |

**Table No.5 Parameters of (Basic) leachate collected between 1st jan 30th jan**

| leachate collected between 1st jan 30th jan Sr.No. | Parameter Sample taken after nth days | **PH** | **Alkalinity (mg/l) x101** | **EC (µS/cm) x10³** | **Turbidity (NTU)** x10-1 | **Hardness (mg/l) x102** | **Chloride (mg/l) x102** | **TDS (mg/l) x103** |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/1/2016 | 8.55 | 36.8 | 3.86 | 34.87 | 42.827 | 80.732 | 1.07 |
| 2. | 10/1/2016 | 8.42 | 28.3 | 3.70 | 33 | 34.810 | 67.3 | 0.78 |
| 3. | 15/01/2016 | 9.24 | 27.5 | 3.02 | 25.07 | 8.635 | 67.806 | 2.68 |
| 4. | 20/01/2016 | 10.71 | 27.0 | 2.96 | 24.25 | 6.282 | 57.2 | 0.63 |
| 5. | 25/01/2016 | 9.84 | 18.4 | 2.47 | 21.05 | 2.92 | 33.42 | 0.52 |
| 6. | 30/1/2016 | 9.75 | 17.46 | 2.32 | 20.86 | 1.45 | 31.35 | 0.41 |

 

**Table No.6. Parameters of (Acidic) leachate collected between 1st Feb 01th Mar**

| Table No.4.5 Parameters of (Acidic) leachate collected between 1st Feb 01th Mar Sr.No. | Parameter Sample taken after nth days | PH | Alkalinity (mg/l) x101 | EC (µS/cm) x10³ | Turbidity (NTU) x10-1 | Hardness (mg/l) x102 | Chloride (mg/l) x102 | TDS (mg/l) x103 |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/02/2016 | 2.83 | 18.6 | 2.84 | 34 | 12.86 | 87.332 | 1.25 |
| 2. | 10/02/2016 | 3.14 | 18.2 | 2.22 | 32.4 | 11.882 | 75.828 | 0.78 |
| 3. | 15/02/2016 | 3.28 | 17.6 | 2.48 | 25.3 | 11.207 | 72.32 | 0.54 |
| 4. | 20/02/2016 | 3.72 | 14.87 | 2.46 | 24.26 | 8.65 | 52.848 | 0.36 |
| 5. | 25/02/2016 | 3.86 | 12.6 | 2.47 | 26.11 | 6.184 | 54.424 | 0.21 |
| 6. | 01/03/2016 | 4.56 | 12.3 | 1.68 | 22.71 | 6.12 | 53.80 | 0.16 |

**Table No.7 Parameters of (Neutral) leachate collected between 1st Feb 01th Mar**

| Sr.No. | Parameter Sample taken after nth days | PH | Alkalinity (mg/l) x101 | EC (µS/cm) x10³ | Turbidity (NTU) x10-1 | Hardness (mg/l) x102 | Chloride (mg/l) x102 | TDS (mg/l) x103 |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/02/2016 | 6.23 | 23.6 | 2.6 | 36.1 | 74.11 | 52.355 | 0.75 |
| 2. | 10/02/2016 | 6.86 | 18.6 | 2.45 | 26.0 | 52.10 | 46.33 | 0.32 |
| 3. | 15/02/2016 | 6.94 | 16.8 | 2.37 | 24.2 | 48.18 | 35.1 | 0.28 |
| 4. | 20/02/2016 | 7.02 | 15.2 | 2.2 | 23.3 | 4.891 | 31.795 | 0.25 |
| 5. | 25/02/2016 | 7.13 | 14.3 | 2.19 | 14.4 | 4.071 | 25.26 | 0.14 |
| 6. | 01/03/2016 | 7.13 | 13.9 | 2.12 | 13.89 | 3.98 | 24.86 | 0.13 |

**Table No.8 Parameters of (Basic) leachate collected between 1st Feb o1th Feb**

| **Sr.No.** | Parameter sample taken after nth days | PH | Alkalinity (mg/l) x101 | EC (µS/cm) x10³ | Turbidity (NTU) x10-1 | Hardness (mg/l) x102 | Chloride (mg/l) x102 | TDS (mg/l) x103 |
|---|---|---|---|---|---|---|---|---|
| 1. | 5/02/2016 | 5.35 | 24.0 | 3.24 | 34.4 | 30.42 | 49.26 | 1.12 |
| 2. | 10/02/2016 | 8.05 | 20.8 | 2.42 | 24.8 | 18.882 | 22.72 | 1.02 |
| 3. | 15/02/2016 | 8.11 | 19.5 | 2.22 | 21.4 | 12.410 | 21.41 | 0.21 |
| 4. | 20/02/2016 | 9.26 | 18.0 | 2.14 | 16.0 | 18.8 | 3.38 | 0.15 |
| 5. | 25/02/2016 | 9.86 | 16.4 | 2.14 | 15.9 | 18 | 4.38 | 0.09 |
| 6. | 01/03/2016 | 10.02 | 16 | 2.1 | 14.98 | 18.11 | 4.38 | 0.08 |

## V CONCLUSION

From the all results and discussion we can conclude following remarks:-

- 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.
- The average particle size, and internal pore structures in the material all control the surface area. Smaller particle sizes produce larger surface area, allowing for increased contact between the solid material and the leaching fluid, resulting in increased contact between the leaching fluid and leachable constituents.
- If the specific gravity increases then the organic compounds from the soil will be decreases it is the geotechnical application and due to this leaching property will be affected. From the selected soil sample clay content more upto 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.
- From the testing result it is conclude that the properties of water goes on decreasing day by day. Some of the properties are within the limit some of the exceeds the limit so it needs a treatment.
- From the heavy metal analysis it shows that Cd and Pb are leached in higher amount and Cu are leached in low concentration. Cr and As was insoluble and does not leach out from these samples.
- From all the analytical data it is conclude that the high concentration of metal leached in acidic sample as compared to neutral and basic medium.

## VI REFERENCES

1. Afrasiab Khan Tareen, Imrana Niaz Sultan & Pramuk Parakulsuksatid, “Detection of heavy metals (Pb, Sb, Al, As) through atomic absorption spectroscopy from drinking water of District Pishin, Balochistan”, *ISSN: 2319-7706 vol.3 No.1(2014) pp. 299-308*
2. Alaska Community Action On Toxics-www.akaction.org
3. Alper BABA, “Investigation of Geochemical and Leaching Characteristics of Solid Wastes”, from Turk J Engin Environ Sci 25 (2001), 321-328. Yenik¨oy Power Plant.
4. B. Behera And M. K. Mishra, ‘Microstructure And Leaching Characteristics Of Fly Ash-Mine Overburden-Lime Mixtures’, (2008).

5. Balaram Pani, Sidhharth Sirohi, Manjeet Singh Barwa ,'Effect of Seasonal Variation on Metal Speciation in Leachate from a Thermal Power Plant Ash Coal: Impact on Ground Waters, IJESRT October, 2013, ISSN: 2277-9655.
6. Balasubramanian P, Nethaji Mariappan V, Joshua Amarnath D, "A study on re-designing the existing ash storage Coal for leachate control of thermal power station", Indian J. Innovations Dev., Vol. 1, No. 3 (Mar 2012).
7. D. L. Morar, A. H. Aydilek, M. Asce, Eric A. Seagren, 'Leaching Of Metals From Fly Ash-Amended Permeable Reactive Barriers', (2011) Doi:10.1061/(Asce) Ee.1943-7870 .
8. Dhananjay Bhaskar Sarode, Ramanand Niwratti Jadhav, Vasimshaikh Ayubshaikh Khatik, Sopan Tukaram Ingle, Sanjay Baliram Attarde, "Extraction and Leaching of Heavy Metals from Thermal Power Plant Fly Ash and Its Admixtures", Polish J. of Environ. Stud. Vol. 19, No. 6 (2010), 1325-1330.
9. Dr. Diganta Goswami and B. N. Choudhury, 'Chemical Characteristics of Leachate Contaminated Lateritic Soil', IJIRT Vol. 2, Issue 4, April 2013.
10. E. Rouholahnejad, S.A. Sadrnejad,"Numerical simulation of leachate transport into the groundwater at landfill sites",18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009
11. 63
12. F. Abraham Samuel , V. Mohan and L. Jeyanthi Rebecca ,' Physicochemical and heavy metal analysis of sugar mill effluent, 'Journal of Chemical and Pharmaceutical Research, 6(4):585-587, (2014)
13. G. de Gennaro, B.E. Daresta, P. Ielpo, M. Placentino, "Analytical methods for determination of metals in environmental samples", Laboratory of Environmental Sustainability Department of Chemistry - University of Bari.
14. Jason Becker, Ahmet H. Aydilek, "Evaluation of Leaching Protocols for Testing of High-Carbon Coal Fly Ash–Soil Mixtures", J. Environ. Eng. 2013.139:642-653.
15. K. Prakash (2009), "Effect of ash disposal Coals on groundwater quality at a coal fired power plant", Water Research, 21(4), 417-426.
16. Kandarp K.S, Lokeshappa B., D. A. Kulkarni, A.K. Dikshit,' Metal Leaching Potential In Coal Fly Ash', American Journal Of Environmental Engineering. 2011; 1(1): 21-27.
17. Lokeshappa B. And Anil Kumar Dikshit, 'Fate of Metals In Coal Fly Ash Coals', International Journal Of Environmental Science And Development, Vol. 3, No. 1, February 2012.
18. Luminiła Popescu and Mihai Cruceru, "Assessment of heavy metal content and leaching characteristics of ash from a coal-fired power plant in Romania," ISBN: 978-960-474-328-5.
19. M. A. Ashraf et al, "Chemical Speciation And Potential mobility Of Heavy metals In The Soil Of Former Tinmining Catchment", The Scientific world Journal Volume (2012), Article Id 125608, 11 pp.
20. M. Vítková, V. Ettler, J. Hyks And T. Astrup, 'Assessment Of The Leaching Behaviour Of Fly Ash From A Cobalt Smelter, Zambia', Third International Symposium on Energy from Biomass and Waste Venice, Italy; 8-11 November 2010
21. Maria Izquierdo and Xavier Querolb, "Leaching behavior of elements from coal combustion fly ash: an overview", Institute of Environmental Assessment and Water Research, Jordi Girona 18-26 (2012).
22. Masatomo Nakayama, Keijiro E. And A.K 'Behaviour of Landfill Leachate Permeating Into Soil And Effects Of Ph And CEC', Sustain. Environ. Res., 20(5), 299-303 (2010). 22. N. S. Pandian, 'Fly Ash Characterization With Reference To Geotechnical Applications' J. Indian Inst. Sci., Nov.–Dec. 2004, 84, 189–216 (2004).

 