ANALYSIS OF HEAVY METALS IN POND ASH SAMPLES FROM HARYANA

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Abstract- This study reports the heavy metal content of three thermal power plant pond ashes from inflow and outflow point. Heavy metal analyses of these ashes were studied by standard leaching tests, namely TCLP-1311 procedure. The ashes were analyzed for the presence of Co, Mn, Zn, Cu, Ni, Pb, and Cr and detectable levels were found in all pond ash samples. In the current study, the concentration of Ni, Pb, and Cr elements are the quite higher side in all ash samples than the limit value of the inert material, but lower concentration than the limit values of non-hazardous materials for waste acceptance criteria and satisfying the landfill regulation criteria.

Index terms- Inflow point, Outflow point pond ash, Leaching Test

I. INTRODUCTION

A large quantity of fly ash and bottom ash is produced by thermal power plants (TPPs) as a by-product. About 80% of the coal ash is in the form of fly ash and rest being bottom ash [1]. For disposal purpose these two types of ashes are mixed with water and transported in the lagoons, results into the ash deposit are called pond ash. The process of slurry deposition causes segregation of ash mixture. Coarser and heavier particles of ash, settle down near the inflow point. Finer and lighter ash particles are carried away and settle near the outflow point [2], [3]. Pond ash requires a large disposal area and creates environmental problems like leaching and dusting. Due to the presence of potentially toxic elements like arsenic, chromium, boron, vanadium, and antimony, coal ash has been considered hazardous for living organisms. Some heavy metals leach out of the ash ponds and contaminate the soil, surface and ground water [4]. The bulk utilization of coal ash is possible in civil engineering projects such as building material (brick, cement concrete, etc.), land and mine fill, construction of roads and embankments, etc. [5]. For any of the above possible uses of ash, the material needs to be considered for environmental safety which is an important parameter [6]. The present study reports the selected heavy metal content of pond ash of three thermal power plants from inflow and outflow point situated in Khedar, Panipat and Yamunanagar, Haryana, India, and compares it to the permissible limit values of waste acceptance for land filling stated in the Annex 2 of the 2003/33/CE Council Decision (based on 1999/31/EC Directive) [7] and ash from other parts of the world.

II. MATERIALS AND METHOD

A. Sample Collection
The pond ash used in the present study was collected from three coal-based thermal power plants of Haryana, India i.e. Khedar, Panipat, and Yamunanagar from inflow and outflow points. Location map is shown in Figure 1. The sample collected from Khedar, Panipat, and Yamunanagar ash ponds are designated as KP, PP, and YP respectively. Inflow and outflow samples are marked with ‘I’ and ‘O’ accordingly.

![Fig. 1 Location Map of Thermal Power Plants in Haryana](image1)

Photograph of inflow and outflow location in a Yamunanagar thermal power plant ash pond is shown in Figure 2.

![Fig. 2 Inflow and an outflow point from Yamunanagar ash pond](image2)
B. Heavy Metal Analysis

The collected samples were tested for the following elements—cobalt (Co), manganese (Mn), zinc (Zn), copper (Cu), nickel (Ni), lead (Pb), and chromium (Cr) at Sophisticated Analytical Instruments Laboratory, Thapar Institute of Engineering and Technology University, Patiala. The standard test method, namely toxicity characteristic leaching procedure (TCLP)-1311 was used to investigate the leaching behavior of the ash samples. For the preparation of leachate solution, 500 ml of distilled water was acidized with 5.7 ml of glacial acetic acid. Further, 1(N) NaOH was added to the solution and the final solution was made to 1 liter by adding additional distilled water. During this process, the pH value of this solution was maintained at 4.94. The crushed sample of 100 g was added to this solution (acetic acid–NaOH buffer solution) in a 2-liter polyurethane bottle. After that, for TCLP test, 1 liter of appropriate solution was added into the bottle. Then, the bottle was horizontally shaken at 30 rpm in an oscillating shaker for 18 h at 25°C. After shaking, the mixture was allowed to settle for 5 min, and then the liquid phase was decanted known as leachate. The pH of the leachate was determined immediately after collection. The leachate was filtered through a 0.45 mm filter paper by vacuum filtration system. The sampling bottle was preserved in order to avoid the volume change and evaporation. Elements concentration in the leachate was determined by using MP-atomic emission spectrophotometer (MP-AES).

III. RESULTS AND DISCUSSIONS

A. Heavy Metal Composition

Results for the heavy metal analysis of inflow and outflow ash samples are presented in Table 1 along with the permissible limit values of waste acceptance for land filling stated in Annex 2 of the 2003/33/CE Council Decision (based on 1999/31/EC Directive) [7].

<table>
<thead>
<tr>
<th>Sample</th>
<th>Co (mg/kg)</th>
<th>Mn (mg/kg)</th>
<th>Zn (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Ni (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Cr (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>inflow</td>
<td>&lt;3.0</td>
<td>4.07</td>
<td>1.90</td>
<td>&lt;0.5</td>
<td>&lt;1.0</td>
<td>&lt;1.0</td>
<td>&lt;3.0</td>
</tr>
<tr>
<td>outflow</td>
<td>&lt;3.0</td>
<td>3.88</td>
<td>1.22</td>
<td>&lt;0.5</td>
<td>&lt;1.0</td>
<td>&lt;1.0</td>
<td>&lt;3.0</td>
</tr>
</tbody>
</table>

Further, Table 2 presents the concentration of heavy metal in ash samples as per literature (mg/kg).

<table>
<thead>
<tr>
<th>Sample/Source</th>
<th>Co (mg/kg)</th>
<th>Mn (mg/kg)</th>
<th>Zn (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Ni (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Cr (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greece [8]</td>
<td>NR</td>
<td>213.33</td>
<td>59.6</td>
<td>31.8-62.8</td>
<td>NR</td>
<td>173-143</td>
<td>110-16</td>
</tr>
<tr>
<td>Spain [9]</td>
<td>29.2</td>
<td>324.6</td>
<td>221.3</td>
<td>71.8</td>
<td>87.9</td>
<td>52</td>
<td>134.2</td>
</tr>
<tr>
<td>UK [10]</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>17-176</td>
<td>NR</td>
</tr>
<tr>
<td>India [12]</td>
<td>ND</td>
<td>0.5</td>
<td>3.5G</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>India (average) [14]</td>
<td>23.6</td>
<td>388.91</td>
<td>NR</td>
<td>100</td>
<td>150</td>
<td>35</td>
<td>120</td>
</tr>
</tbody>
</table>

NR—Not Reported

A study of Table 1 further reveals that the concentration of Co is <3.0 mg/kg in all ash samples and concentration of Mn is ranged between 1.85-4.07 mg/kg and 2.39-3.71 mg/kg for inflow and outflow ash samples, respectively, but there is no permissible limit is provided by EC Directive. The concentration of Zn and Cu are found within permissible limits as prescribed by the EC Directive.
1 and 2, it is observed that concentrations of reported heavy metals in ash samples from Haryana, India are much lesser than the average for India and other countries samples.

CONCLUSIONS

Inflow and outflow pond ash samples of three thermal power plants in Haryana were used in the present study. The heavy metal analysis of some selected elements, such as Co, Mn, Zn, Cu, Ni, Pb, and Cr has analyzed under TCLP 1311 method. Based on the findings and discussion mentioned above, the following conclusions can be drawn:

- In all the ash samples, concentration of Ni, Pb and Cr are within permissible limit of non-hazardous materials, for waste acceptance criteria.
- Concentration of Ni, Pb and Cr may be higher than the inert limit for waste acceptance criteria.
- The heavy metal concentration in the ash samples from TPPs in Haryana, Indian are very less as compared to average of India and other country samples.

From the study, it can be concluded that the leachate analysis results are useful and enlightening for understanding the mobility of some heavy metals from inflow and outflow pond ash samples. Further, the long-term metal analysis tests are still required to know the behavior of these selected heavy metals for making an adequate assessment. On the basis of results of the present study it can be concluded that there is no potential danger of ground water contamination in dumping the pond ashes in embankment construction of roads/ highways and railways subject to engineering properties.

ACKNOWLEDGMENT

The authors are thankful to Sophisticated Analytical Instruments Laboratory, Thapar Institute of Engineering and Technology University, Patiala for extending the laboratory facility to carry out Leachate analysis.

REFERENCES

