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Research Paper :

Sequential extraction and spectrophotometric estimation of heavy metals from thermal power plant generated coal fly ash and its admixtures

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ABSTRACT

An attempt is made to study the extractability of heavy metals from fly ash generated from Thermal Power Plant which is used as an admixture with cement, brick manufacturing, land filling and in agriculture. From the utilization point of view, it was notable that the total heavy metal concentrations (Cu, Pb, Zn, Ni, Fe, and Mn) in fly ash from a coal-fired power plant were lower than those limit values. A six-stage sequential extraction procedure was used to evaluate the extractability of different elements in fly ash into the following fractions: (1) the water-soluble fraction, (2) the exchangeable fraction (1M $MgCl_2$ at pH 7), (3) Carbonate bound (1M Na-OAC at pH 5), (4) Fe- Mn bounded (0.04M NH_2OH, HCl in 25% acetic acid), (5) Organically bound (0.02 M nitric acid and 30% H_2O_2 at pH 2 and 90^0C, followed by 1.2 M ammonium acetate in 10% nitric acid) and (6) Residual metal ions (HNO_3 and $HClO_4$ acid digestion until dryness).

Key words : Sequential extraction, Fly ash and Heavy metals

In thermal power plant, coal is burnt at temperatures ranging around 1400-1500^0C with about 20% excess air in the furnace. The utilization of flyash is 70% in Australia, 40% in UK, 40% in cement manufacturing in France (Nath, 1997). Actually flyash is extensively used in concrete as an admixture in order to reduce cost of cement. Up to 25% to 30% industrial flyash was successfully blended with ordinary Portland cement without sacrificing strength and durability characteristics (Rao *et al.*, 1999). Moreover, manufacture of Portland cement is a significant contributor of greenhouse gases (Sharma, 2006). With a view to reduction of green house gases, in this study flyash was collected from Bhusawal Thermal Power Plant, for estimation of heavy metals from fly ash admixtures utilized in cement and brick manufacturing. Coal from Bhusawal Thermal Power Plant has been also collected and made it to ash by burning at 1200-1500^0C.

Utilization of solid wastes in activities such as land spreading allows industry to reuse, reduce, and recycle waste as beneficial products. Inorganic materials such as ashes from energy production (especially from coal and peat-fired power stations) and some metallurgical slugs are typical materials with potential for utilization in earthworks. However, according to Wahlstom and Laine-Ylijoki (1996) from the Technical Research Centre of Finland, if inorganic materials and by-products, e.g., wastes, are to be utilized in earthworks, the content of harmful compounds must be low and the harmful components must be tightly bound to the matrix. Before ash residue can be utilized or deposited, according to Steenari *et al.* (1999), its chemical as well as leaching characteristics must be known. The total element concentrations represent a source term only for the unrealistic environmental scenario in which the entire mineral structure of the solid material is dissolved. Thus, measurement of the total concentration of metals provides relatively misleading information for assessing the bioavailability and mobility of metals. In order to estimate the real bioavailability of metals and their potential toxicity, it is necessary not only to determine the total concentrations but also the different chemical forms or processes binding the heavy metals to the solid phase of the sample (Albores *et al.*, 2000). Extraction tests are widely used as tools to estimate the release potential of constituents from waste materials over a range of possible waste management activities, including recycling or reuse, for assessing the efficacy of waste treatment processes, and after disposal (Kosson *et al.*, 2002). Sequential extraction tests are designed to treat the material with different solutions, resulting in the allocation of constituents into separate fractions. Such an approach gives information on which chemical conditions are needed to obtain different extraction efficiencies. Extraction is a procedure that is widely applied to the extraction of elements from various environmental samples such as soil, sediment, airborne particulate matter, sludge, and waste (Filgueiras *et al.*, 2002). Extraction does not necessarily mean total decomposition, and the extractable recoveries of analyte are generally lower than the total concentrations. Recoveries can only reach the total values if an element is completely soluble in the extraction