ABSTRACT

Combustion of coals in thermal power plants is one of the major sources of environmental pollution due to generation of huge amounts of ashes, which are disposed off in large ponds in the vicinity of the thermal power plants. Indian coals are characterized by very high ash content (~55 wt %), thus resulting in the generation of large amounts of fly ash (~100 million tonnes per annum). This ash is disposed off by the wet disposal method in large ponds, which are located near the power plants. Since the thermal power plants and the ash ponds are located in densely populated areas, there is potential chance for contamination of soil and groundwater of the surrounding areas from the toxic trace elements and radionuclides in the ash. The Kolaghat Thermal Power Plant, at Mecheda, West Bengal is one of the largest thermal power plants of Eastern India. The discarded ash of the power plant presents a source of environmental pollution to the surrounding areas.

Geochemical, mineralogical and radiometric analysis of the feed coal, pond ash, water and soil have been carried out to assess the contamination of the soil and the groundwater system. The feed coal of the power station consists mainly of quartz, kaolinite and siderite. Major, minor and trace element analyses of the coal document predominance of silica and alumina. Trace elements in the feed coal show both organic and inorganic association. The resulting pond ash is dominantly composed of quartz, mullite and hematite. The pond ash is a Class-F ash (ASTM classification) containing trace elements, including Pb, Cu, Ni, As, Cd, Cr, V, Mo etc which are enriched in the pond ash than their crustal abundances. Radiometric study of the feed coal shows that the average concentrations of ^{232}Th, ^{238}U and ^{40}K are 51.36 Bq kg^{-1}, 38.64 Bq kg^{-1}, and 120.36 Bq kg^{-1} respectively. The average values for activity concentrations of U, Th and K for ash pond 1A is 86.53 Bq kg^{-1}, 160.86 Bq kg^{-1} and 210.74 Bq kg^{-1}, for ash pond 1B is 92.75 Bq kg^{-1}, 170.86 Bq kg^{-1} and 211.25 Bq kg^{-1}, ash pond 4A is 92.64 Bq kg^{-1}, 188.12 Bq kg^{-1} and 211.38 Bq kg^{-1} and for ash pond 4B is 90.92 Bq kg^{-1}, 169.56 Bq kg^{-1} and 211.00 Bq kg^{-1}. Radionuclides (U, Th) also show enrichment of 3-5 times in the coal ash as compared to their crustal average and are much higher than in the pond ashes of other thermal power stations of India.

Groundwater samples have also been collected from the tube wells located near the ash ponds and analysed for pH, TDS and trace elements. Results of the chemical analysis show high values of TDS and high concentration of the trace elements (Al, Ni, Fe, As, Zn, Co, V, Mo, Ba, Rb, Pb, Cr, Cu, Cd, Mn and Sr) whose distribution is mainly controlled by the ash deposited in the area. Among these elements Al, As, Zn, Mo, Ba, V, Cd, Mn, and Pb show higher concentration in the tube well waters near the ash pond than those of the neighbouring villages implying significant input from the ash pile. The enrichment of these elements above WHO guidelines for drinking water denotes significant contamination of the groundwater from the toxic elements leached from the ash pile. Radon analysis of the water samples shows enhance levels of ^{222}Rn in the waters samples, much higher than the guideline set by USEPA (1991) for drinking water.

DC resistivity studies conducted in and around the ash disposal sites of Kolaghat Thermal Power Plant in West Bengal, shows that the subsurface lithology as determined from the Vertical Electrical Sounding curves consists of alternate layers of clay and sand upto a depth of 60m. All the sounding locations show a general thin top layer of ash of high resistivity mixed with coarse sand or clay followed by a 29-50m thick layer of wet clay of very low resistivity. The lowermost layer is sandy clay to clayey sand in all the cases. The low resistivity values of the intermediate clayey layer along with the high values of TDS and high concentration of the toxics imply that the contaminant zone lies at a shallow depth of 29-50m thick, is formed due to leaching of the toxics from the top sandy layer and adsorption in the clayey layer.

Chemical and radiometric analysis of the top soils and the soils collected from the different depth profiles surrounding the ash ponds, show that the top soils are enriched in the trace elements Mo, As, Cr, Mn, Cu, Ni, Co, Pb, Be, V, Zn, which show maximum enrichment (2-5) in the top soils collected from all the soil profiles. These elements are also enriched in the pond ash. Since there are no other sources of industrial effluents, it can be said that the enrichment of the trace elements (Mn, Co, Mo, Cr, Cu, Pb, Zn, As, Ni, Be, V) is attributed to their input from ash from the disposal pond. Radionuclide study of the top soil samples show that the average activity concentrations of ^{238}U, ^{232}Th and ^{40}K in the top soils from the four soil profiles around the ash ponds 1A, 1B, 4A and 4B are 64.13 $Bqkg^{-1}$, 106.79 $Bqkg^{-1}$ and 216.52 $Bqkg^{-1}$, 86.39 $Bqkg^{-1}$, 104.01 $Bqkg^{-1}$, 215.24 $Bqkg^{-1}$, 90.43 $Bqkg^{-1}$, 121.61 $Bqkg^{-1}$, 219.74 $Bqkg^{-1}$ and 74.38 $Bqkg^{-1}$, 116.99 $Bqkg^{-1}$ and 219.74 $Bqkg^{-1}$ respectively. The background soil samples on the other hand show 37.70 $Bqkg^{-1}$, 54.52 $Bqkg^{-1}$ and 79.67 $Bqkg^{-1}$ of activity of ^{238}U, ^{232}Th and ^{40}K respectively. The enrichment factor of U and Th in the surface soils as compared to their crustal abundances are 1.9 – 2.5 for U and 2.2 –2.5 for Th respectively.

Combustion of coal thus cause significant amount of soil and groundwater contamination from the trace elements and radionuclides in the ash. An attempt has been made in the present study to evaluate the total gamma dose rates in air at 1m above the ground surface at each of the sample location points from each of the ash ponds. The average absorbed gamma dose rates at 1m above the ground from the ash ponds of Kolaghat due to the presence of ^{232}Th, ^{238}U and ^{40}K is 160 nGy h^{-1} which is ~4 times higher than the world average (43 nGy h^{-1}) as reported by UNSCEAR (2000). The absorbed dose from the top soils around the thermal power plants is 115nGy/h which is 2.6 times higher than the world average. Hence the population around the ash ponds are subjected to higher collective doses due to continuous disposal of ash for years.