ANALYSIS OF FLY-ASH SAMPLES OF COAL FIRED POWER PLANTS USING GAMMA RAY SPECTROMETER

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ABSTRACT

Suratgarh super thermal power station, Suratgarh and Guru Nanak thermal power station, Bathinda are the two potential sites selected for the study of radionuclides in fly ash samples using gamma-ray spectrometer. The activities of K-40, Ra-226 and Th-232, (in Bq/Kg.) are 98.5, 29.0 and 120.2 respectively for Suratgarh thermal power plant and 96.5, 25.0 and 123.0 respectively for Bathinda power plant. The absorbed dose rate (nGy h^{-1}) obtained for Suratgarh power plant is 90.10 and for Bathinda power plant is 89.86 .The effective dose rate (mSv y^{-1}) in case of former is 0.110498 and for latter is 0.110204. Radium equivalent activity (Ra_{eq}) and External hazard index (H_{ex}) are calculated for by-products to assess the radiation hazards arising due to the use of fly ash in the construction of dwellings. The values of Ra_{eq}.(Bq/Kg) and H_{ex} for Suratgarh thermal power plant are 208.4 and 0.5624 respectively and for Bathinda thermal power plant are 208.2 and 0.5610 respectively. These results are below safe use values.

I. INTRODUCTION

In India coal fired thermal plants produce around 69,616 MW of electricity which is 54.1% of the total electricity produced in the country. Coal, when burnt in power plants, mainly produces two type of solid wastes namely fly ash and bottom ash. Bottom ash is the coarse –grained material which is collected at the bottom of boiler and is disposed off to a nearby ash pond (waste disposal site). Due to lack of sophisticated emission control devices, most of the fly ash is released into the atmosphere. Since the ash produced is used for variety of purposes viz. production of cement and bricks, so it is essential to study the radiological characteristics of its components. The radiological hazards of fossil fuels were first studied by Eisenbud and Petro [1]. Although many studies are going on across the nation and world [2-5] on the radioactive hazards of fly ash emitted from various coal fired thermal plants, yet data for Suratgarh Super Thermal Power Station, Suratgarh (Raj.) and Guru Nanak Thermal Power Station, Bathinda (Pb.) are not available. So the activities of K-40, Ra-226 and Th-232 (in Bq Kg^{-1}) present in the fly ash samples have been studied in this context using γ -ray spectrometer. Along with this the absorbed dose rate (nGy h^{-1}), effective dose rate (mSv y^{-1}), Radium equivalent activity (Ra_{eq}) as well as External hazard index (H_{ex}) are calculated for the by products to assess the radiation hazards arising due to the use of fly ash in the construction of dwellings.

II. LOCATION OF SITES

Guru Nanak Thermal Power station is located on Bathinda- Malout road, Bathinda (Punjab) and Suratgarh Thermal Power Station is located at Village Raiyanwali which is 4 Km distant from Suratgarh Tehsil, Distt. Sri Ganganagar (Rajasthan)

III. EXPERIMENTAL

The samples were collected and stored in polythene bags. They were dried in an oven for 24 hrs. at 60^0 C to remove moisture. They were then kept in radon impermeable containers and were stored for 40 days before counting for Ra and Th daughter products to attain radioactive equilibrium. The activities of K-40, Ra -226 and Th-232 were calculated using γ-ray spectrometer at D.R.D.O. Lab, Jodhpur (Rajasthan). The detector consisted of NaI (Tl) crystal coupled to a 5x4 inch photomultiplier tube. A 256 channel data set covering the energy range 0-4 KeV was attached to detector. The energy reason for K-40, Ra-226, Th 232 and were 1.46 MeV, 1.76 MeV, 2.6 MeV and 0.662 MeV respectively. The standard samples were prepared by mixing Pthalic acid powder obtained from BARC Lab. Mumbai. The samples were counted for about 200 to 400 Min. The absorbed gamma dose rates for the uniform distribution of radionuclides (K-40, Ra-226 and Th-232) were calculated on the basis of directions given by UNSCEAR [3]. Conversion factor to transform specific activities A_k, A_{Ra} and A_{Th} of K, Ra and Th respectively, in absorbed dose rate at 1 m above the ground (in nGy h^{-1} by Bq Kg^{-1})are calculated by Monte Carlo method and the values are [6].

$$D(nGy\ h^{-1}) = 0.0417\ A_k + 0.462\ A_{Ra} + 0.604\ A_{Th}.$$

The annual effective dose rate is calculated using the formula

$$\text{Effective dose rate } (mSv\ y^{-1}) = D\ (nGy\ h^{-1}) \times 8760\ (h\ y^{-1}) \times 0.2 \times 0.7\ (Sv\ Gy^{-1}) \times 10^{-6}$$

where the conversion coefficient from the absorbed dose in air to the effective dose (0.7 Sv Gy^{-1}) and the outdoor occupancy factor (0.2) as proposed by UNSCEAR are used.

About 83.59% of the fly ash and bottom ash of these thermal plants is used for the production of dwelling materials such as cement and bricks , so in order to assess the radiological hazard of fly ash, the radium equivalent (Ra_{eq}) and external hazard index (H_{ex}) are calculated using the relation given by Beretka and Mathew [7].

$$Ra_{eq} = A_{Ra} + 1.43\ A_{Th} + 0.077\ A_K$$

$$H_{ex} = A_{Ra}/370 + A_{Th}/259 + A_K/4810$$

Where A_{Ra}, A_{Th} and A_K are the activities of Ra-226, Th 232 and K 40 in Bq Kg^{-1} respectively. For safe use , the values of Ra_{eq} should be less then 370 Bq Kg^{-1} and that of H_{ex} should be equal to unity.

IV. RESULT AND DISCUSSION

The various data pertaining to above study are presented in the following table. These results reveal that the activities of K-40 and Ra 226 (Bq Kg^{-1}) in the samples of Suratgarh power plant are higher as compared to Bathinda power plant.

Site of sample collection	Activity concentrations of Radio Nuclides (Bq Kg^{-1})			Absorbed dose rate (nGy h^{-1})	Effective dose rate (mSv yr^{-1})	Ra_{eq} (Bq Kg^{-1})	H_{ex}
	K-40	Ra 226	Th 232				
Suratgarh Super Thermal Power Station	98.5	29	120.2	90.10	0.110498	208.4	0.5624
Guru Nanak Thermal Power Station	96.5	25	123	89.86	0.110204	208.3	0.5610

The absorbed dose rate (nGy h^{-1}) for Suratgarh power plant exhibits higher value as compared to Bathinda power plant .The effective dose rate (mSv y^{-1}) in case of the former is 0.110498 and for the latter is 0.110204. Lastly , a glance at the values of Ra_{eq} (Bq Kg^{-1}) and H_{ex} reveals that these are greater in the samples of Suratgarh power plant than for Bathinda power plant . But the results in either case are below safe use values i.e below unity.

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