

Review Article on Radionuclides in Fly Ash

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ABSTRACT— To examine the awareness of evidently happening radioactive cloth particularly, uranium awareness in fly ash, samples had been amassed from Guru Nanak Dev Thermal Plant, Bathinda, Punjab, India and Suratgarh Super Thermal Power Station, Suratgarh, Rajasthan, India for the duration of 2010 to 2012. Samples had been processed the usage of ICP-MS (Inductively coupled plasma – mass spectrometry) with multi-detail standards. A most and minimal awareness of uranium (4.ninety nine mg.kg-1 and 0.sixty three mg.kg-1) turned into recorded in fly samples amassed from SSTP, Suratgarh. Further, effects had been determined to be very alarming and unique movement can be taken to save you the exploration of uranium to the human being, stay shares and herbal vegetations. However, this turned into a touch attempt, and in addition take a look at on this course is recommended. Concentration of cesium turned into determined in permissible stage as records given through WHO however Uranium awareness is excessive in the ones area.

Keywords— fly ash, ICP-MS, Thermal plant, uranium, WHO.

I. INTRODUCTION

NORM is an acronym for Naturally Occurring Radioactive Material, which probably consists of all radioactive factors observed withinside the surroundings. However, the time period is used extra specially for all evidently happening radioactive substances, wherein human sports have multiplied the capacity for publicity in comparison with the unaltered situation. These factors have usually been gift withinside the Earth's crust and atmosphere, and are focused in a few places, together with uranium ore our bodies which can be mined. Coal is essentially composed of natural depend, however it's miles the inorganic depend in coal—minerals and hint factors— which have been referred to as viable reasons of fitness, environmental, and technological troubles related to the usage of coal. Some hint factors in coal are evidently radioactive. Recently, NORMs of fly ash and backside ash generated in lignite-fired

electricity flora in Kosovo had been analyzed the use of a gamma-ray spectrometry approach for the pastime attention of herbal radionuclide (F. Hashmi, 2014). Increased hobby in measuring evidently happening radionuclide concentrations in coal and fly ash is because of the attention of fitness dangers and of those substances contributing to environmental pollution (J. Tadmor et al., 1986). These radioactive factors encompass uranium (U), thorium (Th), and their severa decay products, which include radium (Ra) and radon (Rn). Although those factors are much less chemically poisonous than different coal elements together with arsenic, selenium, or mercury, questions were raised regarding viable danger from radiation. Natural radioactivity relies upon often at the geological and geographical conditions, and looks at one of a kind ranges withinside the soils. The combustion of coals releases herbal radioactive factors withinside the shape in their oxides to the surroundings studied in Jharkhand, (Tripathi et al,2013) located that the content material of the radionuclide withinside the soil, FA and crop produce is in the permissible limits. In evaluation to this, Sahu et al., (2014) studied that fly ash and backside ash incorporates to 5 instances extra herbal radionuclide's than feed coal. The pastime concentrations and the gamma-absorbed dose fees of the terrestrial evidently happening radio nuclides viz. ^{226}Ra , ^{232}Th and ^{40}K had been decided in soil samples amassed from twelve oil fields and their host groups, the use of gamma ray spectrometry. The soil pastime tiers from 10.10 to forty one.23 Bq/kg for ^{226}Ra , 7.forty two to 30.31 Bq/kg for ^{232}Th and 92.forty two to 482.seventy nine Bq/kg for ^{40}K with suggest values of 19.16, 21.26 and 224.29 Bq/ kg, respectively for host network soil. In the sector soil sample, the pastime attention tiers from 16.27 to 52.19 Bq/kg for ^{226}Ra , nine.seventy two to 34.thirteen Bq/kg for ^{232}Th and 134.50 to 395.15 Bq/kg for ^{40}K with suggest values of 29.61, 17.forty one and 262.sixty three Bq/kg, respectively.(G.O.Avwiri, C.P. Ononugbo, 2012). The attention of the NORM in soil and sediment samples amassed from

Ogba/Egbema/Ndoni oil fields and their host groups changed into measured with the aid of using figuring out the gross alpha and gross beta pastime attention in twelve oil fields and their host groups with the aid of using the use of fueloline go with the drift proportional counter (EURISYS MEASURE-IN-20 low historical past a couple of channel alpha/beta counter). The gross alpha pastime attention in host network soil tiers from BDL to 2590.zero±34.0Bqkg-1 with an average price of 289.16±7.zero Bqkg-1. While the gross beta pastime attention tiers from 1660.zero±27.0Bqkg-1 to 206,600.00±1906.0Bqkg-1 with an average price of 22690.zero±104.0Bqkg-1.(Avwiri,G.O. and Ononugbo, C.P, 2014) Concentrations of uranium-238 and thorium-232 in soil samples amassed from a place of excessive historical past radiation in Malaysia had been decided the use of neutron activation analysis (NAA). U-238 attention in soil ranged from four.nine mg kg(-1) (58.eight Bq kg(-1)) to forty.four mg kg(-1) (484.eight Bq kg(-1)), Th-232 attention ranged from 14.nine mg kg(-1) (59.6 Bq kg(-1)) to 301.zero mg kg(-1) (1204 Bq kg(-1)).(Ramli,et al, 2005). Recently, excessive precision uranium isotopic measurements are in speedy system the use of multi-color inductively coupled plasma mass spectrometry (MC-ICP- MS) (R.

Parrish et al, 2006 and Yang Lu, 2009). On publicity to the surroundings and people with the aid of using concentrating the portions of evidently happening radiation past everyday historical past ranges, EPA(2005) on environments, fitness and protection on line said that the extra radiation dose someone receives, the extra the threat of growing cancer, leukemia, eye cataracts, erithemia, hematological despair and occurrence of chromosome aberrations. This might not seem till a few years after the radiation dose is received (typically, 10-forty years). By viewing this stuff in mind, a observe were done, to correctly cope with those questions and to are expecting the mobility of radioactive factors throughout the coal fuel-cycle. Moreover, it's miles essential to decide the attention, distribution, and shape of radioactive factors in coal and fly ash.

II. MATERIALS AND METHODS

The Study Area:

Two thermal sites viz., Guru Nanak Dev Thermal Plant (GNDP) Bathinda of Punjab and Suratgarh Super Thermal Plant (SSTP) of Rajasthan, India were selected representing the rural areas with sparse vegetation.

Table 1. Sites selected for the study in Punjab and Rajasthan, India.

| Character | Suratgarh Super Thermal Power Station, Rajasthan | Guru Nanak Dev Thermal Plant, Bathinda, Punjab |
|---------------------|--|--|
| Altitude | 167 meters above sea level | 210 meters above sea level |
| Climate | It is having extreme hot and cold climate. Temperature, 50°C to -1°C | Climate correspond to semi arid with high variation between summer and winter temperatures |
| Physiographic units | Dry valley | Indo gangatic alluvial plains |
| Latitude, Longitude | 29.32N, 73.9E | 30.2N, 74.59E |

Source: Falling Rain Genomics, Inc. 1996-2010

Sample Collection and Preparation
 Different fly ash samples had been amassed randomly from Guru Nanak Dev Thermal Plant, Bathinda (Punjab) and Suratgarh Super Thermal Power Station, Suratgarh (Rajasthan) and had been processed to decide the uranium attention. Analysis of Uranium became achieved with the aid of using ICP-MS. These fly ash samples had been amassed from outside and inside elements of thermal plant and ash dickeria (wherein fly ash stored) from each

vegetation and uranium attention had been analyzed. High purity water became acquired with a Millipore Milli-Q water purification system. Fly ash is first off air dried after which oven dried at 200°C for 2 days after which samples are acid digested and Analysis became achieved with the aid of using ICP-MS as in keeping with well known protocol defined with the aid of using Jorhem and Engman, 2000. Preparation of samples for evaluation For general elemental evaluation,

samples are acid digested (2 Nitric Acid: 1 Perchloric Acid) at 100°C in warm plate and in addition analyzed thru ICP-MS. The heavy metals and Uranium requirements used had been of ICP-MS grade (Merck) (Jorhem and Engman, 2000) after which samples are 4-acid digested that allows you to dissolve maximum silicate minerals. This digestion is performed in open vessels on a warm-plate. Fly ash samples are acidified with conc. nitric acid earlier than evaluation to make sure balance and comparison with calibration requirements and analyzed with the aid of using ICP-MS approach. Estimation of Uranium attention in fly ash: ICP-MS approach is used for evaluation of uranium in fly ash samples amassed from GNDP, Bathinda and SSTP, Suratgarh. It is a multielement analytic method. It has very low restrict of detection this is in ppb (elements in keeping with billion) or under for stable and answer samples. Samples are added into argon plasma as aerosol droplets. The plasma dries the aerosol, dissociates the molecules, after which eliminates an electron from the components, thereby forming singly-charged ions, that are directed right into a mass filtering tool called the quadrupole mass spectrometer. In this situation 10 ml of the acidified fly ash samples became taken. The samples had been run on a Argon plasma or aerosol droplets in ICP-MS. Background and requirements counts had been additionally cited to calculate the performance of the instrument. The outcomes had been calculated in ppb unit. Similarly, A.R. Roper, et al, 2013, at the same time as examined the samples of coal fly ash, flue fueloline desulfurization, gypsum and scrubber sludges, fixated scrubber sludges, and waste water clear out out desserts from more than one coal-fired

electricity vegetation withinside the United States, determined that fly ash from bituminous and sub bituminous coals had U precise sports various from 30-217 Bq kg (mean + 1 s.d. $119 \pm$ forty five Bq kg) and 72- 209 Bq kg ($115 \pm$ forty Bq kg), respectively. In an some other look at of E. Charro and V. Pena , 2013, concentrations of six herbal radionuclide's had been decided in coal, ash, mine wastes and sediments with the aid of using gamma-ray spectrometry.

III. RESULT AND DISCUSSION

Mean uranium concentration in fly ash sample was found to be high in GNDP, (Bathinda) as compared to SSTP, Suratgarh (Rajasthan). Maximum uranium (4.99 mg.kg⁻¹) was recorded in fly ash sample collected from inside Suratgarh thermal plant while minimum value (0.63 mg.kg⁻¹) was found from outside thermal plant. However, it was seen that the sample contain large concentration of uranium, which is harmful for human beings. Uranium concentration ranges from 0.63-4.99 mg.kg⁻¹ in thermal plants. E.Charro et al, 2013, confirmed that the almost non- existent radioactive risk posed by the presence of the Coal-fired power-plants, which may be a source of contamination because the coal contains trace amounts of natural radionuclide's, such as (40)K and (238)U, (232)Th and their decay products. These radionuclide's can be released as fly ash from the CFPP and deposited from the atmosphere on the nearby top soils, therefore modifying the natural radioactivity background levels, and subsequently increasing the total radioactive dose received for the nearby population.

TABLE 3: DETERMINATION OF CONCENTRATIONS OF URANIUM AND CESIUM IN FLY ASH SAMPLE

| | PLACE | MEAN VALUE OF NORM CONCENTRATIONS | |
|-----------------|---------------------------|-----------------------------------|-------------------------------|
| | | URANIUM (MG.KG ⁻¹) | CESIUM (MG.KG ⁻¹) |
| GNDTP, BHATINDA | INSIDE THERMAL PLANT | 1.6 ± 0.04 | 0.3 ± 0.011 |
| | ASH DYEKERIA | 1.42 ± 0.02 | 0.17 ± 0.011 |
| | OUTSIDE THE PLANT (5 KM) | 1.49 ± 0.05 | 0.26 ± 0.005 |
| | OUTSIDE THE PLANT (10 KM) | 1.62 ± 0.127 | 0.3 ± 0.017 |
| | OUTSIDE THE PLANT (15 KM) | 1.45 ± 0.02 | 0.17 ± 0.011 |

| | | | |
|-----------------|--|-------------|-------------|
| SSTP, SURATGARH | INSIDE THERMAL PLANT | 1.38 ±0.028 | 0.15 ±0.005 |
| | ASH DYKERIA | 4.99 ±0.202 | 0.75 ±0.011 |
| | OUTSIDE THE PLANT (5 KM) | 1.35 ±0.311 | 0.15 ±0.028 |
| | OUTSIDE THE PLANT (10 KM) | 0.7 ±0.167 | 0.1 ±0.017 |
| | OUTSIDE THE PLANT (15 KM) | 0.63 ±0.098 | 0.09 ±0.023 |
| | * DATA REPRESENTS THE MEAN VALUE OF TEN REPLICATIONS | | |

Naturally going on radioactive substances (NORM) are discovered nearly everywhere. NORM is inherent in lots of geological substances and therefore encountered at some stage in geological associated sports. NORM encountered in hydrocarbon exploration and manufacturing operations originate in subsurface formations which could include radioactive substances including Uranium and thorium and their daughter products, ²²⁶Ra and ²²⁸Ra. In fueloline processing sports, NORM commonly happens as radon fueloline withinside the herbal fueloline stream (Ajayi et al, 2009; Mokobia et al. 2006). Radioactive tracers had been utilized in comparing the powerful of nicely cementing and underground water and crude oil waft course for the reason of correlation (Ajayi et al, 2009). Concentration of NORM specifically uranium is analyzed with the aid of using ICP-MS method in water samples gathered from Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station, Suratgarh. The Uranium awareness changed into withinside the variety of 0.769ppb to 76.499ppb. Sewerage water of Guru Nanak Dev Thermal Plant, Bathinda has most uranium that is 76.499 ppb or 0.076mg/l and minimal uranium in Drinking water 0.769ppb. (Brijesh, Pathak and Bindu Khatri,2012). The awareness of the NORM and gross alpha pastime awareness of soil and plant samples from villages to udaipur and their host groups changed into measured with the aid of using Alpha Counting System, Nucleonix, Hyderabad. The gross alpha pastime for soil and plant samples are withinside the variety of 48-477 Bq kg⁻¹ on dry weight basis. In vegetation most gross alpha pastime (477Bq kg⁻¹) changed into discovered in Coriandrum sativum. In soil samples, most gross alpha pastime (821 Bq kg⁻¹) changed into discovered in pattern no. US VI-6S (Jatropha curcus) and minimal (303 Bq kg¹) in Diospyros cordifolia at US VI-2S site. (B. Pathak and A. Pathak, 2012). Co- composting of sewage sludge and coal fly ash has been an powerful manner to convert the fly ash into nutrient wealthy product. However those methods do now no longer make

use of a main part of the ash and accordingly thermal electricity stations ought to manipulate its storage, even as maintaining the tiers of air and water pollutants related to it to a minimal. To triumph over this, diverse feasible strategies for the secure disposal and reuse of fly ash had been envisaged with the aid of using extraordinary researchers, of which the composting manner has acquired a selected interest (Bhattacharya and Chattopadhyay, 2004). In a few cases, diverse quantities of radioisotopes are injected with the secondary healing flooding fluids to facilitate waft. In Nigeria and different countries, many research had been achieved at the radioactivity matrices (Tchokossa, 2006, Ajayi et al, 2009, Diad et al, 2008, Al-Masri and Suman 2003; Isinkaye and Shitta, 2010 and Fatima et al (2008). It has been mentioned that radiation is a part of the herbal surroundings and it's far predicted that about 80% of all human publicity comes from obviously going on radioactive substances. Mineral exploration and manufacturing sports have the capacity to boom the threat of radiate. Somewhat capacity and prospectus of awareness of uranium changed into discovered.

IV. CONCLUSION

The main target of this work was to assess the naturally occurring radioactive material (Norm) content in Guru Nanak Dev Thermal Plant, Bathinda and Suratgarh Super Thermal Power Station. Radioactive elements from coal and fly ash may come in contact with the general public when they are dispersed in air and water or are included in commercial products that contain fly ash. Natural radioactivity is directly related to the kind of geological layers and of their physico-chemical conditions. The overall results showed a gross radiological pollution of the area, which could be detrimental to the health of the general public as continuous exposure can lead to build up of radionuclide in the body which could lead to cancer and other related sicknesses. Therefore, we recommend further studies on radiological burden of the various resources of the area and ascertain

safety measure to limit exposure to these ionizing radiations.

REFERENCES

- [1]. Ajayi, T.R., Torto, N., Tchokossa, P. and Akinlua, A. 2009. Natural radioactivity and trace metals in Crude oils: Implication for health. *Environ Geochem Health*. 31:61-69.
- [2]. Al-masri and Siman. 2003. NORM waste management in the oil and gas industry: the Syrian Experience. *Journal of Radioanalytical and Nuclear chemistry*. 256 (1):159-162.
- [3]. Avwiri, G. O. and Ononugbo, C. P. 2012. Natural Radioactivity Levels in Surface Soil of Ogba/Egbema/Ndoni Oil and Gas Fields. *Energy Science and Technology*, 4(2): 92-101.
- [4]. Avwiri, G.O. and Ononugbo, C.P. 2014. Assessment of naturally occurring radioactive material (NORM) content of hydrocarbon exploration and production activities in OGBA/ EGBEMA/ NDONIOIL/GASFIELD, RIVERS STATE, NIGERIA. *Proceedings of the 1st International Technology, Education and Environment Conference (c) African Society for Scientific Research (ASSR) Human Resource Management Academic Research Society*. (572-580).
- [5]. Bhattacharya, S.S. and Chattopadhyay, G.N. 2004. Transformation of nitrogen during vermin composting of fly ash. *Waste management resources*. 22:488-491.
- [6]. Charro, E. And Peña, V. 2013. Environmental impact of natural radionuclides from a coal-fired power plant in Spain. *Radiat Prot Dosimetry*. 153(4):485-95.
- [7]. Charro, E., Pardo, R., Peña, V. 2013. Statistical analysis of the spatial distribution of radionuclides in soils around a coal-fired power plant in Spain. *J Environ Radioact*. 124:84-92.
- [8]. Diab, H.M., Nouh, S.A., Hamdy, A., & El-fiti, S.A. 2008. Evaluation of Natural radioactivity in a Cultivated area around a fertilizer factory. *Journal of Nuclear and Radiation physics*. 3 (1) 53-62.
- [9]. Environmental Protection Agency (May 22, 2000). "Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels". Federal Register 65, No. 99. p. 32214.
- [10]. Fatima et al, 2008. Measurement of Natural Radioactivity and Dose rate gamma radiation of the Soil of Southern Punjab, Pakistan. *Radiation Protection Dosimetry*. 128 (2):206-212.
- [11]. Hasani, F., Shala, F., Xhixha, G., Xhixha, M.K., Hodolli, G., Kadiri, S., Bylyku, E., Cfarku, F. 2014. Naturally occurring radioactive materials (NORMs) generated from lignite-fired power plants in Kosovo. *J Environ Radioact*. 2014 Dec; 138:156-61.
- [12]. Isinkaye, M.O and Shitta, M.B.O. 2010. Natural Radionuclide Content and Radiological assessment of clay soil collected from different sites in Ekiti state, Southwestern Nigeria. *Radiation Protection Dosimetry*. 139 (4):590-596.
- [13]. Jia, G., Belli, M., Sansone, U., Rosamilia, S., Gaudino, S. 2005. Concentration and characteristics of depleted uranium in water, air and biological samples collected in Serbia and Montenegro. *Appl. Radiat. Isot*. 63, 381.
- [14]. Jorhem, L. Engman, J. 2000. Determination of lead, cadmium, zinc, copper, and iron in foods by atomic absorption spectrometry after microwave digestion: NMKL Collaborative Study. *J AOAC Int* 83:1189-1203.
- [15]. Mokobia et al, 2006. Radioassay of Prominent Nigerian Fossil Fuels using Gamma and TXRF Spectroscopy: *Fuel* 85:1811-1814.
- [16]. Bulut, H. A., & Şahin, R. (2022). Radiological characteristics of Self-Compacting Concretes incorporating fly ash, silica fume, and slag. *Journal of Building Engineering*, 58, 104987.
- [17]. Qaidi, S. M., Tayeh, B. A., Ahmed, H. U., & Emad, W. (2022). A review of the sustainable utilisation of red mud and fly ash for the production of geopolymer composites. *Construction and Building Materials*, 350, 128892.
- [18]. Jain, S., Banthia, N., & Troczynski, T. (2022). Leaching of immobilized cesium from NaOH-activated fly ash-based geopolymers. *Cement and Concrete Composites*, 133, 104679.
- [19]. Zhu, Y., Zheng, Z., Deng, Y., Shi, C., & Zhang, Z. (2022). Advances in immobilization of radionuclide wastes by

- alkali activated cement and related materials. *Cement and Concrete Composites*, 126, 104377.
- [20]. Xie, Y., Zhu, A., Chen, M., Shi, K., Zhang, Q., Peng, G., & Liu, Y. (2022). Effect of alkali activation on coal fly ash and its role in microwave-sintered ceramic for radionuclide immobilization. *Ceramics International*.