J. Myanmar Acad. Arts Sci. 2019 **Vol. XVII. No.2B**

RADIONUCLIDE LEVELS IN COAL ASH SAMPLE DISCHARGED FROM CEMENT FACTORY

Moe Moe Aung[1], Ni Ni Lwin[2]

Abstract

This research work was to analyze the content of radionuclide in coal ash sample which collected from Myanmar Elephant cement factory, Pathein Gyi Township, Mandalay division. The HPGe detector was used for the study of radionuclide in coal ash sample and analyzed by using Gamma Vision-32 software. The radionuclide present in coal ash sample such as Bi-207, U-235, Ac-228, Pb-212, Pb-214, Tl-208, Bi-214 and K-40 were observed. But Bi-207 and K-40 do not exactly present in coal ash sample. The radionuclide (Ac-228, Pb-212, Pb-214, Tl-208 and Bi-214) found in the measured sample was the daughter nuclei of Actinium, Uranium and Thorium series. U-235 is the parent nucleus of Actinium series. It is expected that Actinium, Uranium and Thorium are concentrated in coal ash sample.

Introduction to Coal and Coal Ash

1.1 Coal

Coal is a fossil fuel created from the remains of plants that lived and died millions of years ago. Coal is the most carbon-rich of all fossil fuels and generates 70% more carbon dioxide (CO_2) than natural gas for every unit of energy produced. This carbon dioxide is dangerous to human health and greatly contributes to global warming.

Coal forms when dead plant matter is converted into peat, which in turn is converted into lignite, then sub-bituminous coal, after that bituminous coal, and lastly anthracite. Coal is located worldwide – it can be found on every continent in over 70 countries, with the biggest reserves in the United States, Russia, China and India.

Coal is used to make electricity. The steel and iron industries use coal for smelting metals. Other industries use coal, too. Paper, brick, limestone, and cement industries all use coal to make products.

[1.] Demonstrator, Department of Physics, University of Magway
[2.] Head and Professor (Rtd.), Department of Physics, Yadanabon University

1.2 Coal Ash

Coal ash is the waste left over from burning coal. Coal ash can be breathed into a person′ s lungs and can cause serious respiratory problems. Coal ash can carry heavy metals into water sources, poisoning ground water and drinking water nearby coal dump storage sites.

1.3 Health Effects and Environmental Effects of Coal

Burning coal releases enormous amounts of harmful pollutants into the air and water, with serious health consequences. In the United States, power plant pollution is responsible for 38,200 nonfatal heart attacks and 554,000 asthma attacks each year.

Burning coal can pollute the air. It also produces carbon dioxide and pollutes the air with sulfur dioxide, and nitrogen oxides, all of which can cause respiratory problems.

Burning coal can pollute the water. A single large power plant may require several hundred acres of landfill space to dispose of its coal ash, which causes the destruction of green areas. The pollutants in the coal ash can get into the soil and contaminate ground water and drinking water nearby coal dump storage sites, endangering marine life, poisoning the fish we eat.

Experimental Procedure

2.1 Sample Collection and Preparation for Gamma Ray Detection Method

Coal ash sample was collected from Myanmar Elephant cement factory, Pathein Gyi Township, Mandalay division. 500g of coal ash sample was transferred to plastic container for gamma activity analysis.

2.2 Experimental Set-Up for Gamma Emission Measurement

In gamma ray spectroscopy system, the follow equipment's were included. They were HPGe detector ORTEC (model GMX 10P4- 70- RB-SMN), cooler (model CFG- X- COOL-III- 230), preamplifier (model A257N), fast spectroscopy amplifier ORTEC (Model- 671), high voltage power supply, photomultiplier tube, digital signal processor (DSPEC-LF), a pulse stored multi-channel analyzer (MCA) together with Gamma Vision-32 software installed in PC and data readout devices. The operation voltage for HPGe detector is negative 1500 V dc. The experimental setup is as shown in Figure (3.1).

To reduce a possible background radiation that comes from the environment, lead (Pb) shielding (thickness is 7 cm) was used in this measurement. For present measurement, the sample (500g) was placed in container and measured for about 3 hours. The background spectrum was measured with the same condition. At the end of the counting period, the spectrum that was recorded may be displayed on the screen. The spectra stored in MCA were analyzed by the application of Gamma Vision-32 software. Using the displayed energy information, an unknown radioisotope can be identified radionuclide with activity concentration and a picture of the spectrum and then determined by gross and net area of full energy peak.

2.3 Calculation of Activity

The activity of the coal ash sample was calculated by following equation

$$A = \frac{N_A}{m \varepsilon P_\gamma T} \tag{2.1}$$

Where, N_A = net count rate for sample

m = mass of sample

P_γ = gamma ray intensity

T = counting time (in second)

ε = efficiency of the interest gamma energy

Figure 2.1: Coal Ash Sample

Figure 2.2: The photo of the experimental set up of HPGe detection system

Results and Discussions

3.1 Results

The presence of radionuclide in coal ash sample was investigated with HPGe detector and analyzed using Gamma Vision-32 Software. The radionuclide present in coal ash sample are ^{207}Bi, ^{235}U, ^{228}Ac, ^{212}Pb, ^{214}Pb, ^{208}Tl, ^{214}Bi and ^{40}K. They were found at different energies. The energy spectra of the background and coal ash sample are shown in Figure (3.1) and (3.2). The activity of radionuclide in this sample is also shown in Table (3.1).

3.2 Discussions

The radionuclide present in coal ash sample was collected by the HPGe detector. ^{207}Bi, ^{214}Pb, ^{235}U, ^{228}Ac, ^{212}Pb, ^{208}Tl, ^{214}Bi and ^{40}K were found in the spectrum. But ^{207}Bi and ^{40}K do not exactly present in coal ash sample. They were found at different energies. Also, they have different activities.

(^{214}Pb and ^{214}Bi) are the daughter nuclei of ^{238}U and (^{212}Pb, ^{208}Tl and ^{228}Ac) are the daughter nuclei of ^{232}Th decay series. ^{235}U is the parent nucleus of Actinium decay series.

It was found in the amount of 500g of coal ash sample that high levels of radionuclide and the activity of each radionuclide, is also very much higher than the world standard of average activity. The average specific activity of ^{232}Th and ^{238}U at standard deviations was found to be 39.8 ± 18.8 and 34.4 ± 22.0 Bqkg^{-1} in the typical coal ash sample.

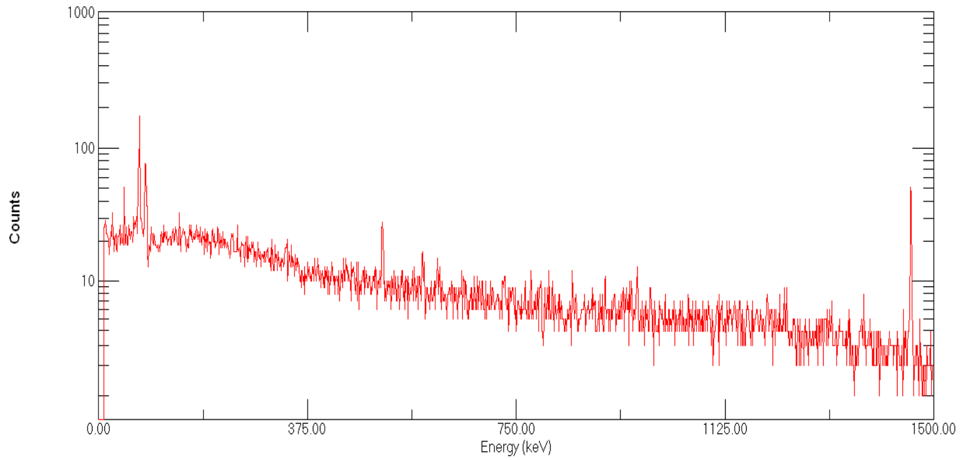

Figure 3.1: The energy spectrum of the background

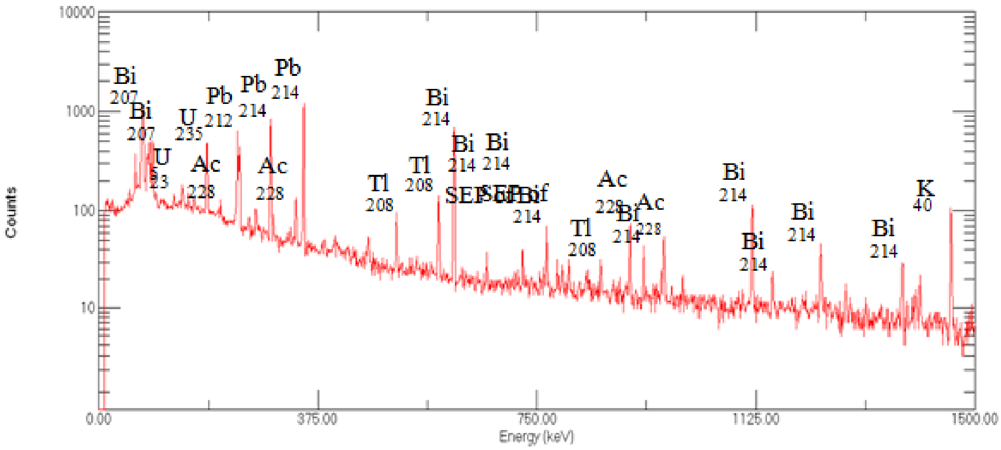

Figure 3.2: The energy spectrum of the Coal ash sample

Table 3.1: The activity of radionuclide in coal ash sample

Sr.No	Radionuclides	Energy(keV)	Activity(Bq/kg)
1	^{207}Bi	74.97	218.59
2	^{207}Bi	87.30	487.29
3	^{235}U	143.76	39.53
4	^{235}U	185.71	61.73
5	^{228}Ac	209.40	112.43
6	^{212}Pb	238.63	113.25
7	^{214}Pb	295.21	486.07
8	^{228}Ac	338.40	117.62
9	^{214}Pb	351.92	501.32
10	^{208}Tl	510.72	119.06
11	^{208}Tl	583.14	38.36
12	^{214}Bi	609.31	478.24
13	^{214}Bi	768.36	716.24
14	^{208}Tl	860.47	160.14
15	^{228}Ac	911.07	68.11
16	^{214}Bi	934.06	599.59

Sr.No	Radionuclides	Energy(keV)	Activity(Bq/kg)
17	^{228}Ac	968.90	143.56
18	^{214}Bi	1120.29	407.41
19	^{214}Bi	1155.19	484.16
20	^{214}Bi	1238.11	478.33
21	^{214}Bi	1377.67	543.27
22	^{40}K	1460.75	849.78

Acknowledgements

Author gratefully acknowledges to Dr Ni Ni Lwin , Head and Professor (Retd.), Department of Physics, Yadanabon University, for her patience, kindness, excellent advice and continuous guidance throughout this research work.

References

A.K. Sam et al., "Radiological Evaluation of Gold Mining Activities in Ariab" Eastern Sudan, (2000).

Bickel L. , "The story of uranium: The deadly element" , Stein and Day, New York, (1979).

Cox P.A., "The elements, their origin, abundance and distribution", Oxford University Press, (1989).

http:// www.nucleide.org/ DDEP WG/ DDEP data.htm.

IAEA-368.

IAEA, Preparation and certification of IAEA gamma spectrometry reference materials RGU-1, RGTh-1 and RGK-1. Report No. IAEA/RL/148, International Atomic Energy Agency, Vienna (1987).

IAEA, Measurement of radionuclides in food and the environment: A guide book. Technical Reports Series No. STI/DOC/10/295, International Atomic Energy Agency, Vienna (1989).

M.Tzortzis et al., "Gamma – ray measurement of naturally occurring radioactive samples from Cyprus characteristic geological rocks", Medical Physics Department, Nicosia (2000).

ORTEC Application Note, "AN-34", Second Edition, USA (1976).

UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) Report to the general assembly. Annex B: exposures from natural radiation sources (2000).