Variation of Mean Radiation Dose with Distance of Sites Proximal to PURECHEM Cement Factory, Onigbedu Ogun State, Nigeria.

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ABSTRACT

Soil samples were collected at various locations around PURECHEM at Onigbedu, which is a cement producing factory in Ogun State, Nigeria. The natural radioactivity concentrations and the mean absorbed doses of ^{40}K, ^{238}U, and ^{232}Th were determined at specified locations. The mean radionuclide concentration corresponding to ^{40}K, 31.2 $\pm$11.7Bq/kg respectively at the selected locations.

It became obvious from present study that the mean absorbed radiation dose decreases with increasing distances from the factory site with the highest mean dose values recorded within 0 to 100m, except at 1000m where a new peak occurred. This present data (on the variation of mean absorbed radiation dose with distance) will constitute a good baseline data and also foster further investigation and future predictions of possible radiation damages or hazards inherent from radiation exposure. However the present results are considerably low and not alarming.

(Keywords: natural radioactivity concentrations, mean absorbed dose, variation, radiation hazards)

INTRODUCTION

The environment is not devoid of radiation exposure arising from sources including cosmic rays, natural radionuclides in water, air, earth, animals and plants; and artificial radioactivity from fallout in nuclear testing and medical applications. The gamma radiation from natural radionuclides and cosmic rays constitute the external exposure while those derived from foods and drinking water constitutes internal exposure to humans (Jibiri et al., 1999). IAEA (1986) estimate of dose contribution in the environment shows that 85% of doses are derived from the natural radionuclides while the remaining 15% is from cosmic ray and nuclear processes.

Over the years, there has been a tremendous increase of industrial establishments for socio-economic purposes, which led to huge releases of various types of materials into the environment contributing to environmental pollution. Environmental pollution has remained a threat and recent challenge following a large increase in industrial concentration. PURECHEM is a major cement factory at Onigbedu adjacent to Ewekoro town which harbors about 50,000 people in Ogun State, southwestern, Nigeria. Ewekoro and its environs are endowed with large deposits of limestone and shale which are the major raw materials in cement production.

Within the vicinity of the cement factory, it has been observed that there is a noticeable whitish solid particle settling on agricultural plants due to accumulation of dust resulting from cement production. This dust has resulted in anxiety anticipated among the area population. Limestone and shale which constitute the major raw materials for cement production are of geological origin and are known to contain some natural radioactive elements. It is postulated that the by-products of cement product may find ways into the soil and the underground water systems; the river and soil surface, hence representing a direct and indirect exposure path ways to man in his environment, through soil to plant to man pathway and water to man. Thus, it was imperative to conduct this study for the evaluation of the natural radionuclide concentrations and mean absorbed radiation doses resulting from this socio-economic activity at selected sites proximal to PURECHEM cement factory.

MATERIALS AND METHOD

Soil samples collected at specific locations from sites around the PURCHEM cement factory were analyzed. The soil samples were dried, pulverized and packed in 200g by mass cylindrical plastic container of radius 6cm and height 6.5cm, which sits on the 7.6cm x 7.6cm NaI(Tl) activated detector with high resolution geometry.

The sealed samples were stored for about 4 weeks to ensure radioactive equilibrium between the parent radionuclide and their gaseous daughter decay products in the uranium and thorium series (IAEA, Schoting et al., 1989). Each sample was counted for 10hrs in a low level gamma counter spectrometer comprising a 7.6cm x 7.6cm NaI (Tl) scintillation detector coupled to a Canberra series 10 plus multi-channel analyzer model No. 802 through a pre-amplifier base. The detector has a resolution of about 8% at 0.662MeV of ^{137}Cs, which is capable of distinguishing the gamma ray energies of the natural radionuclides measured in this study.

The detector was calibrated using certified standard uranium (IAEA/RGU-1) and thorium (IAEA/RGR–1) ores diluted with silica and potassium sulphate (IAEA/RGK-1) salt supplied by IAEA, Vienna, Austria (AQCS, 1995). The standard samples were also counted for 10hrs with the same geometry as the soil samples.

The concentration of ^{238}U estimated from 1.76MeV trainsition line of 2.14MeV Bi, while that of ^{232}Th was estimated from 2.615 MeV of ^{208}Th and gamma energy value of 1.465 MeV was used to determine the concentration of ^{40}K in all the samples.

The background distribution in the environment of the detector was determined by counting an empty sealed container for 10hrs (Abbady et al, 2005).

The radiation dose is calculated using the equation:

$$D = 0.429C_Ra + 0.66C_{Th} + 0.042C_K \text{----- (i)},$$

where,

C_{Ra}, C_{Th} and CK are the activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K respectively in that order.

RESULT AND DISCUSSIONS

The concentrations of potassium, thorium, and uranium with the dose contributions to the environment at selected locations are given in tables (1) and (2), respectively.

The mean dose ranges from 4.0–11.3nGyhr^{-1} with a mean dose of 11.3nGhr^{-1} on the factory site and 4.0nGyhr^{-1} at a distance of 25,000m (2.5km) away from the factory site. However, the trend was a decreasing order with a mean dose of 10.1nGyhr^{-1} at a distance of 1,000m away from the factory site.

The overall mean dose for PURECHEM factory was found to be 8.1nGyhr^{-1}. The mean radionuclide's concentration ranges between 67.0 ± 6.0 and 267.0 ± 39.0 for ^{40}K; 11.0 ± 6.0 and 31.0 ± 9.0 for ^{238}U; and 19.0 ± 6.0 – 48.0 ± 18.0 for ^{232}Th.

CONCLUSION

The radionuclide concentration levels of the primordial natural radionuclides; ^{40}K, ^{28}U, and ^{232}Th proximal to PURECHEM factory have been estimated. Thus, the radiation dose derivable from these radionuclides have been determined the quite low; within a recommended world average of 13.5 – 69.8nGyhr^{-1}.

Table 1: Mean Radionuclides Concentration at Selected Locations away from PURECHEM Factory.

Distance (m)	^{40}k	^{238}U	^{232}Th (Bq/Kg)
0	267.0 ± 39.0	31.0 ± 9.0	48.0± 18.0
50	248.0 ± 37.0	28.0 ± 11.0	47.0± 13.0
100	243.0 ± 40.0	32.0 ± 10.0	44.0± 11.0
150	216.0 ± 31.0	16.0 ± 5.0	37.0± 27.0
300	238.0 ± 27.0	15.0 ± 4.0	42.0± 16.0
500	241.0 ± 37.0	15.0 ± 4.0	42.0± 12.0
1000	234.0 ± 34.0	25.0 ± 9.0	46.0± 20.0
1500	230.0 ± 33.0	38.0 ± 18.0	30.0± 14.0
2500	210.0 ± 30.0	20.0 ± 2.5	41.0± 20.0
5000	224.0 ± 32.0	16.0 ± 7.0	33.0± 15.0
7500	218.0 ± 3.0	14.0 ± 5.0	25.0 ± 7.0
10,000	185.0 ± 12.0	30.0 ± 9.0	29.0 ± 7.0
15,000	150.0 ± 27.0	23.0 ± 17.0	29.0 ± 8.0
20,000	67.0 ± 8.0	68.0 ± 5.0	20.0 ± 6.0
25,000	67.0 ± 6.0	11.0 ± 6.0	19.0 ± 0.6

Table 2: Mean Radiation Doses at Different Locations from PURECHEM site.

Location (m)	Mean Dose (nGy/hr)
0	11.3
50	10.7
100	10.6
150	8.1
300	8.9
500	9.3
1000	102
1500	9.2
2500	8.1
5000	7.6
7500	6.8
10,000	5.5
15,000	7.1
20,000	4.6
25,000	4.0

Hence, there is no cause for alarm with insignificant possibility of health hazards resulting from these values. This constitutes a baseline data and dose estimates at locations adjacent or proximal to PURCHEM factory can be extrapolated.

REFERENCES

1. Abbady, A.G.E., Usifo,M.A.M., Eltaher, A. 2005. "Natural Radioactivity and Dose Assessment for Phosphate Rocks from Wadi. El-Mashash and El-Mahamid Mines". *Egypt, J. Environmental Radiocativity*. 84:65-87.

2. International Atomic Energy Agency (IAEA). 1986. *Facts about Low Level Radiation Exposure*. IAEA Publications: Paris, France. No.A.N.E. 895 – 06482.

3. Jibiri, N.N., Mabawoaku, A.A., Oriade Ujugbedion, C.J.. 2005. "Natural Radionuclide Concentration Levels in Soil and Water around a Cement Factory at Ewekoro, Ogun State, Nigeria". *Journal of Phy*. 5(11):12-16.

4. Schotzing, V. and Derberting, K. 1993. "Photoemission Probabilities per Decay of Ra-226 and Th-232 in Equilibrium with their Daughter Products". *Appl. Radiat. Issot*. 34:533-535.

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