Radiological Impact Survey Of Sites Around Two Cement Producing Factories: Wapco And Purechem, Ewekoro, Southwestern, Nigeria

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ABSTRACT: Soil samples were collected around WAPCO at Ewekoro and PURECHEM at Onigbedu, which are both cement producing factories in Ogun State, Nigeria. The natural radioactivity concentrations are the mean absorbed doses of ^{40}K, ^{238}U and ^{232}Th at various selected locations were determined. The mean radionuclides concentration of ^{40}K, ^{238}U and ^{232}Th were 141.6 ± 21.5, 27.5 ± 9.7 and 31.3 ± 11.1 Bq/l for WAPCO factory at selected sites. Also these values were 179.5 ± 28.3, 21.9 ± 7.6 and 31.2 ± 11.7 Bq/l respectively in the same order for PURECHEM factory at selected locations. The survey revealed that the radiation doses due to natural radio nuclides in the environment under investigation are very low and insignificant to cause any serious health problems to the people living in the area.

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1. INTRODUCTION

Humans are exposed to ionizing radiation from numerous sources in the environment. Among them include the cosmic rays and natural radionuclide sources in air, food and drinking water (NCRP, 1976).

It is well known that a large percentage of human exposure to ionizing radiation comes from natural origin, the major contributors being the naturally occurring radioactive elements of the uranium and thorium series and the non-series radioactive potassium (Farai *et al.*, 2003).

Over the years, there has been an increase of industrial establishments of socio-economic purposes, which has led to the release of different types of materials into the environment thus constituting environmental pollution. With recent trends in increase in industrial concentrations, environmental pollutions has been on the increase and has been of great concern to both international and national development in situations anticipated by the enormous impact of pollution to the ecosystem.

The West Africa Portland Cement Company WAPCO is the largest cement producing company in Nigeria, situated at Ewekoro, town of about 500,000 people in South Western, Nigeria. The town and its environs have the largest deposit of limestone and shale, the major raw materials in cement production. The town is about 30km from Lagos city, the most populated and strong economic base of Nigeria. PURECHEM is another major cement factory at Onigbedu within the same environment both in Ogun State, Nigeria.

These two towns are in constant visit for cement acquisition by companies, thus attracting customers from different parts of the country dominantly due to the developing stage of Nigeria calling for massive construction of broad ranges of physical structures. Within the vicinity of these cement companies, there is a noticeable whitish solid particle settling on agricultural plants, due to accumulation of dust resulting from their production activities. This has created anxiety among the populace in these areas.

It is well known that, a large percentage of human exposure to ionizing radiation comes from natural origin, the major contributors being the naturally occurring radioactive elements of the uranium and thorium series and the non-series radioactive potassium (Farai *et al.,* 2005, Ademola et al, 2010). The two major raw materials in the production of cement, limestone and shale are of geological origin and they are known to contain some natural radioactive elements. It is envisaged that the by-product resulting from the process of cement production may find ways into the underground water systems, the river and may settle on the soil surface, hence, representing a direct and indirect exposure pathways to man in his environment, through soil to plant to man pathway and water to man. The gamma radiation from natural radionuclides and cosmic rays constitute the external exposure while those derivable from foods and drinking water constitute internal exposure to humans (Jibiri et al,1999). Consequently, the evaluation of the concentrations of the natural radionuclides mentioned earlier in selected location around the sites of these two cement factories and their radiation dose contribution to the environment formed the focus of this study.

2. MATERIALS AND METHOD

Soil samples were collected at selected locations from sites around the two cement factories mentioned. The soil samples were dried, pulverized and packed in 200g by mass in cylindrical plastic container of radius 6cm and height 6.5cm, which sits on the 7.6cm x 7.6cm NaI (TL) detector with high geometry. The containers are sealed for about four weeks to ensure radioactive equilibrium between the parent radionuclides and their gaseous daughter decay products in the uranium and thorium series (UAEA, Schotzing *et al.,* 1989). Each of these samples was counted for 10hrs in a low level gamma – counting spectrometer comprising of a 7.6cm x 7.6cm NaI (TL) sanctification detection coupled to a camberra series 10 plus multichannel analyzer model No. 802 through a pre-amplifier base. The detector has a resolution of about 8% at 0.662 Mev 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 the International Atomic Energy Agency (IAEA), Vienna, Austria (AQCS, 1995). These standard sources were counted at the same geometry as the soil samples for 10hrs.

The concentration of ^{238}U was estimated from 1.76 Mev transition line of 2.14Bi, 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. In order to determine the background radiation distribution in the environment around the detector, an empty sealed container was counted for 10hrs (Abbady *et al.,* 2005).

The radiation dose is calculated using the equation:

$$D=0.429C_{Ra}+0.666C_{Th}+ 0.042C_{K} \ldots\ldots\ldots.. \text{(i)}$$

where C_{Ra}, C_{Th} and C_k are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K respectively in Bq/kg. With this equation, the radiation level in an environment can be assessed if within or outside an accepted recommended standard level by regulating authorities.

3. RESULTS AND DISCUSSION

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

From estimates, it is observed that the mean dose decreases with increase in distance from the factory site. For WAPCO site, the mean dose was found to vary with the range 4.0 – 10.4, the highest mean dose of 10.4nGyhr^{-1} was found just at the factory site and found to decrease to 4.0nGyhr^{-1} at a distance of 25,000m (2.5Km) from the factory site. For PURECHEM, almost the same trend was observed with the mean dose ranges from 11.3 – 4.0nGyhr^{-1}. On the factory site, the mean dose is 11.3nGyhr^{-1} and found to be 4.0nGyhr^{-1} at a distance of 25,000m (2.5Km) from the factory site. Whenever, at 1000m, the mean dose increased to 10.2378nGyhr^{-1}, but relatively showed a decreasing trend with distance increasing from the factory site.

The overall mean radiation dose for WAPCO was found to be 7.4nGy/hr while the overall mean for PURECHEM was found to be 8.1nGy/hr.

The mean radionuclides concentration at specific locations from WAPCO ranged between 67.0 ± 6.0 and 257.0 ± 34.0 for ^{40}K, 11.0 ± 6.0 and 68.0 ± 5.0 for ^{238}U and 19.0 ± 6.0 and 42.0 ± 15.0 for ^{232}Th. Whereas for PURECHEM, the radionuclides 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 and 48.0 ± 18.0 for ^{232}Th.

Table 1: Mean radionuclides concentration at specific locations away from WAPCO Factory

Distance (m)	Radionuclide Concentration (Bq Kg^{-1})		
	^{40}K	^{238}U	^{232}Th
0	257.0 ± 34.0	31.0 ± 10.0	42.0 ± 15.0
50	126.0 ± 22.0	28.0 ± 11.0	42.0 ± 9.0
100	207.0 ± 29.0	32.0 ± 11.0	36.0 ± 11.0
150	150.0 ± 26.0	21.0 ± 11.0	38.0 ± 11.0
300	118.0 ± 30.0	21.0 ± 10.0	28.0 ± 12.0
500	168.0 ± 29.0	27.0 ± 8.0	29.0 ± 7.0
1000	108.0 ± 14.0	22.0 ± 5.0	26.0 ± 7.0
1500	76.0 ± 10.0	35.0 ± 14.0	32.0 ± 17.0
2500	86.0 ± 16.0	31.0 ± 13.0	33.0 ± 17.0
5000	185.0 ± 25.0	29.0 ± 15.0	31.0 ± 13.0
7500	173.0 ± 22.0	20.0 ± 5.0	33.0 ± 14.0
10000	186.0 ± 25.0	14.0 ± 5.0	31.0 ± 14.0
15000	150.0 ± 27.0	23.0 ± 17.0	29.0 ± 8.0
20000	67.0 ± 8.0	68.0 ± 5.0	20.0 ± 6.0
25000	67.0 ± 6.0	11.0 ± 6.0	19.0 ± 6.0

Table 2: Mean radionuclides concentration at specific locations away from PURECHEM Factory

Distance (m)	Radionuclide Concentration (Bq Kg^{-1})		
	^{40}K	^{238}U	^{232}Th
0	267.0 ± 39.0	31.0 ± 9.0	48.0 ± 18.0
50	248.0 ± 37.0	28.0 ± 10.0	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	10.0 ± 2.5	41.0 ± 20.0
5000	224.0 ± 32.0	16.0 ± 7.0	33.0 ± 15.0
7500	218.0 ± 31.0	14.0 ± 5.0	25.0 ± 7.0
10000	185.0 ± 12.0	30.0 ± 9.0	29.0 ± 7.0
15000	150.0 ± 27.0	23.0 ± 17.0	29.0 ± 8.0
20000	67.0 ± 8.0	68.0 ± 5.0	20.0 ± 6.0
25000	67.0 ± 6.0	11.0 ± 6.0	19.0 ± 6.0

4. Conclusion

The radioactivity concentration levels of the primordial natural radionuclides (^{40}K, ^{238}U and ^{232}Th) in and around cement producing factories are very low. The radiation dose derivable from the radionuclides due to cement production in this area is very low and almost insignificant to cause any serious health problems to the people living in the area.

The estimated and overall mean radiation doses in the environment surveyed are extremely low and both locations surveyed showed lower radiation doses compared with the recommended world average of 13.5 – 69.8nGy/hr (UNSCEAR, 1988).

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