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Research Paper

Verification of Natural Radionuclides Content of Soil Samples at Purechem Cement Factory Site and Its Immediate Environment in Ogun State

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Abstract: *Samples of soil around PURECHEM at Onigbedu (a cement producing factory in Ogun State) were obtained and analyzed to determine the natural radioactivity concentrations of 40K, 238U and 232Th with a gamma ray spectrometer. The activity concentrations of 40k 238u and 232Th varied from 67±6 to 267±39 Bqkg-1 and the mean values of a bsorbed dose at various distances from the factory ranged from 4.04 to 11.30nGyhr-1 with an overall average dose of 8.17nGyhr-1. The study revealed that the radiation concentrations and doses due to radionuclides in the surveyed area are very low and almost insignificant to cause any serious health problems to the people living in the area compared with the recommended world average of 13.5 to 69.8nGyh-1.*

Keywords: Samples, Radioactivity, Dose, Concentration, and Health.

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1. Introduction

Natural radionuclide verification forms an important aspect of environmental monitoring, which is periodic measurement of the dose of some ionizing and non-ionizing radiation exposure to natural background radiation and the general distribution of radiation exposure is not only important for its sake, but also because it creates a proper perspective vis-à-vis the radiation caused by the industrial activities and it helps in epidemiological studies on radiation exposures.

The basic requirement of dosimetry system for environmental monitoring is that it should register the dose received at the position of measurement with reasonable accuracy for the various background radiation over the whole range of energies, does and does rate likely present in the environment. In many situations this requirement is difficult to meet but it should be as closely approached as possible. Information about the type and energy of the radiation should be provided by the dosimeter.

Environmental radiation study forms a major aspect of radiation monitoring all over the world, which has been a subject of serious concern since the manifestation of some of its effects on human beings. These effects include introduction of cataract if an eye is irradiated, leukemia if the blood-forming organs are irradiated, lung cancer due to the inhalation of radioactive dust, as by Uranium miners; induction of bone cancer due to ingestion of radioactivity, such as Radium, which is deposited in bones, as by workers who paint luminous dials, skin cancer caused by chronic irradiation; and even, reduction of life span due to the imperceptible impairment of a number of body functions.

It is therefore clear that constant study of the environment has revealed a lot of useful information concerning the radiation levels in our environment.

The development of nuclear reactors and weapon during the Second World War created a number of radiation problems (Morgan, 1965). This promoted a search for standards and therefore a need for constant monitoring.

With relevance to Nigeria, radiation analysis started during the French nuclear test in the Sahara (1960). This was with a view to assess the radiation fallouts and effects of the radiation on the Nigerian populace. This followed, in the mid sixties, a constant radiation study of Ibadan. The results showed that duing the harmatan specific peaks for atmospheric radioactivity exist. This has been attributed to radionuclides in the earth crust and continental north-easterly winds. This has been shown to be true from work published by Sanni (1973). He has shown that the winds transport radioactive dust from radioactive fields in Niger republic and Jos Plateau in Nigeria down to the southern Nigeria –during the harmattan.

Farai and Jubiri (2000), studied the total radiation of a specific environment in Ogun, that the effective dose of the area is 0.4± 0.27 msv/y. The average cosmic radiation level is 0.18sv/y and other background radiations contribute 0.27sv/y.

Study was made of the natural radionulclide concentration levels on soil and water around a cement factory at Ewekoro in Ogun State. The result of the study revealed that the radionuclide concentration levels in the areas are very low and almost insignificant to cause any serious health problem to the people living in the area (Jibril et al, 1999).

Also, analysis of radionuclide concentrations of soil in and around WAPCO cement factory at Ewekoro, a town in Ogun State, Nigeria was made and the result revealed that the radiation concentrations and doses due to radionuclides are very low almost insignificant to cause any serious health problems to the people living in that environment (Familusi, T.O. et al).

The aim and objective of this study is to critically examine the radioactivity contents and hence the average doses in the environment of PURECHEM cement factory in Ogun State, Nigeria in order to buttress the results of the previous researches on the possible health hazard of radionuclide contents in Ogun State due to cement production and packing over there.

2. Materials and Methods

The method of gamma-ray scintillation spectrometry is employed in the determination of the natural radionuclide concentrations in the soil samples. The spectrometer used is Canberra 7.6cm x 7.6cm Nal(Tl) (Model No 802 - series) detector coupled to a Canberra series 10 plus Multichannel Analyzer (MCA) through a preamplifier base. The resolution of the detector is about 8% at 662Kev of ^{137}Cs. At

this resolution the detector is capable of distinguishing well the principal transition lines of the primordial radionuclides.
The transition line of 1.46Mev was used for the measurement of ^{40}K, 1.173Mev and 1.332Mev were used for the measurement of ^{60}Co, 1.765Mev of ^{214}Bi and 2.615Mev of ^{208}TI were respectively used for the measurement of ^{238}U and^{232}Th.

3. Sites Selection and Samples Collection

The site used for this study is the PURECHEM CEMENT FACTORY at Onigbedu town in Ogun State. The company deals with cement production; it is about 17.5km from the West African Portland Cement Company (WAPCO) located at Ewekoro, also in Ogun State.

Soil samples were collected using a *coring* instrument. The cross (composite) method of sampling was employed. The core depth was in the range between 0 and 30cm. The samples were transferred to waterproof nylon bags and were taken to the laboratory for analysis. A total of 20 samples were collected altogether

4. Soil Sample Analysis

About 200g of each soil sample was analyzed. Samples were oven dried including surface grasses and crushed to pass 1mm-mesh sieve. Sieved samples were transferred to ilitre Marinelli container and kept for a period 6f 28days far equilibration prior to γ - spectroscopy.

Counting of each sample was done for l0hrs (360000s). The areas under the photopeaks of the radionuclide were computed using the Multi Channel Analyzer. The net areas under the photopeaks were related to the specific activities of the radionuclide using-the calibration factors obtained from the relative method of activity determination.

5. Calibration of Equipment

The calibration of the measuring equipment was carried out using certified standard calibration radioactive specimens of ^{137}Cs, ^{238}U, ^{232}Th and ^{152}Eu supplied by the Radiochemical Center Amersham, England through the technical aid of International Atomic Energy Agency (IAEA), Vienna, Austria.

The transition energies of these specimens are ranged between 0.662Mev and 2.16Mev. In order to obtain the current activities of these specimens of the time of our study, a correction for radioactivity decay was made. The method of calibration described by Farai and Sanni (1992) was employed. The calibration was of two folds. The first was for energy calibration while the second was for efficiency calibration. The results of the calibration are shown in table 1.

Table 1: Calibration Result

Radionuclide	**Channel**	**Energy (Mev)**
Cs - 137	08	0.662
Co -60	21	1.172
Co- 60	25	1.332
K – 40	29	1.460

U – 238	38	1.765
Th – 232	61	2.615

The background area counts of the radionuclides are 370±9.052%, 88±11.10% and 183±19.58% for ^{40}K, ^{238}U and ^{232}Th respectively.

6. Results and Discussion

The aim of this research work is to determine the level of natural radioactivity concentrations in and around PURECHEM cement factory and hence the individual absorbed doses at different locations from the source factory of ^{40}K, ^{238}U, ^{232}Th in the top soil. The net areas of under the photo-peak were related to the specific activities of the radio-nuclides using the calibration factors obtained from the relative method of activity determination (Farai and Sanni, 1992 and Olomo et al, 1994).

$$C = A/(MYE_p\gamma) \quad (1)$$

where C is the specific activity of the radionuclide in $Bqkg^{-1}$, A is the net area count under the photopeak of each radionuclide, γ is the gamma yield, E_p is the efficiency of the detector at a given gamma ray energy, M is the mass of the sample and T is the counting time.

Table 2 shows the gross areas of ^{40}K, ^{238}U, ^{232}Th under photo-peak, table 3 shows the net areas of ^{40}K, ^{238}U, ^{232}Th under photo-peak, table 4 shows the mean concentrations ($Bqkg^{-1}$) of ^{40}K, ^{238}U, ^{232}Th and table 5 shows the mean radiation doses at different locations from PURECHEM cement factory.

From Table 5, the highest mean dose values recorded during the practical verification occurred within 0m to 100m and range within 11.2962$nGyhr^{-1}$ to 10.6476$nGyhr^{-1}$, which are very small values to cause any serious health hazard. The mean dose approaches an approximate average constant value (8$nGyhr^{-1}$) from 300m to about 15,000m and falls to about 4$nGyhr^{-1}$ at 20,000m and beyond away from the factory.

The difference in the values of the absorbed dose at different locations from the company site might be due to the background radiation from people, building materials, houses and environmental factors. Figures 1-2 show the graphical illustration of the verification results. The results obtained revealed that radiation concentrations and doses due to radionuclides in PURECHEM cement factory environment are very low and almost insignificant to cause any serious health problems to the people living in the area compared to the recommended world average of 13.5 to 69.8$nGyh^{-1}$. The result buttresses the outcome of several researches carried out by different researchers on radionuclides content of other cement factory environment, such as WAPCO environment, also in Ogun State in Nigeria.

Table 2: Gross areas of ^{40}K, ^{238}U, ^{232}Th in the soil samples under photopeak

Sample	^{40}**K**	^{238}**U**	^{232}**Th**
1	893±13.21%	410±24.13%	1093±34.12%
2	837±09.03%	398±29.95%	1111±27.03%
3	841±12.42%	394±23.37%	1095±13.59%
4	816±11.47%	345±32.16%	1047±12.09%
5	815±12.7%	421±39.77%	1076±13.01%
6	821±14.33%	413±18.09%	998±11.08%

7	769±11.12%	249±27.32%	892±69.10%
8	809±7.03%	242±26.5%	993±33.11%
9	816±12.17%	311±36.67%	972±21.21%
10	803±11.49%	349±32.19%	1079±39.03%
11	758±10.92%	193±96.59%	984±45.13%
12	784±10.75%	273±43.23%	822±41.11%
13	712±24.88%	401±29.18%	745±29.26%
14	618±11.20%	409±18.27%	745±12.01%
15	631±09.14%	311±31.33%	745±19.33%
16	695±19.01%	276±36.89%	725±27.12%
17	487±429%	251±37.41%	564±13.61%
18	499±11.02%	253±1952%	561±19.1o%
19	503±13.81%	198±64.30%	563±29.14%
20	482±06.18%	191±51.24%	537±16.67%

Table 3: The Net Areas of Under Photo-Peak of ^{40K}, ^{238}U, and ^{232}Th in the Soil Samples

Sample	**^{40}K**	**^{238}U**	**^{232}Th**
1	523±16.01%	322±26.56%	910±39.34%
2	467±12.79%	310±31.94%	928±33.38%
3	471±15.37%	306±25.87%	912±23.83%
4	446±14.61%	257±34.02%	864±23.01%
5	44515.60%	333±41.29%	893±23.51%
6	451±16.95%	325±22.00%	815±22.50%
7	399±14.34%	161±29.49%	709±71.82%
8	439±11.46%	154±28.73%	810±38.47%
9	446±15.17%	223±38.31%	789±28.87%
10	433±14.63%	261±34.05%	896±43.67%
11	388±14.18%	10597.23%	80149.19%
12	414±14.05%	185±44.63%	63945.54%
13	342±26.48%	313±31.22%	562±35.21%
14	248±14.40%	321±21.38%	562±22.97%
15	261±12.86%	223±33.24%	562±27.51%
16	326±21.06%	188±38.52%	542±33.45%
17	117±10.02%	163±39.02%	381±23.85%

18	129±14.26%	165±22.46%	378±27.35%
19	133±16.51%	110±65.25%	380±35.11%
20	112±10.96%	103±52.43%	354±25.72%

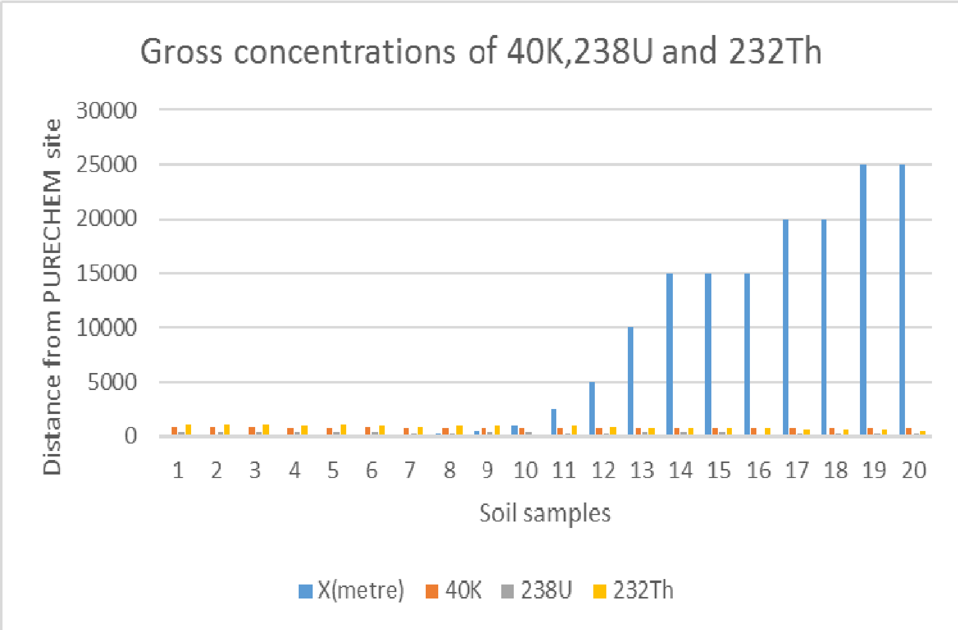
Table 4: Mean Concentrations ^{40}K, ^{238}U, ^{232}Th at Specific Locations Away From Purechem Site

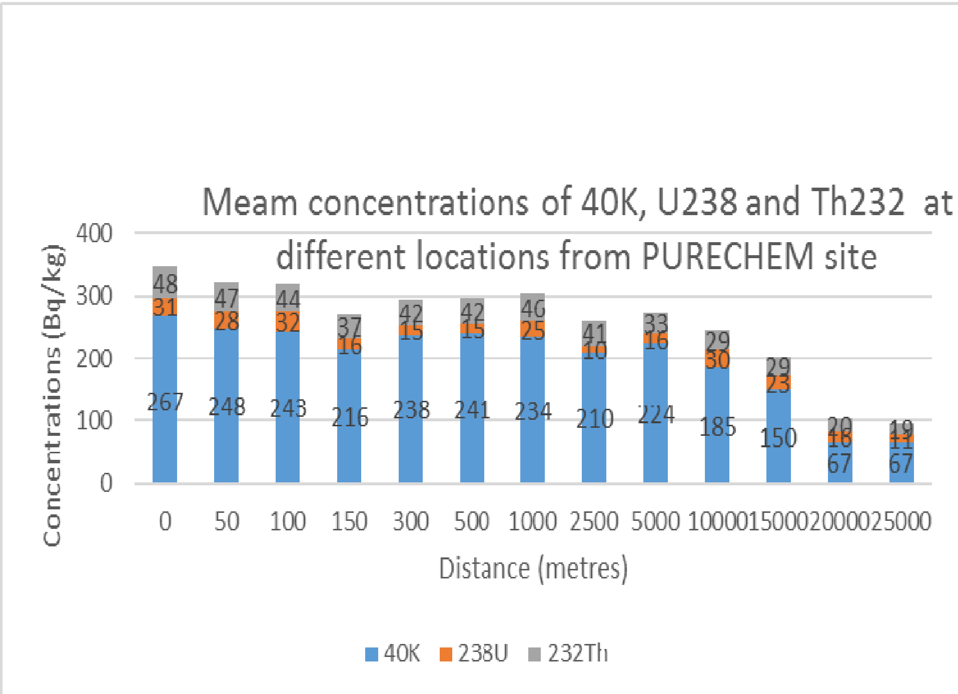
Distance (metres)	**^{40}K**	**^{238}U**	**^{232}Th**
0	267±39	31±09	48±18
50	248±37	28±10	47±13
100	243±40	32±10	44±11
150	216±31	16±05	37±27
300	238±27	15±04	42±16
500	241±37	15±04	42±12
1000	234±34	25±09	46±20
2500	210±30	10±10	41±20
5000	224±32	16±07	33±15
10000	185±12	30±09	29±07
15000	150±27	23±17	29±08
20000	67±08	16±05	20±06
25000	67±06	11±06	19±06

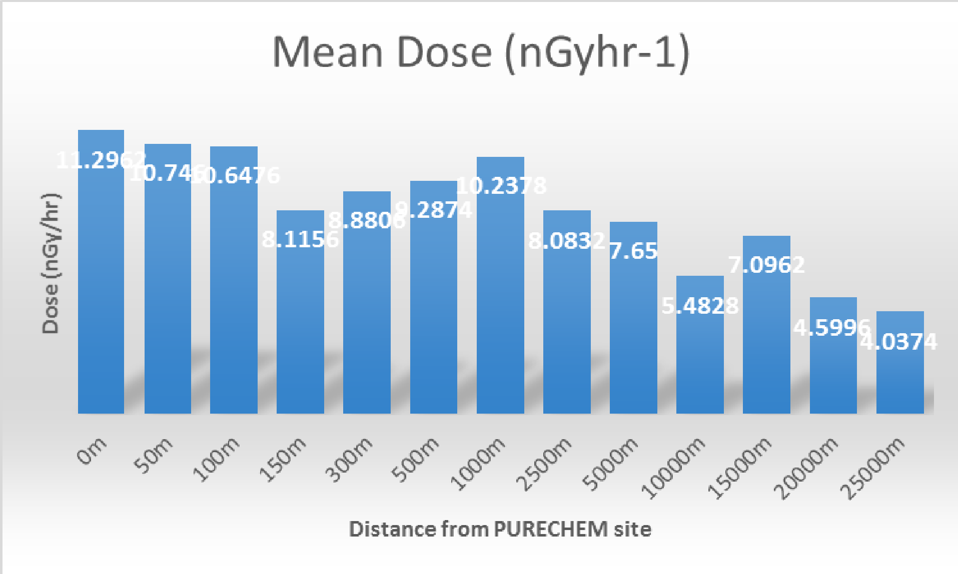
Table 5: The Mean Radiation Doses at Different Locations from Purechem Cement Factory Site

Location	**Mean Dose ($nGyhr^{-1}$)**
0m	11.2962
50m	10.7460
100m	10.6476
150m	8.1156
300m	8.8806
500m	9.2874
1000m	10.2378
2500m	8.0832
5000m	7.6500
10000m	5.4828
15000m	7.0962
20000m	4.5996

25000m	4.0374
Mean Average	8.1668







7. Conclusion

The radioactivity concentrations of primordial radio-nuclides (^{40}K, ^{238}U and ^{232}Th) in and around this factory in Ogun State are every low. That is, the radiation dose derivable from the radio-nuclides 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 overall mean average absorbed dose 8.1668 nGyhr^{-1} compared to the recommended world average of 13.5 to 69.8nGyh^{-1}.

8. Recommendations

Despite the fact that both the occupation and the public doses that can be derived from the radio-nuclides contribution in this environment is very low, each worker of these factories should be provided with a film-badge that will monitor the amount of radiation dose absorbed by individual worker. The film-badge should be analyzed at least once every 5 years to determine dose level of radiation absorbed by the worker. Deductions from the results of processing the film datat will provide a more comprehensive radiation data of site and it environs.

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