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RESEARCH ARTICLE

MEASUREMENT OF NATURAL RADIOACTIVITY IN CERAMIC WHITEWARE SAMPLES

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ABSTRACT

This paper presents the results of the measurement of natural radioactivity present in the ceramic whiteware samples collected from the Government ceramic institute, Vridhachalam, Cuddalore District,Tamilnadu. Natural radioactivity in the ceramic whiteware samples in mainly due to ^{226}Ra, ^{232}Th and ^{40}K and their daughter products. In this study, these measurements have been estimated in Gamma-ray spectrometry and their levels for ceramic samples are compared and also the Radium equivalent concentration (Ra_{eq}) are calculated and is compared well with the reported values.

INTRODUCTION

All building materials contain various amounts of natural radioactive nuclides materials derived from rock and soil. These contain mainly natural radionuclides of the Uranium (^{238}U) and thorium (^{232}Th) series, and the radioactive isotope or potassium (^{40}K). In the uranium series the decay chain segment starting from radium (^{236}Ra) is radiologically the most important and, therefore, reference is often made to radium instead of uranium.The knowledge of the natural radioactivity of building materials is important for the determination of population exposure to radiations, as most of the determination of population exposure to radiations, as most of the people spend ~80% of their time indoors (Amrani and Tahtat,2001). High levels of radioactivity in construction materials can increase external and internal indoor exposure currently, a worldwide effort is underway to measure the activity concentrations in building materials.

Ceramic whiteware samples are one of the commonly used decorative building materials: They are made of a mixture of earthly materials that has been pressed into shape and fired at high temperature. The body of whiteware samples may than be glazed or left unglazed dust-pressed with water absorption levels <0.5>, and high mechanical and chemical characteristics. Ceramic whiteware samples can show natural activity concentration significantly lower than the average values of Earth's crust. This report contains a summary of result obtained on ceramic whiteware samples (eight) collected from Govt. Ceramic Institute, Virudhachalam manufacturing firms. The survey consisted of measurement of ^{226}Ra, ^{232}Th and ^{40}K activity concentration by HpGe gamma-ray spectrometer.

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The results of this investigation are compared with the findings of similar studies carried out in other countries.

MATERIALS AND METHODS

Sample collection and preparation

A total of 8 samples of ceramic whiteware materials with different additives were collected from the Govt. Ceramic Institute, Virudhachalam manufacturing firms for the measurement of radioactive concentrations. The ceramic whiteware samples were powdered to obtain even grain size. The dry samples were transferred to uniform (250ml) containers. Weighed, sealed and kept for 4 weeks so that a secular equilibrium between ^{226}Ra and ^{232}Th and their progeny could be reached. (The sealed counting vials were stored for 30 days to allow ^{226}Ra and its short lived decay products to reach radioactive equilibrium).

Experimental Technique

The concentration of the natural radioactivity (^{226}Ra,^{232}Th and ^{40}K) in the ceramic whiteware samples, were measured using the gamma ray spectrometer in the Laboratory of Health and Safety Division, IGCAR, Kalpakkam, Tamilnadu,India. NAI(TI) crystal detector of size 3"×3" combined with 8K multi channel analyzer was used. The technique used for measurement is a direct ɣ-counting method. The counting time fixed for each sample was 20,000 seconds. The activity of standard sources used were KCL (329 grams), R-226(0.09µci) and Ra228 (6000pci) with the counting time of 20,000 seconds, the minimum detectable activity limits were 13.25 Bq/Kg for K-40, 8.5 Bq/Kg for U-238 and 1 Bq/Kg for Th-232. In-site dose rate measurement was done by using digital environmental radiation dosimeter (ERDM Type 107, nucleonix).

RESULTS AND DISCUSSION

The activity concentration (in Bq Kg^{-1}) of ^{226}Ra, ^{232}Th and ^{40}K in the ceramic whiteware samples (S1-S8) were analyzed and the activity values obtained in this study are given in Table.1 and Fig.1. It may be seen from the table that for whiteware samples, the values of ^{232}Th has been found to be varying from 33.83 to 70.40 Bq Kg^{-1}.

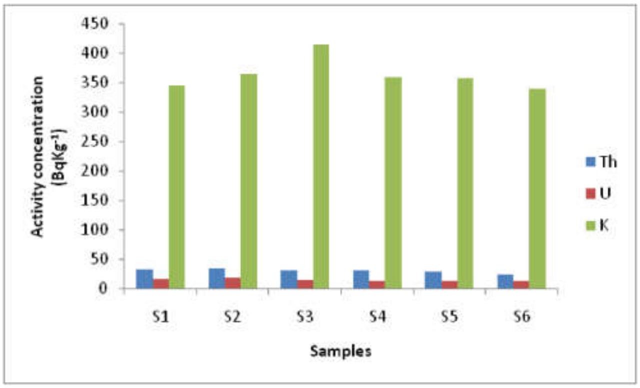

Fig 1. Activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K ceramic white ware samples

European Commission. The commission suggests that building materials should be exempted from all restrictions concerning their radioactivity if the excess gamma radiation originating from them increases the annual effective dose of a member of the public by 0.3mSv at the most. On the contrary, does higher than 1mSv should be accepted only in some very exceptional cases where materials are used locally. The European Commission recommends that controls should be based on a dose in the range 0.3-1mSv y^{-1}. This is the excess gamma does to that received outdoors. The European Commission has proposed the following activity concentration index (I) for identifying whether a dose criterion is met:

$$I = \frac{C_{Ra}}{300BqKg-1} + \frac{C_{Th}}{200BqKg-1} + \frac{C_K}{3000BqKg-1} \quad \text{------------------ (2)}$$

Where C_{Ra}, $C_{Th,}$ and C_K are the activity concentration of ^{226}Ra, ^{232}Th and ^{40}K (Bq kg^{-1}) respectively, in the building material. The activity concentration index shall not exceed the values shown in Table 1. Note that the activity concentration index should be used only as a screening tool for identifying materials which might be of concern. Any actual decision on restricting the use of a material should be based on a separate dose assessment. Such assessment should be based on scenarios where the materials are used in typical way for the type of material in question. Large variation in Ra_{eq} activities has been reported in many studies on natural radioactivity in building materials.

Table 1. Activity concentrations, radium equivalent and activity concentration index due to natural radio nuclides in ceramic whiteware samples

S.no	Samples	Activivity concentrations ^{232}Th (Bq kg^{-1})	^{226}Ra (Bq kg^{-1})	^{40}K (Bq kg^{-1})	Radium equivalent activity (Bq kg^{-1})	Activity concentration index (mSvY^{-1})
1	S1	42.5	30.75	349.99	118.4742	0.431
2	S2	37.05	24.56	325.09	102.5734	0.375
3	S3	33.83	14.90	318.31	87.78677	0.324
4	S4	36.69	12.99	325.84	90.54638	0.335
5	S5	43.20	22.50	376.03	113.2303	0.413
6	S6	43.66	16.96	342.95	105.801	0.389
7	S7	46.40	17.16	340.51	109.7313	0.402
8	S8	70.40	16.52	237.7	135.4949	0.486

The activity concentration of ^{226}Ra varies from 12.99 Bq Kg^{-1} to 30.75 Bq Kg^{-1}. The activity concentration of ^{40}K varies from 237.7 Bq Kg^{-1} to 376.03 Bq Kg^{-1}. An index Ra_{eq} called the radium equivalent activity is also presented in Table.1 to compare the specific activities of material containing different amounts of radium, thorium and potassium. This is a widely used radiological hazard index and was calculated according (Ahmed,2005).

$$Ra_{eq} = C(Ra) + 1.43C(Th) + 0.077C(K) \qquad \text{------ (1)}$$

Where C(Ra), C(Th), and C(k) are the activity of ^{226}Ra, ^{232}Th and ^{40}K respectively in Bq Kg^{-1}. The value of Ra_{eq} of whiteware samples (S1-S8) are ranging from 87.78 to 135.49 Bq Kg^{-1} (Table.1) from the result obtained, there's an evidence of considerable variation in the Ra_{eq} of the eight different (types) properties of whitewares, but also using the same type. A number of indexes dealing with the assessment of the excess gamma radiation originating from building materials have been proposed (Krisiuk,1971, Stranden et al,1976, Krieger,1981, Swedjemark,1986, Bruzzi *et al.,*1992). In this study, the gamma- index was calculated as proposed by the

For examples, in 1985 Beretka and Mathew, calculated Ra_{eq} values ranging between 15 and 883 Bq Kg^{-1} in Australian building materials. The values obtained by Amrani and Tahtat (2001) in Algeria building materials ranged from 28 to 190 Bq Kg^{-1}. In Egypt, Ahmed (2005) recorded the lowest values in mud and clay bricks (about 100 Bq Kg^{-1}), and the highest ones granites and marbles (about 400Bq Kg^{-1}). The recommended maximum level of radium equivalent for building materials to be used for homes is less than 370Bq Kg^{-1}. It is worth noting that the average radium equivalent values are within the limit proposed by the OECD countries. Nevertheless, it is important to note that this recommended value is calculated for materials used in bulk amount, and it is not appropriate for decorative building materials such as tiles. Gamma indexes of the sample are shown in Table.1. The gamma index (I) has been found to be verifying from 0.324 to 0.48. The European commission (1999) suggests that building materials should be exempted from all restrictions concerning their radioactivity if the excess gamma radiation originality from them increases the annual effective close of a member of the public by 0.3m as the most, corresponding to a gamma index ≤ 1 (Table.1) on the contraly, closes higher than 1m (corresponding to a gamma index >6) should be accepted only in some very exceptional cases, when materials are used locally eight ceramic whiteware samples show gamma indices lower than 1. Activity concentration and radium equivalent activities for ceramic whiteware samples are compared with results obtained by other authors. As it is possible to observe, activity concentrations results lower than those reported by the other authors (Ahmed,2005)

Conclusion

Activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K were measured and next radium equivalent activities and gamma indexes were calculated in a eight number of ceramic whiteware samples. Results confirm that mean values measured in ceramic whiteware samples are comparable with mean world wide value in earth crust. From a radiological point of view, the results indicate that the use of these materials in construction of dwellings could be considered safe for in habitants. As matter of that, all samples shown gamma indexes much lower than the limit indicated by the European Commission and the radium equivalent activity is within the limit set by the OECD.

REFERENCES

Ahmed, N.K., 2005. Measurent of natural radioactivity in building materials in Qena city, upper Egypt. J.Environ. Radioact. 83 : 91-99.

Amrani, D. and Tahtat, M. 2001. Natural radioactivity in Algerian building materials. Appl. Radiat. Isot. 54 (4), 687-689.

European Commission Radiation Protection 112, Directorate-General Environment, Nuclear Safety and Civil Protection (1999).

Krisiuk E.M, Tarasov S.I,Shamov V.P, Shalak N.I,Lisachenko E.P and Gomelsky L.G, A study on radioactivity in building materials, Leningrad Research Institute for Radiation Hygiene (Leningrad,1971).

Krieger, R. 1981. Radioactivity of construction materials. Betonwerk+Fertigteil- Techn. 47, 468-473.

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