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MEASUREMENT OF RADIUM CONTENT AND RADON EXHALATION RATES IN SOIL SAMPLES ALONG THE COASTAL REGIONS OF KARUNAGAPALLY, KOLLAM DISTRICT, KERALA

S. MONICA[1a], S.R. SONIYA[b], A.K. VISNU PRASAD[c] AND P.J. JOJO[d]

[abcd]Center for Advanced Research in Physical Sciences, Department of Physics, Fatima Mata National College (Autonomous), Kollam, India

ABSTRACT

Indoor radon at elevated levels can be one of the health hazards for the general people. Soil and building materials used for construction of houses are considered as major sources of radon gas in indoor environment. Radon emanated from the soil accumulates in indoor environment and contributes to 55% of inhalation dose. In the present work, the radon exhalation rates in some soil sample collected from the coastal region of Karunagapally, Kollam district,were measured using 'Canister' technique. Sealed can technique` using LR-115 type-2 plastic track detector strippable has been used in order to measure effective radium content, radon mass exhalation rates and radon surface exhalation rates. Etching was done with 2.5 N NaOH and Spark counter was used with the purpose of counting of alpha particle tracks. The values of effective radium content were found to range from 0.155to 0.755 Bq/Kg with the mean value of 0.367 Bq/Kg which are lower than the permitted value of 370 Bq/Kg as recommended by Organization for Economic Cooperation and Development (OECD). The values of surface exhalation rates are found to range from 0.0171 to 0.131 Bq/m^{2}h with the mean value of 0.0688 Bq/ m^{2}h while the values of surface exhalation rates are found to range from 0.00149 to 0.00685 Bq/ Kgh with the mean value of 0.00354 Bq/Kg h.

KEYWORDS : Radium content, Healthhazards, Surface exhalation rate, Mass exhalation rate

Knowledge of radioactivity present in soil enables one to assess any possible radiological hazard to general population. Indoor radon and its decay product contribute 55 % of the total radiation dose from the natural source to the population. This contribution can be much higher in radon prone areas, the natural dose exposure being 5-10 times higher. Many studies have demonstrated the evidence of occurrence of lung cancer with radon even at low levels of radon in residential buildings (Chauhan et al., 2001 and Chauhan et al., 2003). But the efforts of the various agencies working to reduce the number of lung cancers related to radon exposures are stymied in somecountries due to very high radon exposure. The approach of indoor radon studies in connection withradon gas from soil and building material due to manyfactors linked to the underlying geological formations andbuilding structure results in increased levels of radon insidehouses. This study has been carried out in many countries (Kellar et al., 2001 and Khan et al., 1992). The worldwide average indoor effective dose dueto gamma rays from building materials is estimated to be about 0.4 mSv per year (UNSCEAR,2000). As individual spend more than80% of their time indoors, the internal and external radiationexposure from building materials (made from effected soil) creates prolonged exposure situations (ICRP,1999). Generally, natural building materials reflect the geology of their site oforigin. The elevated levels of natural radio nuclides causingannual doses above the recommended limits were identified in some regions around the world, e.g. in Brazil, France, India, Nigeria, Iran etc. The exposure of population to high concentrations of radon and its daughters for a long periodlead to pathological effects like the respiratory functional changes and the occurrences of lung cancer. Radon now has been identified as occupational respiratory carcinogen by International Agency for Research and ClassifiedCancer. Radon is the second major cause of lung cancer after smoking. According to BEIR reports (Barooach et al., 2009), the exposure of population to high concentrations of radon and its daughter a long period lead to pathological effects like the respiratory functional changes and the occurrence of lung cancer. Thus, it is important to study the radon emission from the soil samples. In present work, track etch Sealed Can Technique (cans fittedwith LR-115 type -2 plastic track detector) has been usedto measure the radon exhalation rate from some soil sample collected from Karunagapally, Kerala .

MATERIALS AND METHODS

Solid State Nuclear Track Detectors (SSNTDs) is an important technique that can be used for measurement of radon soil exhalation rate. The passive canister technique can is used in the resent study. This technique is one of the

[1]Corresponding author

most widelyused for radon measurement. The detection principle consists of the damage caused in the detector by alpha particles from radon. As the track produced per unit area in a detector is proportional to exposure time and rate, so the tracks densityper time could be used to calculate radon concentration and hence exhalation rate. For the measurement of exhalation rates from soil samples, the Can Technique given by Abu-Jaradwas used. A known quantity of soil sample were sealedin a plastic can having same dimension as used in the calibration exercise (Singh et al., 2007). LR-115 Type-II nuclear track detector was fixed on the inner side of lid of each can with tape such that sensitive side of the detector facing the material sample. The can was tightly closed and sealed for 100 days. After 100 days, the detectors were removed, etched and tracks were counted using Spark counter.

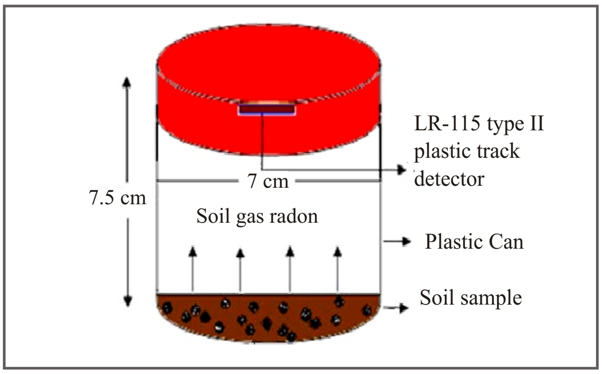

Figure 1 : Experimental setup for measurements of radium concentration and radon exhalation rates in soil samples

These tracks were converted into radon concentrations using calibration factor. The mass and surface exhalation rates, radon concentration and annual effective dose can be calculated using following relation

$$E_M = \frac{CV\lambda}{M\left(T + \frac{(e^{-\lambda T}-1)}{\lambda}\right)} \ldots \ldots (1)$$

$$E_S = \frac{CV\lambda}{A(T + \frac{(e^{-\lambda T}-1)}{\lambda})} \ldots \ldots (2)$$

where EM and EA are mass and surface exhalation rates, C is the Integrated radon exposure (Bq m^{-3} h), M is the mass of sample (kg), V is the volume of air in the canister (m^3), T is the exposure time (h), λ is the decay constant for radon (h^{-1}), and A is the area covered by the canister or surface area of the sample (m^2). Effective radium content in the soil samples of study area
were calculated by using following formula .

$$C_{Ra}\left(\frac{Bq}{kg}\right) = \frac{\rho hA}{KMT_e} \ldots \ldots (3)$$

Where ρ is the track density measured in tracks cm^{-2}, K is the sensitivity factor, h is the distance in meters between the top of soil and detector fitted in can, M is the mass of soil in Kg, A is area of cross-section of cylindrical can.

RESULTS AND DISCUSSION

The values of effective radium content, mass exhalation rates and surface exhalation rates in the soil samples collected from the coastal region of Karunagapally are depicted in table-1.The values of effective radium content vary from 10.25 to 15.25 Bq/Kg with mean value of 0.367 Bq/Kg. These values are lower than the value of 370 Bq/Kg as recommended by OECD, 1979) [oecd,1979]. The mass exhalation rate varies from 33.11 mBq/kg/h to 67.12 mBq/kg/h while radon surface exhalation rate varied from 171.12mBq/m^2/h to 909.12 mBq/m^2/h. The radon exhalation rate from the soil sample are greater than the world wide average 56 mBq/m^2/h.

CONCLUSION

The average values of radium content in the study area are comparable to the global average value of radium in soil. The values of radon exhalation rate in soil samples of the study area are quite lower than the areas known for Uranium mineralization nevertheless is higher from the global value. Therefore the use of soil of this area in Brick manufacturing for building construction is considered to be safe. Radium concentration was found with safe limit recommended by a group of experts of the OECD. The results reveal that the area is safe as far as the health hazard effects of radium and radon exhalation rate are concerned. The study area is advisable to be used as residential area.These results are reported for the first time with the best of our knowledge.

Table 1: The Effective Radium content, Mass and Surface Exhalation rate for the soil samples collected from the coastal region of Karunagapally is shown below

Location	Sample code	Effective radium content(Bq/kg)	Surface Exhalation rate[Bq/m^2 h]	Mass Exhalation rate[Bq/kg h]
Karunagapally	KAR 1	10.22	0.074	0.004
	KAR 2	12.22	0.071	0.003
	KAR 3	9.52	0.091	0.004
	KAR 4	8.56	0.051	0.002
	KAR 5	15.22	0.104	0.005
	KAR 6	11.22	0.125	0.006
	KAR 7	13.22	0.073	0.003
	KAR 8	15.22	0.131	0.006
	KAR 9	9.89	0.111	0.005
	KAR 10	10.22	0.061	0.003
	KAR 11	14.22	0.062	0.003
	KAR 12	16.25	0.061	0.003
	KAR 13	13.89	0.029	0.001
	KAR 14	8.88	0.061	0.003
	KAR 15	7.55	0.017	0.0008
	KAR 16	12.55	0.058	0.003
	KAR 17	14.88	0.065	0.003
	KAR 18	11.77	0.041	0.002
	KAR 19	12.22	0.036	0.002
	KAR 20	12.44	0.048	0.002
Average		14.22	0.068	0.0035

Table 2: Comparison of the average radon exhalation rates and radium (Bq kg^{-1}) in soil samples in different part in India

Location	Exhalation rate		Radium content(Bq/Kg)	Reference
	Surface(mBq/m^2/h)	Mass(mBq/Kg/h)		
Margherita Thrust area	362.12	10.9	-	[Barooach et al.,2009]
Kangra (H. P)	806.1	24.3	18.5	[Singh et al.,2007]
Villages of Haryana and Himachal Pradesh States, India	524.9	12.8	14.8	[Singh et al.,2009]
Aravali hills in India	540	25.5	-	[Chauhan et al.,2011]
Jamtara district	642.9	18.9	15.7	[Singh et al.,2010]
Present Study	681.4	3.56	0.36	-

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