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Depth Dependence Radon Study in Indian Tube-Wells

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Radon a radioactive gas arising from decay of ^{226}Ra, has been recognized to be one of the major contributors to the natural radiation. In the present investigations, measurements of radon and its progeny were carried out under ground in Indian tube-wells at different depths situated at A.M.U., Aligarh (U.P) India. The twin chamber dosimeter cups were fixed for exposure at a depth of 5 to 35 feet with difference of 5 feet from the surface at three different locations. After exposure, the detectors were retrieved, etched and analyzed in the laboratory for the calculation of radon and its progeny. All the values of the radon concentration presents in this paper are higher than the action level (200-600 $Bq.m^{-3}$) as recommended by ICRP.

Key Words: SSNTDs, Radon, Radon Progeny, Twin Chamber Dosimeter Cups.

INTRODUCTION

Radon is ubiquitous in the natural environment and supposed to be the second most important factor of health hazards caused by natural radioactivity. It is a radioactive gas arising from the uranium (^{238}U) decay series, which is the largest single source of radiation exposure to many populations 1. Inhalation of radon and its progeny can cause a significant health hazard, if it is present at enhanced level 2. ^{222}Rn has the highest concentrations in the underground building, mines and basements that are in contact with soil 3.

The Investigations have been carried out for the measurements of radon and its progeny levels in the tube-wells of Halls of residence of the Aligarh Muslim University, Aligarh (U.P) India. The Aligarh district of Uttar Pradesh Province in Northern part of India situated between (27°53'24"N lat., & 78°3'36"E long.,) and occupies a land of area 3700.4 km^2. The district lies on the plains of river Ganges and Yamuna.

EXPERIMENTAL

Measurements were carried out employing twin chamber dosimeter cups fitted with LR-115 type-II plastic track detectors. These cellulose nitrate detectors are sensitive to α-particles and are widely used for radon and its progeny measurements. The detectors of size 2cm x 2cm were used as passive detectors in "Bare mode" [4] for recording the tracks of α-particles emitted by ^{222}Rn gas present in our ambient air and also its short lived daughters, typically ^{218}Po and ^{214}Po which generally attach themselves to the aerosols. The twin chamber dosimeter cups were mounted on the wall in underground tube-wells at depths 5 to 35 feet with a gap of 5 feet from the surface of the ground at three different locations in Indian tube-wells viz. Staff Club, S .S. Hall North and R. M. Hall situated at A.M.U., Aligarh (U.P) India. The detectors were mounted in such a way that the sensitive surfaces facing the air, taking due care that there was nothing to obstruct the detectors within a hemispherical volume of radius 9.1 cm in front of them. The α-particles originating from radon and its progeny were registered as tracks in the detectors, if α-particles from radon and its progeny have their energies in the range of about 1.7- 4.1 MeV [5,6]. Thus, the radon progeny, which plate out on the surface of the detectors will not be detected because their α-particles are too energetic [7]. The detectors were exposed in underground tube-wells for about 150-160 days. After exposure, the detectors were retrieved and etched for 2 hours in 2.5 N NaOH solution at 60 ± 1^0C in the laboratory. Subsequently the detectors were thoroughly scanned using an optical microscope at a magnification of 100X and track density of through-etched holes was evaluated. The potential alpha energy concentration (PAEC) was determined using the relation:

$$C_P = \frac{\rho}{K \times t}$$

Where ρ is the corrected track density (number of tracks per cm^2), K is the sensitivity factor or calibration factor and t is the total time of exposure. The radon concentrations in $Bq.m^{-3}$ were calculated by using the relation:

$$C_{Rn(Bqm^{-3})} = \frac{3700 x WLconc}{F}$$

where F (=0.4) is equilibrium factor [8].

RESULTS AND DISCUSSION

The tables-1, 2 and 3, shows the values of PAEC and concentration of radon in tube-wells at different depths at A.M.U., Aligarh (U.P) India. In table-1, the values of PAEC vary from 122.46 m WL to 2029.89 mWL with a mean value of

TABLES: Potential alpha energy concentration and radon concentrations in tube-wells at different depths in A.M.U., Aligarh (India).

TABLE-1 (Staff Club)

S. No.	Location	Detector Code	Corrected track density (tracks.cm^{-2})	PAEC (mWL)	Conc. of Rn (Bq.m^{-3})
1.	5 feet	43	11343.75	122.46	1053.74
2.	10 feet	40	20656.25	222.99	1918.79
3.	25 feet	31	37531.25	405.17	3486.33
4.	30 feet	28	40656.25	438.90	3776.62
5.	35 feet	25	188031.25	2029.89	17466.50
			Mean	643.88	5540.40
			Standard Deviation	785.66	6760.33

TABLE-2 (S. S. Hall North)

S. No.	Location	Detector Code	Corrected track density (tracks.cm^{-2})	PAEC (mWL)	Conc. of Rn (Bq.m^{-3})
1.	5 feet	19	15468.75	154.69	1331.01
2.	10 feet	13	21343.75	213.44	1836.56
3.	15 feet	16	29781.25	297.81	2562.57
4.	25 feet	01	41406.25	414.06	3562.86
5.	35 feet	04	230156.25	2301.56	19804.14
		Mean		676.31	5819.43
		Standard Deviation		913.76	7862.58

TABLE-3 (R. M. Hall)

S. No.	Location	Detector Code	Corrected track density (tracks.cm^{-2})	PAEC (mWL)	Conc. of Rn (Bq.m^{-3})
1.	5 feet	64	18656.25	204.28	1757.73
2.	10 feet	67	31281.25	342.52	2947.22
3.	15 feet	73	55656.25	609.41	5243.76
		Mean		385.40	3316.24
		Standard Deviation		205.94	1772.07

643.88 mWL and a standard deviation of 785.66. The values of concentration of radon vary from 1053.74 Bq.m^{-3} to 17466.50 Bq.m^{-3} with a mean value of 5540.40 Bq.m^{-3} and a standard deviation of 6760.33.

Table-2 shows that the values of PAEC vary from 154.69 mWL to 2301.56 mWL with a mean value of 676.31 mWL and a standard deviation of 913.76. The values of concentration of radon vary from 1331.01 $Bq.m^{-3}$ to 19804.14 $Bq.m^{-3}$ with a mean value of 5819.43 $Bq.m^{-3}$ and a standard deviation of 7862.58.

It is clear from table-3 that the values of PAEC vary from 204.28 mWL to 609.41 mWL with a mean value of 385.40 mWL and a standard deviation of 205.94. The values of concentration of radon vary from 1757.73 $Bq.m^{-3}$ to 5243.76 $Bq.m^{-3}$ with a mean value of 3316.24 $Bq.m^{-3}$ and standard deviation of 1772.07.

It is clear from tables-1, 2 and 3 that the value of radon increases as the depth increases. The concentration of radon at 35 feet is about 15 times higher than that at 5 feet.

Soil radon measurements carried out in the Alburqurque area in New Mexico showed an average radon concentration of about 6660 $Bq.m^{-3}$ at a depth 40 cm [9]. Another investigation held in Germany at Dottingen has found that the radon level in the soil air varies from 5000 $Bq.m^{-3}$ to 15000 $Bq.m^{-3}$ [10]. The variation of radon concentration in different sites may be due to the difference in soil texture or porosity. The exact sources of radon in soil air might be at a deep distant from the surface. Since the mean diffusion distance is definite to a few centimeters, the mechanism of pressure driven flow must be operative to carry them to the surface of earth [11]. The lower radon concentration in the top layer of the soil is attributable to the proximity of the soil to the atmosphere [12].

Conclusions

The data presented in this paper show that the values of radon and its progeny increases as depth increases. The concentration of radon at a depth of 35 feet is about 15 times higher than the value of radon concentration at a depth of 5 feet.

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