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Natural Radioactivity Levels in Some Villages in Shahjahanpur, Uttar Pradesh (India)

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ABSTRACT : *Study of indoor radon and its progeny has been carried out in some dwellings of Shahjahanpur, Uttar Pradesh, India using LR-115 type II plastic track detectors. Radon is an invisible radioactive gas that occurs naturally in the indoor atmosphere. It comes from the natural breakdown of uranium in soils and rocks. Lung cancer risk depends upon the concentration of radon and their decay products in air above recommendation level. In the present study the value of concentration of radon ranges from 28* Bq/m^3*to 69* Bq/m^3 *with an average of 40* Bq/m^3*whereas the value of radon progeny ranges from 3.01 mWL to 7.46 mWL with an average of 4.84 mWL. The results obtained with twin cup radon/thoron dosimeter shows that the concentration of indoor radon and its progeny were found within recommended levels.*

KEYWORDS: *Indoor radon, Thoron, Solid state nuclear track detector, Natural Radioactivity.*

I. INTRODUCTION

The radioactive element viz. uranium, thorium and potassium are present in traces in the earth's crust and are distributed more or less uniformly throughout the crust. These elements emit nuclear radiations, which can hazards for human beings. Thus the monitoring of any release radioactivity to the environment is necessary for environmental protection. Studies of natural radioactivity are necessary not only because of their radiological impact, but also because they act as excellent biochemical and geochemical traces in the environment. Uranium, the heaviest radioactive toxic elements is found in almost all types of soils, rocks, sands and waters. High values of uranium in drinking water and foodstuffs may lead to harmful effects in human beings. Adverse effects from natural uranium can be due to its radioactive and chemical properties. Chemically it can be harmful to the kidneys from large exposures. Uranium is ultimate source of radium and radon. Radon is the decay product of uranium present in radioactive series just after the radium. As an inert gas radon can diffuse through the soil and enter the atmosphere. It is well knownthat (**Henshaw et al; 1990**) indoor radon exposure is associated with the risk of leukaemia and certain other cancers such as malenomia and cancers of the kidney and prostate. If uranium rich material lies close to surface of the earth, there can be high radon exposure hazards (**Sevc et al; 1976,UNSCEAR,2000).**

Radon is the most common in the environment because its half life of 3.825 days makes its diffusion more feasible from its origin point towards external air. In the atmosphere, the decay of radon isotopes of polonium, lead and bismuth (**Nikezic and Yu, 2000**) that are heavy metals and chemically active. By property, they exist briefly as ions of free particles in air, forming the molecules in condensed phase or attached to airborne particles as dust, typically with of size of micron, forming radioactive aerosols. A variable fraction of airborne radon daughters can remain unattached and is referred as unattached airborne friction. This fraction, after the inhalation by man, can be deposited in the respiratory tract, in which it releases alpha particles. The alpha emitted radon progeny is entirely responsible for the absorbed dose due to radon exposure. Thus, the most appropriate physical quantity associated with dose estimation is not the radon concentration, but the Potential Alpha Energy Concentration (PAEC). The PAEC is sometimes expressed in terms of the so called equilibrium equivalent radon concentration (EERC). Based upon current knowledge about health effects of inhaled radon and its progeny, ICRP has made recommendations for the control of this exposure in dwellings. Keeping this in mind the natural radioactive levels in Shahjahanpur has been carried out using twin cup radon/thoron dosimeter with solid state nuclear track detector.

II. MATERIALS AND METHODS.

Radon and its progeny concentration were measured by using LR-115 Type II plastic track detector. Three small pieces of detector films of size 2.5 cm x 2.5cm were fixed in a twin chamber radon dosimeter having three different modes. The bare mode gives the values of radon/thoron concentrations and their progeny while the filter and membrane modes records the values due to radon/thoron and pure radon gas, respectively. The dosimeters were suspended inside the house at a height of about two meters from the ground floor. After an exposure time of about three months, the detector films were removed, etched and scanned for the track density measurements. The recorded track density was then converted in the Bq/m^3 by using an appropriate calibration factor **[Ramola et. al., 1996].**

$3.12x10^{-2}$ tracks cm^{-2} d^{-1}=1 Bqm^{-3} ………. (1)
CR (Bq/m^3) =PAEC (mWL) x 3700/F…….(2)
Where F is the equilibrium factor between radon and its progeny having values 0.4 (**UNSCEAR, 1999**).
This measurement was repeated on a time integrated four quarterly cycles to cover all the four seasons of a calendar year.

A twin cup dosimeter based on the above considerations has been designed and developed in the BARC laboratory for use in the radon-thoron mixed field. This has been effectively deployed in the field for the measurement of radon-thoron and progeny concentrations in the High Background Radiation Areas (HBRAs) and in several other areas of the country for a National survey programme. It is a twin chamber cylindrical system using 12 µm thick, LR-115 type II cellulose nitrate based SSNTDs manufactured by Kodak Pathe, France. Each chamber has a length of 4.1 cm and a radius of 3.1 cm. The SSNTD1 placed in compartment M measures radon alone which diffuses into it from the ambient air through a semi-permeable membrane (e.g. latex, cellulose nitrate etc.) of 25 µm thickness having diffusion coefficient in the range of 10^{-8} to 10^{-7} cm^2 s^{-1} **[Ilic and Sutej, 1997; Wafaa Arafa, 2002]**. It allows the buildup of about 90% of the radon gas in the compartment and suppresses thoron gas concentration by more than 99%. (The mean time for radon to reach the steady state concentration inside the cup is about 4.5 h). On the other hand, the glass fiber filter paper of thickness 0.56 mm in the compartment F allows both radon and thoron gases to diffuse in and hence the tracks on SSNTD2 placed in this chamber are related to the concentrations of both the gases. The SSNTD3 exposed in the bare mode (placed on the outer surface of the dosimeter) registers alpha tracks attributable to both the gases and their alpha emitting progeny, namely ^{218}Po, ^{214}Po, ^{216}Po and ^{212}Po. The choice of the detector LR-115 is made in view of the fact that LR-115 detectors do not develop tracks originating from the progeny alphas deposited on them **[Eappen et al, 1998; Nikolaev and Ilic, 1999; Durrani, 1997]** and therefore is ideally suited for air concentration measurements. Fig 1 gives the schematic diagram of the dosimeter.

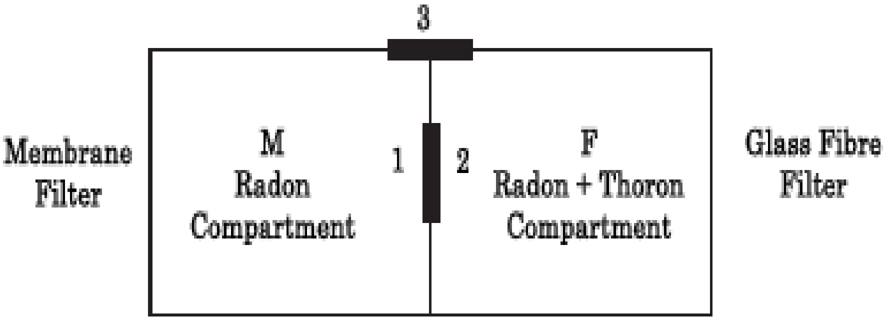

Fig. 1: SCHEMATIC DIAGRAM OF TWIN CUP RADON-THORON DOSIMETER

III. RESULT AND DISCUSSION.

The concentration of indoor radon and its progeny are shown in table 1.

Based on the results it was found that the radon concentration in study area varied from 28 Bq/m^3 to 69 Bq/m^3 with an average of 45 Bq/m^3 while radon progeny varied 3.01 mWL to 7.46 mWL with an average of 4.84 mWL. The levels of radon and its progeny are higher in villages of Hullapur and Mirjapur as compare to Piprola, Katra and Jalalabad. Higher concentration in Hullapur and Mijrapur due to the mostly houses taken under study is mud.The high values of radon and its progeny in the mud house may be due to typical construction of the houses and the construction materials used. The emanation from the ground surface and from the building materials of mud houses results in the high value of radon and thoron inside room (**Ramola et al., 1988**). As the soil is an important source of indoor radon (**Schery 1989**), the emanation of radon is also higher from the ground surface of the house.

Table 1 radon and its progeny concentration during summer season.

S. No.	Villages	No. of dwellings	Radon Concentration (Bq/m^3)	Radon progeny(mWL)
1	KANT	5	38	4.11
2	JALALABAD	4	32	3.46
3	ALLAHAGANJ	3	35	3.77
4	MIRJAPUR	5	66	7.11
5	TILHAR	8	43	4.65
6	KATRA	3	28	3.01
7	MADNAPUR	4	57	6.14
8	DADRAUL	5	41	4.48
9	BANTHRA	4	39	4.22
10	KALAN	6	54	5.84
11	HULLAPUR	2	69	7.46
12	PIPROLA	2	28	3.03
	Min.		**28**	**3.01**
	Max.		**69**	**7.46**
	Average		**45**	**4.84**

IV. CONCLUSION.

Based on the results it is concluded that the concentration of radon and its progeny levels in mud houses are higher compared to the other houses. The high concentration of radon and its progeny in mud houses is possibly because of the poor ventilation condition in the houses. Emanation from the ground surface and from the building materials of mud houses results high value of radon and its progeny concentration in the houses.

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