International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Measurement of Indoor Radon and Thoron Concentration in Environment of Shahjahanpur District of Uttar Pradesh

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Abstract: ***Measurement of radon and thoron concentration was carried out in the residential houses of district Shahjahanpur, Uttar Pradesh using solid state nuclear track detector (SSNTD). Radon and thoron are the most important contributions to human exposure from natural sources. Radon exists in soil gas, building materials, Indoor atmosphere etc. Among all the natural sources of radiation dose to human beings, inhalation of radon contributes a lot. The work presented here emphasizes the measurement of indoor radon and thoron concentration in 75 dosimeters using solid state nuclear track detector in different types of dwellings of Shahjahanpur district. The measurements were made in residential houses at a height of 2 m from ground level using a twin chamber radon dosimeter. It is found that the value of radon concentration varies from 10.60 Bq/m^3 to 68.00 Bq/m^3 with an average of 27.88 Bq/m^3 and thoron concentration varies from 7.33 Bq/m^3 to 30.00 Bq/m^3 with an average of 16.74 Bq/m^3 respectively. All the values in the above study have been found under the safe limit laid down by International Commission on Radiological Protection (ICRP) and United Nations Scientific Committee on the effect of Atomic Radiation (UNSCEAR).***

Keywords: radon , thoron , mud houses, SSNTD, twin cup dosimeter

1. Introduction

The behaviors of the radioactive gases have received considerable attention over the past few decades due to the radiological risks to humans in indoor atmosphere. High radon levels were measured in dwellings in a number of countries including United States, Sweden and the United Kingdom (UNSCEAR, 1988) and there is a concern that high levels of radon may contribute to an increased risk of lung cancer. These high indoor radon levels can exceed international guidelines (ICRP, 1988) and are associated with a number of factors including soil porosity, uranium content of the soil, building materials mode of construction, ventilation and metrological parameters. The variability of these factors accounts for the large range of the radon levels measured in dwellings. Recent epidemiological evidence suggests that inhalation of radon decay products in domestic environments could be a cause of lung cancer (; ICRP, 1993; UNSCEAR, 1993; Lubin et al., 1995; NRC, 1999; WHO, 2007; 2008). The present study was performed in order to estimate the indoor radon and thoron concentration levels in environment of Shahjahanpur district of Uttar Pradesh, India. Measurements were made both in traditional and new houses in bedrooms as well as in drawing rooms. The few traditional mud houses in rural area are also selected for installation of dosimeters which are old, mostly poor ventilated having small one window or without window and with only one door.

2. Measurement Techniques.

Concentration of radon and thoron 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/thoron dosimeter having three different modes. The bare mode gives the values of radon, thoron and their progeny concentrations 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 three months, the detector films were removed etched with 10 % NaOH solution for one hour at a bath temperature of 60°C. The bulk etching rate is about 4 µm/h. The detector films are then washed in distilled water. After washing, the detectors are air dried in dust free environment The detectors, having a residual thickness of 8 µm after etching, are peeled off from their plastic bases and the tracks are registered with spark counter. The recorded track density was then converted in the Bq/m^3 by using an appropriate calibration factor (Ramola et. al., 1996). This measurement was repeated on a time integrated four quarterly cycles to cover all the four seasons of a calendar year.

Figure 1: Twin Cup Radon-Thorn Dosimeter

3. Result & Discussion

The work presented here emphasizes the long term measurements of radon and thoron concentrations in 75 dwellings using solid state nuclear track detectors. The houses chosen for installing dosimeters are new as well as old one. In rural area like Mirjapur and Kalan, some dosimeters are installed in mud houses. The dwellings in the study area are mainly made of bricks using cement and concrete. The selection of dwellings for installing dosimeters was done taking into account the degree of ventilation, type of floor, number of windows and doors as they all responsible for variation in indoor radon concentration.

Table 1 shows the seasonal variation of indoor radon & thoron concentration in different types of dwellings in shahjahanpur district of Uttar Pradesh. In present study it is observed that the minimum indoor radon concentration (10.60 Bq/m^3) was recorded in Shahjahanpur city in summer while the highest concentration (68 Bq/m^3) is recorded in Mirjapur in winter season. The overall average value of indoor radon concentration was found 27.88 Bq/m^3 for the complete year. The minimum indoor thron concentration (7.33 Bq/m^3) was recorded in Dadraul in summer while the highest concentration (30 Bq/m^3) is recorded in Nigohi in winter season. The overall average value of thoron concentration in study area was found 16.74 Bq/m^3 for the complete year. The concentration was found least in summer while highest in winter. This is because, in summer season, the houses remain open for long time which contributes in increasing air exchange rate while in winter; the rooms are remaining closed for long hours decreasing air exchange. This is the possible cause for radon/thoron variation. In a national radon survey done by BARC, Mumbai and published by Head, Library and information services Division in September 2003, the minimum and maximum concentration of thoron in India was reported 3.5Bq/m^{3}and 42.8 Bq/m^3 respectively. The concentration of indoor, thoron and their progeny in study area was observed in the above range and below the recommended action level set by various organizations.

Table 1: Variation of Indoor Radon And Thoron Concentration In Different Seasons

S. No.	Location	Indoor radon concentration (Bq/m^3)				Indoor thoron concentration(Bq/m^3)			
		Summer	Rainy	Winter	Autumn	Summer	Rainy	Winter	Autumn
1	Shahjahanpur City	10.6	21	35	24.8	7.8	10.5	19.6	13.8
2	Kant	13	24	38.33	27.33	7.6	16.33	23.33	19
3	Jalalabad	18	25.66	31.6	18.5	13	12.33	17.66	14
4	Allahaganj	14.66	18.33	34.33	29	9	11.33	20.66	15.33
5	Mirjapur	21.5	32.66	68	50	14	17	28.33	20.33
6	Powyan	19.33	36	36.5	33.33	13	19.33	20.5	18
7	Banda	20.33	28.33	40	31.33	18	18	20	23.66
8	Tilhar	10.67	18.25	37.25	32.25	10	14.66	23.25	16.25
9	Katra	20	27	32	27	11.66	19.33	20.33	14
10	Khudaganj	15.5	40	36.5	32.5	9	21	19.5	19
11	Nigohi	18.67	29	43.66	34.5	18.66	23	30	19.5
12	Madnapur	15.33	17.33	29	23	14	22	20.33	24
13	Roza	14.5	26	33.33	30.67	10.67	18.33	24	18.33
14	Khutar	15	24.33	44.33	36.6	15.67	17.67	25.5	16.33
15	Dadraul	11	25	41	29	7.33	11.5	19	11.66
16	Sharamau	11.33	26	38.33	24.67	10	14	17.66	14
17	Banthra	17.33	29.67	38	27	9.5	17	23	20
18	Kalan	22.5	38.5	38.5	34.5	7.5	17	18.5	21.5
19	Hullapur	16.5	28.5	55.5	35	10.5	17.5	19.5	19.5
20	Chaurasia	11	20.5	43.5	33	14.5	17.5	19	24.5
21	Sindhauli	23.5	31.67	33.5	33	22.5	11.67	20	16.33
22	Kurria	13	18.5	31.5	25	8	11	19.5	14.5
23	Piprola	13	18	36	27	11	11.5	22	13.5
		10.6	17.33	29	18.5	7.33	10.5	17.66	11.66
		23.5	40	68	50	22.5	23	30	24.5
		15.92	26.27	38.94	30.4	11.86	16	21.35	17.74

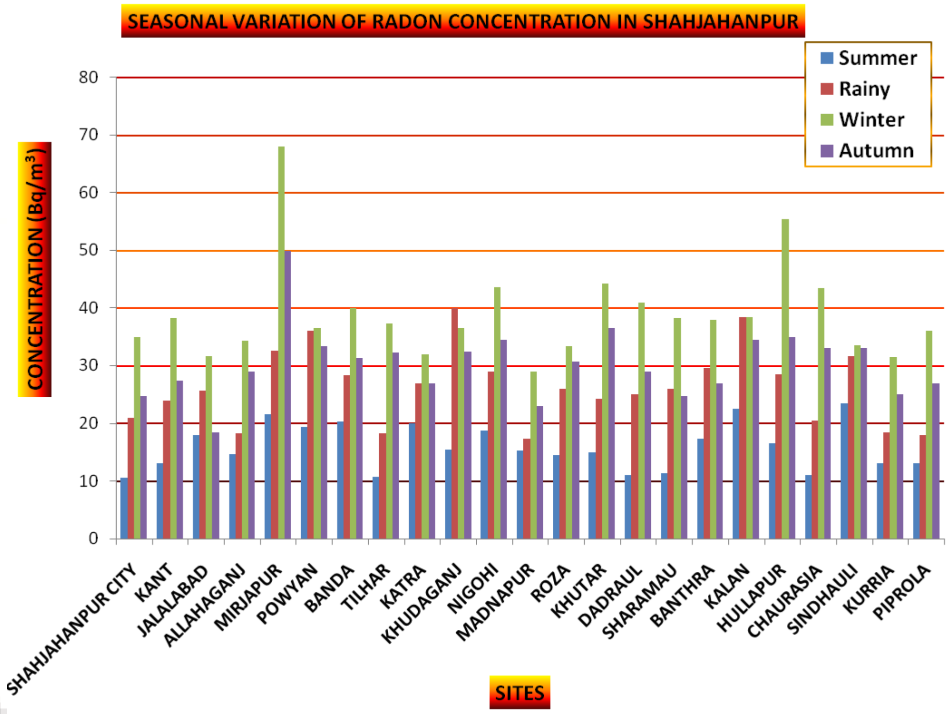

Figure 2: Graphical Representation of Radon Concentration

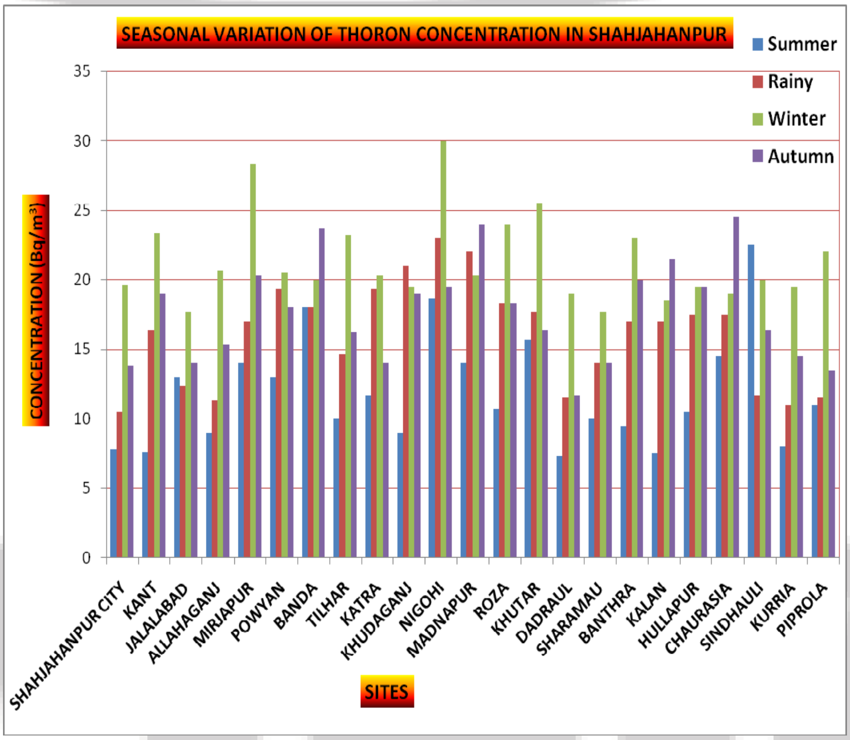

Figure 3: Graphical Representation Of Thoron Concentration Conclusions And Suggestions

The aim of present work was to measure the concentration of radon, thoron and their daughter products in indoor atmosphere in Shahjahanpur district. The radon, thoron, and their daughter products concentration in the dwellings of Shahjahanpur were measured using LR-115 type IInd plastic track detectors based on SSNTD technique using twin cup dosimeter. The houses chosen for installing dosimeters are new as well as old one. In rural area like Mirjapur, some dosimeters are installed in mud houses. The seasonal variation of radon, thoron and their daughter products was studied. The results of systematic study are obtained by considering the room as a space in which the radon and thoron levels are directly related to the dynamic and static parameters. The minimum radon concentration (10.60 Bq/m^3) was recorded in Shahjahanpur city in summer while the highest concentration (68 Bq/m^3) is recorded in Mirjapur in winter with average value 27.88 Bq/m^3.

The least concentration in summer was due increase in temperature which results virtual mixing and rising of aerosol and dust particles to higher altitude ,so there will be the reduction in aerosol and dust particles near the earth surface and hence the radon concentration decreases. The maximum concentration in winter is essentially influenced by the intense temperature inversion, which generally occurs in winter when the wind velocity is low. The maximum concentration in winter is also the result of decreased ventilation because in winter season the houses are closed for long time and radon accumulated inside the room.

The minimum thoron concentration (7.33 Bq/m^3) was recorded in Khudaganj, Kant, Dadraul and Kalan and Piprola in summer while the highest concentration (30 Bq/m^3) is recorded in Mirjapur in winter. The average value of thoron concentration in study area was found 16.74 Bq/m^3 for the complete year.

The concentration of radon and thoron in study area were observed below the recommended action level set by various organizations. In a national radon survey done by BARC, Mumbai and published by Head, Library and information services Division in September 2003, the minimum and maximum concentration of radon, thoron in India was reported 4.6 Bq/m^{3}and 147.3 Bq/m^3, 3.5 Bq/m^{3}to 42.8 Bq/m^3 respectively.

Based on the result, it was concluded that radon concentration vary with, temperature, humidity and atmospheric pressure As humidity decreases the temperature increases which results in the maximum vertical mixing and rising of dust particles and vice versa. The significant variation of radon concentration was observed for different seasons. It is found that the average radon concentration is maximum during winter season and minimum during summer season. The radon concentration gradually decreases towards summer and monsoon, the factors that may affect is high temperature and low pressure in summer. During the monsoon with south west winds having strong wind velocity and heavy precipitation, a decrease in radon concentration was found. Decrease of radon in monsoon is due to other factors also i.e. soil is saturated with water during monsoon.

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