Indoor radon measurement in the some houses of Mandi district Himachal Pradesh, India using solid state nuclear track detectors.

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Abstract

Radon is the most important source of natural radiation and exposure to radon (^{222} Rn) can result in a significant inhalation risk to population particularly to those living in homes. Because of this, the monitoring of the indoor radon levels in the different geographic areas is important where human activities are developed. In the present study indoor radon levels have been measured in some houses of Mandi district Himachal Pradesh, India using solid state nuclear track detectors (SSNTDs) commercially known as LR - 115 type II. Forty (40) indoor radon detectors were placed in the various houses for three months (i.e. From April 2012 to July 2012) in the study area. Indoor radon concentration in the study area found to be varies from 42.22 Bq/m^3 to 398.3Bq/m^3 with the average value of 138 Bq/m^3 which are higher than the world average of 40 Bqm-^{3} and are below the recommended action level (200-600 Bq m-3).

Key Words: *Radon, SSNTDs, Alpha Particle, LR-115 type-II.*

1. Introduction:

The measurement of radon in man‘s environment is of interest because of its alpha emitting nature. Many environmental pollutants are classified as cancer-causing solely on the basis of laboratory studies using either animals or cell cultures. In the case of radon, there is direct evidence from human studies of a link between exposure to radon and lung cancer. Most of our time is spent indoors; therefore, the measurement and evaluation of radon concentrations in buildings are important. Radon is a naturally occurring odourless, colorless, tasteless inert gas which is imperceptible to our senses. It is produced continuously from the decay of naturally occurring radionuclide such as ^{238}U, ^{235}U and ^{232}Th.The radioisotope ^{222}Rn, produced from the decay of ^{238}U, is the main source (approximately 55%) of internal radiation exposure to human life [1]. Worldwide average annual effective dose from ionizing radiation from natural sources is estimated to be 2.4 mSv, of which about 1.0 mSv is due to radon exposure [2]. The numerous measurements of the activity concentrations of radon in different countries along with epidemiological studies regarding the indoor radon and risk of lung cancer have been published in recent years [3,4,5]. The main natural sources of indoor radon are soil, building materials (sand, rocks, cement, etc.,), tap water, natural energy sources used for cooking like (gas, coal, etc.,) which contain traces of ^{238}U, the topography of the area, house construction type, soil characteristics, ventilation rate, wind direction, atmospheric pressure and even the lifestyle of people. The Solid State Nuclear Track Detectors (SSNTDs) are an important tool in investigations concerning the presence of radon gas [6, 7]. Solid State Nuclear Track Detectors (SSNTDs) are insulating solids both naturally occurring and man-made. In the present study, Solid State Nuclear Track Detectors (SSNTDs) technique has been utilized for the study of indoor radon level in the some houses of Mandi district Himachal Pradesh.

2. Material and methods:

The indoor radon level was measured in forty houses between the MCT and MBT in the Mandi district of Himachal Pradesh using the LR-115 type –II (SSNTDs). The houses were selected at randomly situated in different areas, at a few kms away from each other. For this purpose the LR film was cut into pieces of size 1.5cm x 1.5cm and was placed on the cardboard such that the sensitive portion of the film was exposed to the air (fig. 1). These detectors were placed at about the 2m height from the ground, so that they were capable of recording the alpha-particles resulting from the decay of radon in the room. After exposure to standard durations of 90 days, the detectors were subjected to chemical processing in a 10 M analytical grade sodium hydroxide solution at (60 ±1)ºC, for 90 min, in a constant temperature water bath to enlarge the latent tracks produced by alpha particles from the decay of radon. After the etching, the detectors were washed for 30 minutes with running cold water, then with distilled water and finally with a 50% water/alcohol solution. After a few minutes of drying in the air, the detector becomes ready for track counting. The etched tracks were counted using an optical microscope (Zeiss at 400× magnification). The recorded tracks recorded on the films were converted into the radon concentration by the following conversion:

0.02tracks/cm^2 /day= 1Bq/m^3 [8].

3. Result and Discussion:

Table 1 shows the type of houses where the LR-115 films were installed and recorded indoor radon concentrations in 40 different houses of Mandi district, Himachal Pradesh during April, 2012 to July, 2012. The indoor radon concentration obtained from the present study varied from 42.22 to 398.33 Bq/m3 with an average value of 138 Bq/m^3 which are higher than the world average of 40 Bqm^3 and are below the recommended action level 200-600 Bq m^{-3}[9].The highest value was observed in the house of survey number 4 with an indoor radon concentration of 398.33 Bq/m^3. The high radon concentration level in survey point 4 is due to poor ventilation, lifestyle and the accumulation of dust in the room due to the closeness of the house to the roadside which are usually considered as important sources of radon in buildings. The lowest value was found in the house of survey number 28 with an indoor radon concentration of 42.22Bq/m^3. Although the indoor radon concentration is within the recommended action level 200-600Bq/m^3, but all the values are higher than the world average of 40 Bqm-^{3}. The factor explaining the high levels of radon in these houses is the poor ventilation status due to the relatively narrow openings. Also, most of the houses in the present study areas serve as both living rooms and bedrooms for the residents. This could also account for the high radon concentration levels since most of the residents valuables are kept in one room making the room non-spacious for inflow of air. Another factor for high values of radon in the study value may be its closest to active faults where radon concentration is more.

Table1: Summary of the results obtained

S. No.	Name of Place	House Type	Rn (Bq/m^3)
1	Barot	Mud Based	97.22
2	Barot	Dwelling	322.78
3	Barot	Wooden and concrete	127.22
4	Barot	Concrete based	398.33
5	Barot	Concrete based	44.44
6	Tikkan	Concrete based	48.89
7	Tikkan	Concrete based	292.78
8	Jhatingni	Mud and granite	124.44
9	Jhatingni	Mud and granite	107.78
10	Mohar dhar	Mud house	133.33
11	Mohar dhar	Mud and granite	92.78
12	Mohar dhar	Concrete House	124.44
13	Chipnu near Mandi	Concrete House	133.33
14	Chipnu near Mandi	Concrete House	160.00
15	Mandi	Concrete House	138.33
16	Mandi	Concrete House	67.78
17	Mandi	Concrete House	113.33
18	Malori	Mud House	117.22
19	Malori	Mud House	213.33
20	Lunapani	Concrete House	65.56
21	Baggi	Mud House	137.22
22	Pali near Baggi	Concrete House	137.22
23	Pali	Mud House	140.00
24	Sundernagar	Concrete House	126.11
25	Harabag	Concrete	128.89

		House	
26	Harabag	Concrete House	60.56
27	Harabag	Mud House	161.67
28	Ropari	Concrete House	42.22
29	Bhubwana	Mud House	71.67
30	Bhubwana	Mud House	143.33
31	Kangu	Concrete House	170.00
32	Kangu	Dwelling	150.00
33	Slappar	Concrete House	76.11
34	Slappar	Concrete House	156.67
35	Sundernagar	Concrete House	375.56
36	Sundernagar	Concrete House	253.33
37	Sundernagar	Mud House	109.44
38	Sundernagar	Concrete House	42.78
39	Sundernagar	Concrete House	49.44
40	Lunapani	Concrete House	62.22
Average			**137.94**

4. Conclusions:

Indoor radon concentration in the study area found to be varies from 42.22 Bq/m^3 to 398.33Bq/m^3 with the average value of 138 Bq/m^3 which are higher than the world average of 40 Bq/m^3 and are below the recommended action level (200-600 Bq/m^3).Variations in levels of radon concentration appear due to the use of building materials used for construction of houses and the degree of their ventilation.

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References:

[1] ICRP, 1993, “Protection against radon-222 at home and work,” ICRP Publications 65, Annals of the ICRP, 23(2)

[2] UNSCEAR, 2000,“United Nation Scientific committee on the effect of atomic Radiations”, United Nation, New York.

[3] S. Singh, A. Kumar, and B. Singh, 2002, “Radon level in dwellings and its correlation with uranium and radium content in some areas of Himachal Pradesh, India”, Environ. Int., 28, pp. 97-101

[4] T. Iyogi,S. Ueda, S. Hisamatsu, K. Kondo, N. Sakurai and J. Inaba, 2003,“Radon Concentration in Indoor occupational Environments in Aomori prefecture, Japan J. Environ. Radioact. 67,pp 91-108.

[5] M.H. Magalhaes, E.C.S. Amaral, T. Sachett and E.R.R. Rochedo, 2003,“ Radon-222 in Brazil: an outline of indoor and outdoor measurement”, J. Environ. Radioact. 67,pp 131-143.

[6] L.S.Bech and J.E.Gingrich, 1976,“Track etch orientation survey in the Cliff Lake area, Northern Saskatchewan”, Canadian Inst. Min and Met., Bull.,69,pp 104-109.

[7] J.E.Gingrich and J.C. Fisher, 1976, “ Uranium exploration using the Track- Etch method, In : Exploration for uranium ore Deposits” ,IAEA, Vienna,pp 213-227.

[8] K.P. Eappen and Y.S. Mayya, 2004, “Calibration factors for LR-115(Type-II) based radon thoron discriminating dosimeter,” Science Direct, Radiation measurement 38, pp 5-17.

[9] R. Mehra, K. Badhan, R.G. Sonkawade, S. Kansal, and S. Singh, 2010, “Analysis of terrestrial natural radio nuclides in soil samples and assessment of average effective dose”, Indian Journal of Pure and Applied Physics, vol 48,pp 805-808.