Measurement of Indoor Radon Concentration in some Dwellings of Amritsar City, Punjab

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ABSTRACT

Radon exists in soil, water, building materials and 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 concentration in 22 dwellings situated in Amritsar city of Punjab using LR-115 type II solid state nuclear track detector in bare mode for three months. The range of indoor radon concentration in present study varied from $(13.19 \pm 3.46)$ Bq/m$^3$ to $(175.67 \pm 56.25)$ Bq/m$^3$ with average value $(49.49 \pm 16.24)$ Bq/m$^3$. The observed value lies within the safe limit recommended by International Commission on Radiological protection (ICRP) 1993.

Keywords: Radon, LR 115, dwellings, chemical etching.

Introduction

Soil, rocks and building materials are the significant contributors of Uranium ($^{238}$U) and Radium ($^{226}$Ra). Radium ($^{226}$Ra) is the 4th daughter product of Uranium ($^{238}$U) decay series. $^{226}$Ra gives a naturally occurring radioactive radon ($^{222}$Rn) gas with an emission of $\alpha$-particle. Radon is inert, colourless, odourless, tasteless and highly densest gas from the family of noble gas with half life of 3.82 days. It has four short lived decay products $^{218}$Po (3.05 min), $^{214}$Pb (26.8 min), $^{214}$Bi (19.9 min) and $^{214}$Po (164 $\mu$s), both the polonium isotopes emit high energy $\alpha$-particle, which are highly effective in damaging stomach, gastro-intestinal, immune system, lung cancer and body tissue[1,2].

Measurement of indoor radon is important because the radiation dose due to radon and its daughters in human being’s contributes is more than 50% of the total dose from the natural sources (UNSEAR, 1994). The three isotopes of radon ($^{219}$Rn, $^{220}$Rn, and $^{222}$Rn) are gaseous and may release from soil, rocks, water and building materials. $^{219}$Rn and $^{220}$Rn are not so important because of short half life. But the concentration of $^{222}$Rn in air may reach a significant level in terms of radiological protection [3]. Henshaw et al. (1990) claimed that indoor radon exposure is associated with the risk of leukemia and certain other cancers, such as melanoma and cancers of kidney and prostate [4]. There is lot of fluctuation in radon concentration due to atmospheric
conditions (temperature variation, change in pressure and ventilation conditions), building materials, wind speed and dimensions of the room i.e. if the room is small there is high value of radon concentration and if the room is large then low value of radon. Ventilation conditions play a significant role because good ventilation conditions helps in decreasing the radon concentration and vice versa.

The work on the measurement of radon concentration levels and its short lived decay products in different countries had been published [5-10]. In India many research workers are engaged in the measurement of indoor radon levels in dwellings for health risk assessments and its control. [1]

In the present study, total of 22 locations have been chosen and three houses in each location were selected for the measurement of indoor radon concentration in Amritsar district. The houses were selected on the basis of ventilation conditions. The detectors in bare mode were deployed in bedroom, drawing room, hall, and study room.

**Geology of the study area**

The present study was carried out in Amritsar city of Amritsar district, Punjab state, India shown in Figure 1. Amritsar is one of the largest cities of the Punjab state in India. Amritsar district is located in northern part of Punjab state and lies between 31° 28’ 30” to 32° 03’ 15” north latitude and 74° 29’ 30” to 75° 24’ 15” east longitudinal with an average elevation of 234 meters (768 ft). Amritsar district falls in between Ravi River and Beas River. And North West parts of the city touches the international border of Pakistan. Amritsar has a semi-arid climate, max temperature range in winter is 0 °C (32 °F) to about 15 °C (59 °F) and in summer can reach up to 42 °C (108 °F). Soils in the western part of the district are coarse loamy, calcareous, where as in the central part of the district soils are fine loamy, calcareous and are well drained.

Figure 1. showing the map surveyed area during present investigation of Amritsar city.
Experimental Technique

There are several techniques for the measurement of indoor radon and its daughter products. Some techniques are used for short period is called active techniques such as Rad 7 in air mode, α guard, and Smart Radon monitor (made by BARC) and other techniques are Passive which are time consuming such as bare mode, Twin cup dosimeter, and pin hole dosimeter. In present study, the radon concentration was measured in bare mode technique by using LR-115 type II plastic track detector film [11, 12, 13]. The detector of size 2 cm x 2.5 cm were fixed on the glass slide as shown in fig. 2 and then mounted on the walls of different dwellings at a height 10 cm below the roof. After the three month of exposure, the detectors were removed. The removed detectors were subjected to chemical etching in 2.5 N NaOH solution at 60°C for 90 min in a constant temperature bath. Then these films were washed, dried and then track density was measured by spark counter. The observed track density was converted to radon concentration (Bq/m^3) using the calibration factors (0.020 ± 0.002 tracks cm^-2 d^-1 /Bq m^-3) determined experimentally by Eappen et al (2001) [14]. In bare mode technique, there is some contribution due to ^220Rn and daughter products of ^222Rn. These contribution i.e. ^220Rn and daughters products of ^222Rn is only 10% of the total reported by UNSCEAR 2000 [15]. So this component can be neglected from the point of inhalation dose.

Result and Discussion

The average indoor radon concentration in 22 locations of Amritsar city, Punjab is given in table 1. The average indoor radon concentration varies from 13.19±3.46 Bq/m^3 in new batala road to 175.67±56.25 Bq/m^3 in Majitha road. All the values are less than the lower limit of the range of action level 200 to 600 Bq/m^3 recommended by the International Commission of Radiological Protection (ICRP) [21]. The indoor radon values obtained in present investigation are comparatively lower than those reported in some dwellings of Pathankot (163-437 Bq/m^3, Kumar et. al. 2013) [1], Muktsar (95-226 Bq/m^3) and ferozepur (75-233 Bq/m^3, Singh et. al. 2005) [16], Bathinda (119-218 Bq/m^3, Bajwa et. al. 2003) [3], Bathinda (95-202 Bq/m^3, Singh et. al. 2005) [17], Kullu (156-635 Bq/m^3, Singh et. al. 2001) [18], Una (235-970 Bq/m^3, Singh et. al. 2002) [19] and Hamirpur (660-635 Bq/m^3, Kumar et. al. 1994) [20] districts of Punjab and Himachal Pradesh as shown in figure 3. Bajwa et. al. 2002 [3] reported the average radon concentration in Amritsar was 64 Bq/m^3, but at present study there reported average radon concentration is (49.48 ± 16.24) Bq/m^3. This shows that
the present average value of radon concentration is slightly lower than the value reported by Bajwa et al. 2002. In the present study, total of 70% are the marble type houses, 15% cemented and 5% are tiles. The lower value of indoor radon concentration in these dwellings is due to lower radium content in building materials i.e. in bricks, cement, and marble [3]. And all the dwellings have marble and cemented floor, with cemented walls contributes low concentration of radon in these houses. Figure 3 shows the bar chart of radon concentration in dwellings of different regions of Punjab and Himachal Pradesh. The values of radon concentration in Himachal Himalayas were high reported by Singh and Kumar [19, 1] that is due to the presence of high uranium and radium content in soil samples.

Table 2 represents the indoor radon concentration according to ventilation conditions. The value of radon concentration is lower in good ventilation, and higher in poor ventilation condition. Figure 4 shows the bar chart of indoor radon concentration in bare mode in the studied dwellings.

Acknowledgement

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Table 1. Indoor radon concentration in some areas of Amritsar city, Punjab

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>LOCATIONS</th>
<th>GPS Co-ordinates</th>
<th>Indoor Radon concentration(Bq/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>New Pawan Nagar</td>
<td>N 31°63'39&quot; E 74°72'26&quot;</td>
<td>29.63 ± 12.56</td>
</tr>
<tr>
<td>3.</td>
<td>Mohini Park</td>
<td>N 31°67'57&quot; E 74°87'89&quot;</td>
<td>39.87 ± 10.59</td>
</tr>
<tr>
<td>4.</td>
<td>Sandhu Colony</td>
<td>N 31°62'87&quot; E 74°80'78&quot;</td>
<td>60.86 ± 25.23</td>
</tr>
<tr>
<td>5.</td>
<td>Hakiman Gate</td>
<td>N 31°61'26&quot; E 74°86'21&quot;</td>
<td>34.17 ± 15.23</td>
</tr>
<tr>
<td>6.</td>
<td>Majitha Road</td>
<td>N 31°65'79&quot; E 74°88'89&quot;</td>
<td>175.67 ± 56.25</td>
</tr>
<tr>
<td>7.</td>
<td>Pawan Nagar</td>
<td>N 31°63'73&quot; E 74°89'56&quot;</td>
<td>88.61 ± 31.45</td>
</tr>
<tr>
<td>8.</td>
<td>Mohkam Pura (1)</td>
<td>N 31°67'57&quot; E 74°87'89&quot;</td>
<td>57.24 ± 23.54</td>
</tr>
<tr>
<td>9.</td>
<td>ShaheedUdam Singh</td>
<td>N 31°60'36&quot; E 74°89'01&quot;</td>
<td>43.58 ± 19.87</td>
</tr>
<tr>
<td>10.</td>
<td>Hargobind Pura</td>
<td>N 31°62'05&quot; E 74°79'95&quot;</td>
<td>46.25 ± 17.54</td>
</tr>
<tr>
<td>11.</td>
<td>Guru Bazar</td>
<td>N 31°62'23&quot; E 74°87'31&quot;</td>
<td>28.33 ± 10.54</td>
</tr>
</tbody>
</table>
Table 2. Average radon concentration according to ventilation conditions of dwellings.

<table>
<thead>
<tr>
<th>Ventilation conditions</th>
<th>Average radon concentration (Bq/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor*</td>
<td>78.94</td>
</tr>
<tr>
<td>Average*</td>
<td>45.72</td>
</tr>
<tr>
<td>Good*</td>
<td>23.79</td>
</tr>
</tbody>
</table>

*Poor ventilation = one door and no window.
Average ventilation = one door and one window.
Good ventilation = one door and more than one window.

References:


