



## Estimation of alpha radioactivity in some soil samples collected from eastern Haryana

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**Abstract:** All humans are constantly exposed to radiations spontaneously emitted by naturally occurring atomic elements ever since their existence on the earth. Radon ( $^{222}\text{Rn}$ ) has been identified as the largest single source of radiation exposure to world population. Indoor radon has been recognized as one of the health hazards for mankind. Common building materials used for construction of houses are considered as major sources of radon gas in indoor environment. In the present work, the radon exhalation rates were measured using 'Canister' technique. The alpha sensitive solid state nuclear track detector (LR-115 type-II) were used in the canisters for recording tracks produced by alpha particles from radon gas emanated from soil samples. The soil samples were collected from Sonapat, Panipat and Karnal districts of eastern Haryana, India. The detectors were exposed in the canisters for 100 days. After the exposure, the detectors were etched using 2.5 N NaOH solution at 60° C for 1.5 hours. The track density was found using an optical microscope at a magnification 600X. The mass and surface exhalation rates are also calculated from the data. The measurements indicate normal to some higher levels of natural radioactivity in soil samples. However, these samples satisfy the universal standards (UNSCEAR, 2000) limiting the radioactivity within the safe limits.

**Key words:** Radon, exhalation rates, building materials, soil, LR-115.

### I. Introduction

Human population is always exposed to ionizing radiation from natural radiations arising from within and outside the earth [1]. Radon, which is a topic of public health concern has been found to be ubiquitous indoor air pollutant to which all persons are exposed [2-3]. The exposure of population to high concentrations of radon and its daughter for a long period lead to pathological effects like the respiratory functional changes and the occurrences of lung cancer. Radon is derived from the radioactive decay of radium, a decay element in uranium series. It has a half life of 3.8 days, which is long enough, allowing a part of it to diffuse from the building materials in to the inside atmosphere of the dwelling. Building materials and the soil beneath the floor are the main sources of radon activity inside the dwellings. A large variation in radon activity is observed in dwellings as the uranium concentration in natural materials used as a building materials vary in a wide range and from place to place. The building materials and the water used in the homes is a source of radon in indoor air [4]. Thus it is desirable to study the radon concentration and exhalation rates from building materials and soil used in different regions. Various researchers have reported that exposure to high levels of radon at the workplace and in other public sector indoor settings are important risk factors for lung cancer for workers [5]. The United States Environmental Protection Agency (US-EPA) has reported that inhalation of radon is the second killer from cancer after smoking. [6]. The health hazards caused by radon and thoron are not primarily due to Isotopes, but due to their short-lived daughters that are inhaled.

### II. Experimental

For the measurement of radon concentration and its exhalation rates in building materials canister technique was used [7]. Soil samples were collected from different sites. The sample dried in oven. The known amount of each sample was taken in plastic canister. LR-115 type –II plastic track detectors were fixed on the bottom of lid of each canister with tape such that sensitive side of the detector faced the sample. The cans were tightly closed from the top and sealed. The size of the detectors was 1cm x 1cm and LR-115 (type –II) detectors were exposed in closed plastic canisters. After 100 days the detector were removed, washed and dried and subjected to a chemical etching process in 2.5N NaOH solution at 60 degree centigrade for 90 minutes. The tracks produced by the alpha particles were observed and counted under an optical microscope at 600X. The measured track density was converted in to radon concentration using a calibration factor ( $.021\text{tracks/cm}^2/\text{day} = 1\text{Bq/m}^3$ ) as used by other workers. [7-8]

The equations used for exhalation rates are:

$$E_M = \frac{CV\lambda/M}{T+1/\lambda(e^{-\lambda T}-1)} \quad (\text{Bq Kg}^{-1} \text{h}^{-1}) \quad \text{for mass exhalation rate} \quad (1)$$

$$E_A = \frac{CV\lambda/A}{T+1/\lambda(e^{-\lambda T}-1)} \text{ (Bq m}^{-2}\text{ h}^{-1}\text{)} \quad \text{for surface exhalation rate} \quad (2)$$

Where

C = Integrated radon exposure (Bq m<sup>-3</sup> h<sup>1</sup>)

M = Mass of sample (Kg)

V = Volume of air in can (m<sup>3</sup>)

T = Time of exposure (hrs)

λ = Decay constant for radon (h<sup>-1</sup>)

A = Area covered by the can or Surface area of the sample (m<sup>2</sup>)

### III. Results and Discussion

The calculated values of radon concentration in soil samples collected from the Karnal District varied from 197 Bq m<sup>-3</sup> to 1495 Bq m<sup>-3</sup> with an average of  $964 \pm 227$  Bq m<sup>-3</sup>. The values of radon concentration in soil samples from Panipat District varied from 708 Bq m<sup>-3</sup> to 2243 Bq m<sup>-3</sup> with an average of  $1346 \pm 151$  Bq m<sup>-3</sup>. The values of radon concentration in soil samples from Sonipat District varied from 905 Bq m<sup>-3</sup> to 2204 Bq m<sup>-3</sup> with an average of  $1175 \pm 142$  Bq m<sup>-3</sup>. The mass and the surface exhalation rates of radon were also calculated for all types of samples under study as shown in tables 1-3. It can be seen from the results that the radon concentration varies appreciably in various soil samples. It is due to the fact that the soil collected from various sites may have different uranium contents which results in change of radon emanation rates<sup>8</sup>.

### References

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**Table -1: Radon Concentration, Mass Surface Exhalation rates in soil samples collected from district Karnal (Haryana).**

| Soil Samples Location | Radon Conc(C) (Bq/m <sup>3</sup> ) | Mass Exhalation Rate (E <sub>m</sub> )(mBq kg <sup>-1</sup> Hr <sup>-1</sup> ) | Surface Exhalation Rate (E <sub>A</sub> ) (mBq m <sup>-2</sup> Hr <sup>-1</sup> ) |
|-----------------------|------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| KNL-1                 | 1023                               | 29                                                                             | 756                                                                               |
| KNL-2                 | 236                                | 07                                                                             | 174                                                                               |
| KNL-3                 | 197                                | 06                                                                             | 145                                                                               |
| KNL-4                 | 2125                               | 60                                                                             | 1570                                                                              |
| KNL-5                 | 1141                               | 32                                                                             | 843                                                                               |
| KNL-6                 | 1180                               | 34                                                                             | 872                                                                               |
| KNL-7                 | 315                                | 09                                                                             | 233                                                                               |
| KNL-8                 | 1495                               | 42                                                                             | 1105                                                                              |
| AM±SE*                | 964±227                            | 27±6                                                                           | 712±168                                                                           |

AM (arithmetic mean); \* SE (statistical error)

**Table -2: Radon Concentration, Mass and Surface Exhalation rates in soil samples collected from district Panipat (Haryana).**

| Soil Samples Location | Radon Conc(C) (Bq/m <sup>3</sup> ) | Mass Exhalation Rate (E <sub>m</sub> ) (mBq kg <sup>-1</sup> Hr <sup>-1</sup> ) | Surface Exhalation Rate (E <sub>A</sub> ) (mBq m <sup>-2</sup> Hr <sup>-1</sup> ) |
|-----------------------|------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| PNP-1                 | 2164                               | 62                                                                              | 1599                                                                              |
| PNP-2                 | 2243                               | 64                                                                              | 1658                                                                              |
| PNP-3                 | 1259                               | 36                                                                              | 931                                                                               |
| PNP-4                 | 1338                               | 38                                                                              | 989                                                                               |
| PNP-5                 | 708                                | 20                                                                              | 523                                                                               |
| PNP-6                 | 1220                               | 35                                                                              | 901                                                                               |
| PNP-7                 | 708                                | 20                                                                              | 523                                                                               |
| PNP-8                 | 1220                               | 35                                                                              | 901                                                                               |
| PNP-9                 | 1260                               | 36                                                                              | 931                                                                               |
| PNP-10                | 1338                               | 38                                                                              | 989                                                                               |
| AM±SE*                | 1346±151                           | 38±4                                                                            | 995±112                                                                           |

AM (arithmetic mean);\* SE (statistical error)

**Table -3: Radon Concentration, Mass and Surface Exhalation rates in soil samples collected from district Sonipat (Haryana).**

| Soil Samples Location | Radon Conc(C) (Bq/m <sup>3</sup> ) | Mass Exhalation Rate (E <sub>m</sub> ) (mBq kg <sup>-1</sup> Hr <sup>-1</sup> ) | Surface Exhalation Rate (E <sub>A</sub> ) (mBq m <sup>-2</sup> Hr <sup>-1</sup> ) |
|-----------------------|------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| SP-1                  | 1613                               | 46                                                                              | 1192                                                                              |
| SP-2                  | 1180                               | 34                                                                              | 872                                                                               |
| SP-3                  | 2164                               | 62                                                                              | 1599                                                                              |
| SP-4                  | 2203                               | 63                                                                              | 1628                                                                              |
| SP-5                  | 2125                               | 60                                                                              | 1570                                                                              |
| SP-6                  | 1417                               | 40                                                                              | 1047                                                                              |
| SP-7                  | 2164                               | 62                                                                              | 1599                                                                              |
| SP-8                  | 2204                               | 63                                                                              | 1628                                                                              |
| SP-9                  | 905                                | 26                                                                              | 668                                                                               |
| SP-10                 | 1775                               | 50                                                                              | 1311                                                                              |
| AM±SE*                | 1175±142                           | 50±4                                                                            | 1311±105                                                                          |

AM (arithmetic mean);\* SE (statistical error)