International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

A REVIEW ARTICLE ON THE STUDY OF RADON AND THORON CONCENTRATION USING SOLID STATE NUCLEAR TRACK DETECTOR

SALONI CHAUDHARY[1], PRATEEK UNIYAL[2], B. S. RAWAT[3]

[1]Scholar, Department of Physics, UCALS, Uttaranchal University, Dehradun, India
[2]Assistant Professor, Department of Physics, UCALS, Uttaranchal University, Dehradun, India
[3]Associate Professor, Department of Physics, UCALS, Uttaranchal University, Dehradun, India

---

Abstract - *The discovery of Solid State Nuclear Track Detectors (SSNTD) in 1958 found promising application in the various field like gamma dose measurement and neutron detection etc. The present article deals with the estimation of concentration of radon in different parts of the India due to the demanding interest on the work of radon and its yields as a source of exposure to radiation. Human beings consume radon as a main radioactive source by inhaling it from surroundings, which is naturally, occurs in atmosphere. Several observations show that radon and its progeny causes lung cancer. Track detectors were used for determining gas concentration levels of radon and its progeny in the dwellings of various parts of India. In the present review article the relation among building materials, insulation systems, and indoor radon pollution has been studied.*

Key Words: **Solid State Nuclear Track Detector, Dose measurement, Radon, Radioactive source, Indoor radon pollution.**

1. INTRODUCTION

A Solid State Nuclear Track Detector (SSNTD) is an example of a strong material presented to nuclear radiation (charged molecule, sometimes additionally gamma rays), etched and inspected infinitesimally. When a heavy charge particle bombards an SSNTD's surface, it will respond with the detector material until it has lost its energy or its goes through the SSNTD making a narrow latent track. This latent track can straightforwardly be observed under an electronic magnifying instrument and can likewise be seen under optical microscope after the utilization of chemical etching procedure to enlarge the latent track estimate. The track of atomic molecule was scratched quicker than the mass material, and the size and state of these track yield data about the mass, charge, energy and course of movement of molecule. If the particle enters with normal incidence into the surface, the pit appears round in shape; generally the ellipticity and circular pit demonstrate the direction of incidence.

Solid state nuclear track location procedure was discovered in 1958 by D.A.Young in crystal of LiF which was well established technique for estimation in huge number of fields including distinctive part of radioactivity or nuclear interaction [1].D.A. Young announced nuclear tracks in dielectric solid by watching carve pits of fission fragment in thick example of Lithium fluoride (LiF) utilizing an optical microscope. He considered the fission fragment delivered in the illumination of uranium foil with warm neutron. He treated the crystal with a chemical reagent to reveal the track and contemplated that as for chemical properties, the damage trail of fission fragment is like that of disengagement. He contended that the free energy of the particle of the harmed area is more than the whole material surrounding around and this region ought to be preferentially assaulted by a suitable chemical reagent.

The Track Detectors is being used for years to detect ionizing particles in a wide range of experimental and applications. This paper is all about Effects of Radon in different parts of India**.** Radon, which is present in the earth, establishes over a large portion of the radiation portion taken by the open yearly. It is among the densest substance that stays in a gas state under ordinary conditions. It's inward breath causes health hazard. Henshaw et al. in 1990 guaranteed that the radon present inside the dwellings are related with the danger of leukemia and certain different malignant growths, for example, melanoma and diseases of the kidney [2]. The grouping of radon and its decay product demonstrates a huge variance in indoor condition because of temperature, pressure, ventilation condition and building material, and so forth. As indicated by the United States Environmental Protection Agency (EPA), radon is the second most successive reason for lung malignant growth, after cigarette smoking, and it is named a cancer-causing specialist of a particular group (confirmed cancerogenity for man) by the International Agency for Research on Cancer (IARC/OMS)[3,4]. All structure material contains common radioactive nuclides primarily normal radionuclide of uranium (^{238}U) and thorium (^{232}Th) to decide and foresee the gas radon focus because of structure materials. Radon is viewed as a contaminant that influences air quality.

2. REVIEW OF LITERATURE

Anil Sharma et al., [2014], Studied radon and thoron concentration and their effect in the city of Aligarh, Uttar Pradesh and Dwarka Delhi, India. Effects of inhalation of radon and the products formed from its decay were studied. So, radon and thoron observation in dwellings was important for human health. Radon (^{222}Rn) and its yields present in the surrounding atmosphere causes inhalation risk to people particularly to those living in homes. The Track Detectors (SSNTDs) based twin chamber dosimeters were used in detecting the radioactive component especially Radon and its yields. The annual effective dose in some dwellings of Aligarh city, Uttar Pradesh and in Dwarka, in the South West Delhi district, which is one of the most populated residential urban area were monitored. The dosimeter employed for the measurements were developed at the Bhabha Atomic Research Centre (BARC) [5]. And thus with the help of them the radon, thoron and gamma dose levels were calculated in dwellings of Aligarh city Uttar Pradesh, India and in the some Flats of Dwarka, Delhi. In Aligarh city, radon concentrations varied from 5.7 to 19.2 Bqm^{-3}, and the thoron concentrations varied from 3.7 to 17.6 Bqm^{-3}. The annual effective dose due to the radon and its progeny were determined [6].

P C Deka et al., [2009], monitored indoor radon and thoron concentration levels in the territories of Nalbari, Assam, India. The levels of indoor radon and thoron were studied by utilizing the LR-115 (type II) Nuclear Track Detector (SSNTD) in Plastic Twin Chamber dosimeter in Nalbari region of Assam [7, 8]. For Assam types houses, concentration of radon fluctuates from approx 0.15 to 0.65 mWL(Potential Alpha Energy Concentration PAEC) with a yearly geometric mean of about 0.25 mWL and that for Reinforced Cement Concrete (R.C.C.) houses change from approx 0.20 mWL to 0.60 mWL with the yearly geometric mean of about 0.35 mWL and the thoron progeny levels in Assam types houses additionally change from about 0.01 to of 0.05 mWL with a yearly geometric mean of approx 0.03 mWL and that for R.C.C. houses differ from about 0.03 to 0.10 mWL with the yearly geometric mean of about 0.05 mWL. A significant variety in the indoor radon/thoron offspring focus levels in various seasons was observed. The proportions of radon and thoron progeny concentration among winter and summer seasons shift from approx 1 to 2.5 and 1.5 to 4.0 separately. In this work higher qualities were found for residences having R.C.C. structure (ground floor). Exhaustive examination of indoor radon levels and their reliance on structure materials, radon substance of soil and topography of the area helped in comprehension reasons for variety of radon and thoron offspring levels [9].

K. S. Babai et al., [2012], shows that estimated levels of radon present inside and retained portion effectiveness in the environment of Chennai city, Tamil Nadu, India. Radon fixations were estimated inside various sorts of homes in Chennai city, quarterly utilizing a Track detector (SSNTD) LR-115-Type II for 1 year. Critical regular varieties were watched. The normal most noteworthy radon fixation was seen amid winter, about 86 Bq m^{-3} and the least in summer about 43 Bqm^{-3}. The radon focuses were likewise changing based on various floor-covering materials. For a given season, the normal most extreme radon focus was seen with concrete deck which was approx 119 Bqm^{-3} trailed by tiles approx 75 Bqm^{-3} and marbles approx 74 Bqm^{-3} [10]. The study was done for a year covering all the seasons and it was viewed that the radon level was highest in winter season by International Commission on Radiological Protection (ICRP-103) [11].

Anil Sharma et al., [2015], studied concentration of radon, thoron levels and yearly effective portion in some home of Jaipur, Rajasthan, India. Nuclear Track Detectors (SSNTD) based twin chamber dosimeter with LR-115 track detector were utilized for evaluating Radon (^{222}Rn) and Thoron (^{220}Rn) gas focus levels in the abodes of Jaipur city [12]. Radon and thoron concentration levels were found to fluctuate from approx 4.5 to 27.5 Bqm^{-3} and thoron focuses is found to differ from about 3.5 to 23 Bqm^{-3}. The yearly effective portion because of the presentation to radon and progeny was found to change from 0.13 to 0.79 mSv though from thoron found to shift from 0.09 to 0.57 mSv. And thus it was concluded that there is no proper radiological threat to the human beings and the houses are safe [13].

Tushar Kandari et al., [2016] studied the radon, thoron and their yield radiation exposure in the surrounding atmosphere of rajpur region of Uttarakhand Himalaya. The concentration of radon, thoron and their descendants estimation were completed in the Rajpur district of Uttarakhand, Himalaya, India by utilizing LR-115 nuclear track detector (SSNTD) based time-coordinated procedures. The concentration of radon was estimated by single-passage stick gap dosimeter procedure, and for the descendents focuses, statement based Direct Thoron and Radon Progeny Sensor strategy has been used. The normal radon concentration changes from approx 70 to 125 Bqm^{-3} with a general normal of approx 90 Bqm^{-3}. The normal thoron fixation fluctuates from approx 25 to 60 Bqm^{-3} with a general normal of approx 40 Bqm^{-3}. The absolute yearly effective portion got because of radon, thoron and their offspring changes from approx 2.5 to 4.0 mSv y^{-1} with a normal of 3 mSv y^{-1}. It was demonstrated that the radon, thoron and its offspring convergences of the considered abodes in the Rajpur area are a lot higher than the world normal concentration yet lower than the prescribed dimension given by ICRP (2014) [14]. The radon, thoron and their offspring focuses particularly rely on the occasional variety and the area of shortcoming zone or fault zone that is main boundary thrust close to the examination territory [15]. The assessed radiation portion in the area was observed to be inside as far as possible [16].

Surinder Singh et al., [2005], studied monitored radon level in Hamirpur district, Himachal Pradesh, India using nuclear track detector (SSNTD). The work was embraced for wellbeing hazard assessment. The yearly normal concentration of radon in residences in the vast majority of the towns falls in the activity level prescribed by ICRP. The radon esteems in a portion of the abodes surpass the activity level. The regular variation in the indoor radon by structure materials used is being talked about. The normal indoor radon focus along with the variation of the yearly qualities monitored in 15 towns of Hamirpur area. The radon focus shifted from approx 260 Bqm^{-3} to 725 Bqm^{-3}. In the vast majority of the towns the indoor radon esteems lie in the scope of the activity level between 200–600 Bqm^{-3} suggested by ICRP (1993) [17]. The high radon esteems have been seen in certain homes. These indoor radon esteems surpass even the maximum furthest reaches of the activity level. Indeed, even the yearly viable portion gotten by the occupants of these towns crosses as far as possible (10 mSv) and may cause genuine wellbeing risk impacts in individuals. These qualities depend on the indoor radon estimations in abodes of towns of Hamirpur region, picked subjectively. There was an impressive variety in the indoor radon focus levels with the seasons amid the total year. The normal indoor radon focus level is least amid the midyear season and most extreme amid the winter season. The high estimation of indoor radon focus level amid the winter season was because of poor ventilation conditions. The radon level in inadequately ventilated houses was contrasted and that in the very much ventilated houses. Along these lines the ventilation conditions were found to influence radon fixation in homes. Also the levels of radon are much higher in houses of mud contrasted and the cement houses [18].

A.N. Shaikh et al., [2003] considered observation and demonstrating of radon present inside multi-storey working at Mumbai, India. Radon levels inside the multi-storey buildings at Mumbai was estimated for a year in all the seasons. Observing was completed utilizing the time-incorporated uninvolved indicator strategy, utilizing Kodak-115 sort Track Detectors (SSNTD). It was seen that over whole year level of radon in ground floor is much more then present in the top floors in every one of the seasons. The most elevated radon dimension of approx 58.0 to 59.0 Bqm^{-3} was seen on the ground floor and the least of approx 12 Bq m^{-3} was seen on the top floors amid in harvest time. The proportion of radon convergences in different seasons for a year in the multi-storey building was likewise determined. The concentration of radon in winter seasons was observed to be approx 75-90% higher in houses up to the eighth floor than the midyear season. For the higher floor houses it was found to be approx 20-70%. It was also observed that Radon level in the winter season was much more than the yearly midpoints which was approx 30-35% for every one of the floor asides from ground floor. The radon fixation amid winters were described by impressive variety and showed a diminishing pattern with the floor level. The variation in summer season in the concentration of radon was not as vast as seen in the winter season. The understanding between estimated esteems and determined qualities utilizing a meteorological model of indoor radon fixation at various floors was generally excellent inside the impediments of different field parameter esteem. The outcomes were in better understanding for the winter seasons. The displayed outcomes demonstrated proceeds with lessening with stature in the radon fixation both outside and inside [19] [20].

Sandeep Kansal et al., [2011], examined the indoor radon fixation in the dwelling of Haryana, India. Concentration of radon considers were completed in 100 dwellings of 20 towns in Haryana areas on west side, utilizing the nuclear track detector (SSNTD) method. LR-115 Type II (SSNTD) films were uncovered for 1 year covering all seasons for the estimation of radon present inside, quarterly. Seasonal variation of radon present inside indicates that in winter season its higher and lower esteems in summer season. The distinction observed with the overall normal fixation was because of the radioactive components with higher concentration, for example present of uranium, radium and other radioactive components in the soil and building materials of the investigation region. Similarly high estimations of concentration of radon are accounted ineffectively in the ventilated houses. The proportion of winter/summer indoor radon ranges from approx 1.5 to 2.5 with a normal of 1.7 for all the contemplated dwellings. The yearly average indoor radon focus in the investigation territory varied from approx 125 to 545 $Bqm^{-3}$with a normal estimation of 252 Bqm^{-3} which was multiple times more than the world average of 40 Bqm^{-3}. In any case, this value exists in the prescribed reference dimension of approx 200-300 Bqm^{-3} (ICRP, 2009) [21]. Henceforth, there is no huge risk to the individuals because of the nearness of common radon in the home [22].

M. Sreenath Reddy et al., [2009], studied radon levels in Hyderabad area, Andhra Pradesh, India. Radon levels were calculated by a time integrated technique using solid state nuclear track detector (SSNTD) -based dosimeters in the areas of Hyderabad. The evaluated radon fixations in the dwelling of Hyderabad area varied somewhere in the range of 17 and 311 Bqm^{-3}. Such wide contrasts in the qualities might be a result of the varieties in radioactivity levels in structure material utilized for the development work and the soil. Soil investigation from the region of Hyderabad showed that the ^{226}Ra content varied from approx 11 to 92 $Bqkg^{-1}$. The variation by the season in the concentration levels of radon, in 100 dwellings of Hyderabad was observed. A slight increment was observed in the winters, as compared to remaining other seasons, the level were the same almost. The study established that in Hyderabad area the radon levels are moderately high in comparison with those seen in different states of India. The national average estimation of approx 23-24 Bqm^{-3} were found and worldwide average estimation of approx 30-31 Bqm^{-3} [23].

3. CONCLUSIONS

In the present article measurement of radon conducted in different parts of India has been reviewed. Most studies reported data for measurements of indoor radon, but few studies covered exhalation rates of radon in building materials and stones. Most homes from various countries had residential surveys, and radon was within recommended limits. It was also viewed that the radon, thoron and their yields concentrations very much particularly rely on the seasonal variation. The outcomes were in better understanding for the winter season than for the late spring season. The estimations were additionally done in an elevated structure. The investigation was conducted all four seasons and radon levels were expected to be highest in the winter season, although very far within the 300 Bqm^{-3} limit for the homes recommended by ICRP-103. The houses with cement as flooring materials show higher levels of radon compared with other flooring materials (Tiles, Marbles).

The results in the above report confirms that the concentrations of the radon rely upon both the idea of the structure materials and the protection strategies of the structures and recommend, for the new developments, to upgrade the decision of the structures materials, with specific reference to the nearby land area. Present investigation reasons that the houses are protected without presenting critical radiological risk to the individuals.

REFERENCES

[1] https://en.wikipedia.org/wiki/Solid-state_nuclear_track_detector.
[2] Surinder Singh, Ajay Kumar, Baldev Singh (2005), "Passive integrating radon studies for environmental monitoring in Hamirpur district, Himachal Pradesh, India using solid state nuclear track detectors," Radiation Measurements, vol 39, 81 – 85
[3] F. Lamonaca, V. Nastro, A. Nastro, D. Grimaldi, "Monitoring of Indoor Radon Pollution," Measurement (2013)
[4] NRPB (National Radiological Protection Board). Health Risks from Radon, ISBN 0-85951- 49-8, 2000.
[5]Eappen, K.P., Mayya Y.S., 2004, "Calibration factors for LR-115 (typeII.) based radon thoron discriminating dosimeter," Radiat. Meas.38 5-17.
[6] Anil Sharma, Ajay Kumar Mahur, S. Asad Ali, R G. Sonkawade and A. C. Sharma (2015), "Monitoring of indoor radon, thoron levels and annual effective dose in some dwelling of Jaipur, Rajasthan, India using double dosimeter cups," Archives of Applied Science Research, vol 7 (2):1-4
[7] P C Deka, B Bhattacharjee, B K Sarma and T D Goswami Indian J. Env. Prot. 21 24 (2001)
[8] P C Deka, Subir Sarkar, B K Sarma, T D Goswami, T V Ramachandran and K S V Nambi Indoor Built Environ. 12 343 (2003)
[9] P C Deka1, H Sarma, Subir Sarkar, T D Goswami and B K Sarma (2009), "Study of indoor radon and thoron progeny levels in surrounding areas of Nalbari, Assam," Indian.J.Phys. vol 83(7), 1025-1030.
[10] K. S. Babai, S. Poongothai, K. S. Lakshmi, J. Punniyakotti, V. Meenakshisundaram(2012), "Estimation of indoor radon levels and absorbed dose rates in air for Chennai city, Tamilnadu, India," J Radioanal Nucl Chem, vol 293, 649–654
[11] ICRP (2007) The 2007 recommendations of the International Commission on Radiological Protection. ICRP publication 103.Ann ICRP 37(2–4):1–33
[12] R.C., Ramola, B.S., Rautela, G.S., Ganesh, Gusain, Prasad, S.K., Sahoo, S., Tokonam, 2013. Radiation Measurements 53-54 71-73.
[13] Anil Sharma, Ajay Kumar Mahur, S. Asad Ali, R G. Sonkawade and A. C. Sharma (2015), "Monitoring of indoor radon, thoron levels and annual effective dose in some dwelling of Jaipur, Rajasthan, India using double dosimeter cups," Archives of Applied Science Research, vol 7 (2):1-4
[14] ICRP. Radiological Protection against Radon Exposure, ICRP Publication 126 Annals of the ICRP, 43(3) (2014).
[15] R.C., Ramola, B.S., Rautela, G.S., Ganesh, Gusain, Prasad, S.K., Sahoo, S., Tokonam, 2013. Radiation Measurements 53-54 71-73.
[16] Tushar Kandari, Sunita Aswal, Mukesh Prasad, Preeti Pant, A. A. Bourai and R. C. Ramola (2016), "Study of radiation exposure due to radon, thoron and their progeny in the indoor environment of rajpur region of Uttarakhand Himalaya," Radiation Protection Dosimetry (2016), pp. 1–4
[17] ICRP, 1993. Protection against radon-222 at home and at work. ICRP Publication 65, Annals of the ICRP, 23 (2).
[18] Surinder Singh, Rajeev Malhotra, Jatinder Kumar, Lakhwant Singh (2001), "Indoor radon measurements in dwellings of Kulu area, Himachal Pradesh, using solid state nuclear track detectors," Radiation Measurements, vol 34 (2001) 505–508.
[19] Ayotte, P., Levesque, B., Gauvin, D., Mc Gregor, R.G., Martel, R., Gingras, S., Walker, W.B., Letourneau, E.G., 1998. Indoor exposure to 222 Rn: A public health perspective. Health Physics 75, 297–302.
[20] A.N. Shaikh, T.V. Ramachandran, A. Vinod Kumar (2003), "Monitoring and modelling of indoor radon concentrations in a multi-storey building at Mumbai, India," Journal of Environmental Radioactivity, vol 67, 15–26
[21] ICRP (2009) 'International commission on radiological protection statement on radon', ICRP Ref 00/902/09.

[22] Sandeep Kansal, Rohit Mehra, N.P. Singh (2011), "Measurement of indoor radon concentration in the dwelling of Western Haryana, India, for health risk assessment," Int. J. Low Radiation, Vol. 8, No. 2, pp.122–134.
[23] M. Sreenath Reddy, P. Yadagiri Reddy, K. Rama Reddy, K. P. Eappen, T. V. Ramachandran and Y. S. Mayya (2009), "Indoor radon levels in urban Hyderabad area, Andhra Pradesh, India," Radiation Protection Dosimetry, Vol. 132, No. 4, pp. 403–408.