STUDY OF RADON, THORON CONCENTRATION AT DIFFERENT PARTS OF INDIA USING SOLID STATE NUCLEAR TRACK DETECTOR: A REVIEW

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Abstract: Since the discovery in 1958, Solid State Nuclear Track Detectors (SSNTD) found promising application in the various field. With the demanding interest on the work of radon and products of it, as a source of exposure to radiation, the estimation of concentration of radon in various parts of the India has been realized. Radon and its decay products inhalation is one the major source of the radioactive dose in taken by the human population from natural radiation. The epidemiological studies have established the fact that radon and its progeny are associated with lung cancer. Track detectors were used for estimating Radon (^{222}Rn) and Thoron (^{220}Rn) gas concentration levels in the dwellings of different parts of India. In this review the relation among building materials, insulation systems, and indoor radon pollution has been studied.

1. Introduction

A solid state nuclear track detector **(**SSNTD), which is an example of a strong material presented to nuclear radiation(neutron or charged molecule, sometimes additionally gamma rays), etched and inspected infinitesimally. 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 appear 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 [1]. He found first track in crystal of LiF the system has throughout the most recent couple of decades became popular and well established technique for estimation in huge number of fields including distinctive part of radioactivity or nuclear interaction.

When a heavy charge particle bombards an SSNTD's surface, it will respond with the detector material (Breaking the molecular bond of SSNTD material making a damage zone along its way) until it has lost its energy on its goes through the SSNTD making a narrow latent track. This latent track can straightforwardly be seen 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.

D.A. Young (1958) announced nuclear tracks in dielectic 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 higher than the surrounding whole material and this region ought to be preferently assaulted by a suitable chemical reagent.

Solid State Nuclear Track Detectors (SSNTD) have being used for many 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 remain in a gas state under ordinary conditions.

It's inward breath causes health hazard. Henshaw et al. (1990) guaranteed that indoor radon presentation is 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 gathering 1 (operators of 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 concentration of radon and thoron and their annual effective dose in some dwellings of Aligarh city Uttar Pradesh and Dwarka Delhi, India. Effects of inhalation of radon and its decay products was demonstrated. So, monitoring of radon and thoron in dwellings was important for human health. Radon (^{222}Rn) and its progeny in the atmosphere results in inhalation risk to people particularly to those living in homes. Solid State Nuclear Track Detectors (SSNTDs) based twin chamber dosimeters were used and annual effective dose in some dwellings Aligarh city near Narora Atomic Power Station (NAPS) and in Dwarka, in the South West Delhi district of the National Capital Territory of Delhi which is one of the most populated residential urban area. The dosimeter employed for the measurements of radon and thoron was made up of a twin cup cylindrical system, developed at the Bhabha Atomic Research Centre (BARC) [5]. And thus the radon, thoron and gamma dose levels were calculated in the some houses of Aligarh city Utter Pradesh, India and in the some Flats of Dwarka, Delhi. In Aligarh city, radon concentrations varied from 5.7 Bq m^{-3} to 19.2 Bq m^{-3} , and the thoron concentrations varied from 3.7 Bq m^{-3} to 17.6 Bq m^{-3}. The annual effective dose due to the exposure to indoor radon and progeny are found to vary from 0.16 to 0.55 mSv with an average value of 0.37 mSv [6].

P C Deka et al., [2009], monitored indoor radon and thoron progeny levels in the territories of Nalbari, Assam, India. The levels of indoor radon and thoron were studied by utilizing the LR-115 (type II) Solid State Nuclear Track Detector (SSNTD) in Plastic Twin Chamber dosimeter in Nalbari region of Assam [7] [8]. For A.T. (Assam types) houses, concentration of radon fluctuates from 0.17 to 0.64 mWL with a yearly geometric mean of 0.27 mWL and that for Reinforced Cement Concrete (R.C.C.) houses change from 0.22 mWL to 0.60 mWL with the yearly geometric mean of 0.37 mWL and The thoron progeny levels in A.T. houses additionally change from 0.01 to of 0.05 mWL with a yearly geometric mean of 0.02 mWL and that for R.C.C. houses differ from 0.02 to 0.08 mWL with the yearly geometric mean of 0.04 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 1.1 to 2.6 and 1.3 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], Estimated levels of indoor radon and retained portion effectiveness in air for Chennai city, Tamil Nadu, India. Radon fixations were estimated inside various sorts of homes in Chennai city, quarterly utilizing a Solid State Nuclear 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 (86.08 Bq m^{-3}) and the least in summer (42.50 Bq m^{-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 (118.96 Bq m^{-3}) trailed by tiles (75.25 Bq m^{-3}) and marbles (74.04 Bq m^{-3}) [13]. The study covered all the four seasons and, as expected, the radon levels are the highest in winter season though very much within the ICRP-103 [14].

Anil Sharma et al., [2015], studied indoor radon, thoron levels and yearly effective portion in some home of Jaipur, Rajasthan, India. Strong State Nuclear Track Detectors 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 [15]. Radon and thoron concentration levels in the studied abodes were found to fluctuate from 4.6 to 27.4 Bq m^{-3} and thoron focuses is found to differ from 3.8 to 22.9 Bq m^{-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 significant radiological threat to the human beings and the houses are safe [16].

Tushar Kandari et al., [2016] studied the radiation exposure in the indoor environment due to radon, thoron and their progeny in the rajpur region of Uttrakhand Himalaya. The indoor radon, thoron and their descendants estimation have been completed in the Rajpur district of Uttrakhand, Himalaya, India by utilizing LR-115 solid state nuclear track detector (SSNTD) based time-coordinated procedures. The concentration of gas have been estimated by single-passage stick gap dosimeter procedure, and for the progeny focuses, statement based Direct Thoron and Radon Progeny Sensor strategy has been used. The normal radon concentration changes from 75 to 123 Bq m^{-3} with a general normal of 89 Bq m^{-3}. The normal thoron fixation fluctuates from 29 to 55 Bq m^{-3} with a general normal of 38 Bq m^{-3}. The absolute yearly effective portion got because of radon, thoron and their offspring changes from 2.4 to 4.1 mSv y^{-1} with a normal of 2.9 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 International Commission on Radiological Protection, ICRP (2014) [17]. The radon, thoron and their offspring focuses particularly rely on the occasional variety and the area of shortcoming zone (MBT) close to the examination territory [18]. The assessed radiation portion in the area was observed to be inside as far as possible [19].

Surinder Singh et al., [2005], studied monitored radon level in Hamirpur district, Himachal Pradesh, India using solid state 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 (International Commission on Radiological Protection). The radon esteems in a portion of the abodes surpass the activity level. The regular varieties and the commitment of structure divider materials to the indoor radon in abodes are being talked about. The normal indoor radon focus along with the standard deviation of the yearly qualities recorded in 15 towns of Hamirpur area. The radon focus shifted from 260.51 Bq m^{-3} to 724.29 Bq m^{-3}. In the vast majority of the towns the indoor radon esteems lie in the scope of the activity level (200– 600 Bq m^{-3}) suggested by ICRP (1993) [20]. The high indoor 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. The regular varieties of indoor radon focus amid the period March 1997– 1998 were accounted for. 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 radon levels were higher in houses of mud contrasted and the cement houses [21].

A.N. Shaikh et al., [2003] considered Monitoring and demonstrating of indoor radon fixation in a multi-storey working at Mumbai, India. Radon levels in an indoor air of a multi-storey working at Mumbai have been estimated for one year covering all the four seasons. Observing was completed utilizing the time-incorporated uninvolved indicator strategy, utilizing Kodak-115 sort Solid State Nuclear Track Detectors (SSNTD). It was seen that the normal yearly radon levels are higher on ground floor and lower on the nineteenth floor in every one of the seasons. The most elevated radon dimension of 59.0 Bq m^{-3} was seen on the ground floor in winter and the least of 12.4 Bq m^{-3} was seen on the nineteenth floor amid harvest time. The proportion of radon convergences of various seasons in the multi-storey building were likewise determined. The radon focuses in winter seasons was observed to be about 73-91% higher in houses up to the eighth floor than the midyear season. For the staying higher floors it was in the scope of 20-65%. Radon focuses in the winter season were higher than the yearly midpoints in the scope of 31-37% for every one of the floor asides from ground and first floor. The radon fixation amid winters were described by impressive variety and showed a diminishing pattern with the floor level. The variety of summer radon focuses 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 of a multi storey building 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 a proceeds with lessening with stature in the radon fixation both outside and inside [22] [23].

Sandeep Kansal et al., [2011], examined the indoor radon fixation in the dwelling of Western Haryana, India. Indoor radon considers were completed in 100 dwellings of 20 towns in western Haryana areas, India, utilizing the solid state nuclear track detector(SSNTD) method. LR-115 Type II (SSNTD) films in the bare mode were uncovered for 1 year on a quarterly premise to cover all the seasons for the estimation of indoor radon levels.
Seasonal variation of radon present inside indicated higher value in winter and lower esteems in summer. The distinction observed with the overall normal fixation was because of the radioactive components with higher concentration, for example uranium and radium in the soil and building materials of the investigation region. Similarly high estimations of radon concentration are accounted for in ineffectively ventilated houses as contrasted and the all around ventilated houses. The winter/summer proportion of indoor radon ranges from 1 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 126 to 546 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 200– 300 Bqm^{-3} (ICRP, 2009) [24]. Henceforth, there is no huge risk to the individuals because of the nearness of common radon in the home [25].

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, Andhra Pradesh, India. The evaluated radon fixations in the dwelling of Hyderabad area varied somewhere in the range of 17 and 311 Bq m^{-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 showed that the ^{226}Ra content varied from 12 to 90 Bq kg^{-1}. The variation by the season in the radon concentration levels, in 100 dwellings of Hyderabad was observed. A slight increment was found in the winter season, while in other remaining seasons the level were almost the same. The study established that in Hyderabad area the radon levels are moderately high compared with those seen in different states of India, the national average estimation of 23 Bq m^{-3} and worldwide average estimation of 30 Bq m^{-3} [26].

3. Conclusion

The relationship between construction year of the buildings and indoor radon concentration demonstrated an expanding of radon focus after 1940, because of better protection and shutting frameworks improved during the years. Buildings built after 1940, demonstrate a higher focus level that rely upon rock materials and on old isolation frameworks from ground. The information of natural radioactivity dimensions of building materials is of important significance for the evaluation of the ionizing radiations introduction in indoor condition.

In the current article radon measurement studies conducted in different parts of India has been reviewed. Most of the studies reported the data for indoor radon measurements
but few studies addressed radon exhalation rates from building materials and decorative stones. Most of the houses from different states were surveyed for residential, radon were within recommended limits. It was also viewed that the radon, thoron and their progeny concentrations very much rely 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 secured all the four seasons and, as expected, the radon levels were found highest in winter season though very much within the ICRP-103 recommended limit of 300 Bq m^{-3} as applicable for the dwellings. The dwellings with cement as flooring materials indicate higher radon levels as compared to 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.

4. Reference

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