

MEASUREMENT OF INDOOR RADON AND THORON CONCENTRATION AND THEIR PROGENY LEVEL IN SOME SPECIFIC PLACES OF KARBI ANGLONG DISTRICT

Ranjan Kr. Kakati

Director, Students' Welfare, Gauhati University, Guwahati, Assam, India

Email : dsw@gauhati.ac.in

Abstract :

Study of radon, thoron and its progeny level is very much important for assessing environmental impact in a society, inhalation and ingestion of which may cause lung cancer, stomach cancer etc. Worldwide radon survey is going on to know the inhalation dose received by the common people, dwellings in the study area. Bhaba Atomic Research Centre developed some standard devices for measurement of radon, thoron and its progeny level in the environs. BARC Dosimeter cup and LR-115 Type II detectors were used to calculate the concentration of radon, thoron and its progeny in the environs of some specific places of Karbi Anglong district of Assam. The radon concentration varies from 98.16 ± 7.38 Bq/m³ to 224.82 ± 11.15 Bq/m³ in RCC type of houses. The annual average radon concentration in different Assam type of houses varies from 84.93 ± 6.84 Bq/m³ to 217.45 ± 10.99 Bq/m³. It has been observed that average annual radon concentration for RCC type of houses is 163.45 Bq/m³ and that for Assam type of houses is 129.05 Bq/m³. The annual effective dose due to radon and thoron in RCC type of houses varies from 1.92 mSv to 4.20 mSv where as in Assam type of houses it varies from 1.52 mSv to 3.98 mSv.

1 INTRODUCTION :

Inhalation of radon (²²²Rn) and its short lived daughter products (²¹⁸Po, ²¹⁴Po) contribute a major fraction of total dose to human beings from all possible sources of natural radioactivity. Radon (²²²Rn) decays to ²¹⁸Po (RaA, 3.05 min), ²¹⁴Pb (RaB, 26.8 min), ²¹⁴Bi (RaC, 19.7 min), ²¹⁰Pb (RaD, 22.3 years) etc. Radon is chemically inactive and does not bind to tissues but upon inhalation the radon daughters like ²¹⁸Po, ²¹⁴Pb irradiates the lung tissues by α -particles of energies 6.0 Mev and 8.7 Mev respectively. Such α -exposure is supposed to be one of the serious causes of increased incidence of lung cancer, skin cancer etc. [M.Sen et al., 1998]. Some fractions of radon progeny will also penetrate into the blood from the lungs and irradiate the whole human body [Nikezic D and Yu K.N, 2009].

The concentration of radon in dwellings is influenced not only by the building materials but also to a large extent by other factors such as natural ventilation, opening and closing of doors and windows, movement of people in and out of the

dwellings etc. Because of poor ventilation, the levels of radon and its daughters in the environs are very high which is supposed to be the cause of increased lung cancer.

Though a nationwide survey has already been carried out on radon and its progeny by many institutions, universities and research centers, very few data were reported from the North-Eastern part of India and particularly no data was reported from Karbi Anglong and NC Hills district.

In Karbi Anglong and N-C Hills districts and some places of Kamrup and Nagoan districts, many people were affected from fluoride present in drinking water. Some experiments indicate that fluorine can react with radon and form radon fluoride (EPA report, 2007). Isam Salih et al., (2004) observed a positive correlation between fluoride and radon concentration in water samples. They pointed out that high fluoride concentrations may either increase the amount of radon in water (from field observation) or/and retain radon already present in the solution (from laboratory studies). As mentioned earlier, about 8% of the population of

Karbi Anglong district suffered from various diseases like Dental flourosis, Skeletal flourosis, Non-Skeletal flourosis etc.

Looking at these facts, in the present study, an attempt has been made to study the concentration of radon/thoron and its progeny level in indoor air in some dwellings of Karbi Anglong district of the state Assam, India.

2 Geographical location of Study area:

The global position of Karbi Anglong district is - latitudinal extension 25°32' North - 26°33' North and longitudinal extension 92°09' East - 93°52' East. Going by latitude and longitude, the exact geographical location of Bokajan town is at 26.02° North and 93.78° East. It has a mean elevation of 138 meters (452 feet) above sea level. The Cement Corporation of India Limited has one of its units in this town.

3 EXPERIMENTAL PROCEDURES :

MEASUREMENT OF RADON, THORON AND THEIR PROGENY USING SSNTDS.

In the present study, strippable cellulose nitrate film, LR-115 (type-II) plastic detector manufactured by Kodak Pathe was exposed for the measurement of indoor radon and thoron using plastic twin chamber dosimeter cups (BARC type). The exposure was done in three different modes (i) bare mode (ii) cup with filter paper and (iii) cup with filter paper-mylar-filter paper (P. C Deka et al., 2003).

The bare mode registered tracks due to total α -activity, the detector facing the filter paper only, registered tracks resulting from the decay of radon and thoron and the detector facing filter paper-mylar-filter paper had registered the tracks of α -particles due to the decay of radon only.

For the present investigation, the exposure was done for a period of one complete session in some selected Assam Type (AT) houses of various places of Karbi Anglong district of Assam. The cups were placed at least 1 m above the ground level and 15 cm away from the nearest wall or roof. Five AT houses were selected at each place for the study of indoor radon, thoron and their progeny.

The detectors were retrieved and etched in 2.5 N NaOH solutions at 60 °C for a period of 90 minutes. For uniform etching, a Remi magnetic stirrer was used. The microscopically visible tracks were then counted in a Carl Zeiss microscope under magnification of 400X. The radon and thoron concentrations are determined by using the following relations(K.K. Dwivedi et al., 2001)

$$C_R = T_1/d.K_R \quad (1)$$

$$C_T = (T_2-T_1)/d.K_T$$

Where C_R = concentration of radon in Bq/m³

C_T = concentration of thoron in Bq/m³

T_1 = Track density recorded in the membrane modes of exposure.

T_2 = Track density recorded in the filter paper compartment exposure.

d = No. of exposure days.

$K_R = 0.020 \text{ Tcm}^{-2} / \text{Bq.d.m}^{-3}$ is the sensitivity factor for radon in the membrane compartment.

$K_T = 0.019 \text{ Tcm}^{-2} / \text{Bq.d.m}^{-3}$ is the sensitivity factor for thoron in the filter paper compartment.

From the obtained values of radon and thoron, the daughter concentration of radon and thoron in terms of Potential Alpha Energy Concentration (PAEC) in mWL has been calculated using the relation (ICRP, 1993)

$$C_R \text{ or } C_T (\text{Bq/m}^3) = \text{PAEC (WL)} \times 3700/F$$

Where F is equilibrium factor and its value is 0.4 and 0.1 for radon and thoron respectively (UNSCEAR, 1999). Annual exposure due to radon and its progeny have been calculated by using the generic relations (ICRP, 1981). In a home with PAEC of 1 mWL, the annual exposure in WLM is $(365 \times 24 \times 0.8)/(170 \times 1000) = 0.0412 \text{ WLM}$.

The PAEC was converted into annual effective dose by using dose conversion factors; the radon daughter dose conversion factor for members of the public is 3.9 mSv per WLM (ICRP, 1993), whereas the effective dose equivalent for thoron is 3.4 mSv per WLM (UNSCEAR, 1993).

RESULTS AND DISCUSSION :

4. MEASUREMENT OF RADON, THORON AND THEIR PROGENY CONCENTRATION IN BOKAJAN SUBDIVISION.

The indoor radon, thoron and their progeny concentration in the Bokajan town and the adjoining areas were measured for one complete session in all the four seasons. In the study area, mainly two types of houses were selected viz. RCC type and Assam type. The annual average values of radon concentration in different RCC and Assam type of houses are shown in the Fig.1 which shows the variation of annual average indoor radon concentration in different places of RCC type of houses of Bokajan subdivision. The radon concentration varies from 98.16 ± 7.38 Bq/m³ to 224.82 ± 11.15 Bq/m³ in RCC type of houses. Fig.2 shows the variation of annual average radon concentration in different Assam type of houses in the range of 84.93 ± 6.84 Bq/m³ to 217.45 ± 10.99 Bq/m³. It has been observed that average annual radon concentration for RCC type of houses is 163.45 Bq/m³ and that for Assam type of houses is 129.05 Bq/m³.

Also, from the present investigation, it is observed that the annual average thoron concentrations for RCC type of houses varies from 33.80 ± 4.44 Bq/m³ to 78.13 ± 6.76 Bq/m³ whereas in Assam type of houses it varies from 29.10 ± 4.12 to 65.23 ± 6.17 Bq/m³. The annual average values of thoron concentration in RCC and Assam type of houses are 57.02 Bq/m³ and 43.48 Bq/m³ respectively. Thus, higher values of radon and thoron concentrations are observed in RCC type of houses compared to Assam type. Fig. 3 and 4 shows the variation of indoor thoron concentration in different RCC and Assam type of houses respectively. The reason for higher values in RCC type of houses may be due to the nature of the building materials used for the construction purposes. The higher levels of radon and thoron concentration in the dwellings also depend upon the type of floor area. Emanation of radon from soil surface is higher than the cement plastered floor area (BARC report, 2003). Radon and thoron concentration in the dwellings of the studied locations are within the International Commission on Radiological Protection action level of (200-600) Bq.m⁻³ [ICRP, 1993].

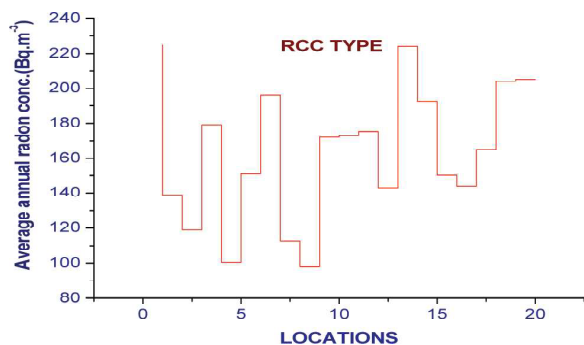


Fig.1. Annual average radon concentration in RCC type of buildings in different locations of Bokajan Sub division.

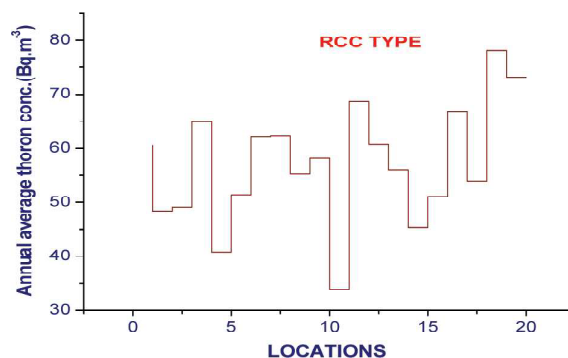


Fig. 3 Variation of average thoron concentration in RCC type of houses in different locations of Bokajan sub-division.

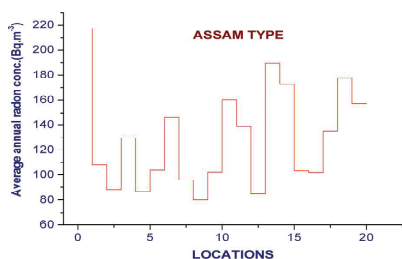


Fig. 2. Annual average radon concentration in Assam type of houses in different locations of Bokajan sub division.

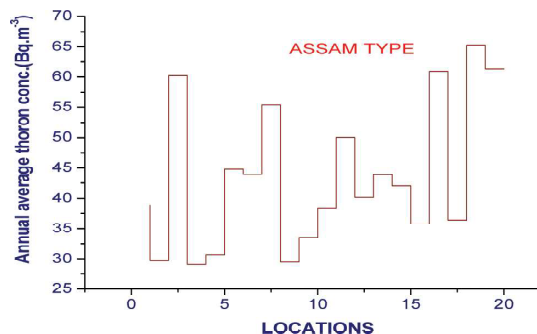


Fig. 4 Variation of average thoron concentration in Assam type of houses in different locations of Bokajan sub-division.

The progeny working level due to radon in RCC type of houses varies from 10.8 ± 0.80 mWL to 24.73 ± 1.22 mWL with a mean value of 17.98 ± 1.04 mWL. The annual exposure to the occupants due to radon concentration varies from 0.44 ± 0.03 WLM to 1.02 ± 0.05 WLM with a mean value of 0.74 WLM for the RCC type of houses. The variation of thoron progeny level in the studied location ranges from 0.91 ± 0.12 mWL to 2.10 ± 0.18 mWL with a mean value of 1.53 ± 0.15 mWL. The annual exposure to the occupants due to thoron varies from 0.037 ± 0.004 WLM to 0.086 ± 0.007 WLM with a mean value of 0.062 WLM for the RCC type of houses. The total annual effective dose received by the inhabitants due to radon and thoron concentration from RCC type of houses varies from 1.92 mSv to 4.20 mSv with a mean value of 3.09 mSv.

The progeny working level due to radon concentration in the Assam type of houses varies from 8.79 ± 0.73 mWL to 23.91 ± 1.20 mWL with a mean value of 14.19 ± 0.92 mWL and that due to thoron concentration, it varies from 0.78 ± 0.11 mWL to 1.76 ± 0.17 mWL with a mean value of 1.17 ± 0.13 mWL. The annual exposure due to radon in Assam type of houses varies from 0.362 ± 0.03 WLM to 0.985 ± 0.04 WLM with a mean value of 0.584 WLM and that due to thoron, it varies from 0.032 ± 0.004 WLM to 0.072 ± 0.007 WLM with a mean value of 0.048 WLM. The total annual effective dose due to radon and thoron concentration from Assam type of houses varies from 1.52 mSv to 3.98 mSv with a mean value 2.44 mSv.

Fig.5 shows the seasonal variation of mean indoor radon concentration in RCC and Assam type of houses. As expected, the average radon values are found to be maximum in winter and minimum in summer for both the type of houses. Similar variations were reported by S.D.Francesco et al., (2010); S.Singh et al.(2002, 2005); M.Manousakas et al., (2010); R.C.Ramola et al., (1997).

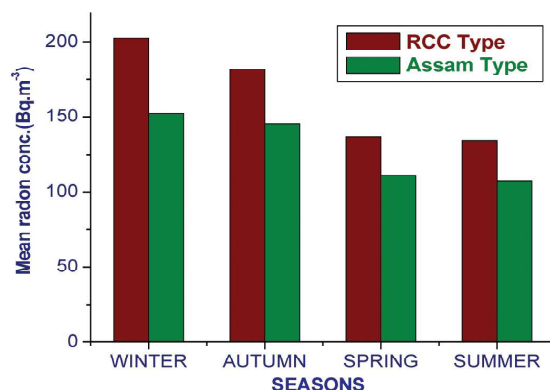


Fig. 5 Seasonal variation of mean indoor radon concentration in RCC and Assam type of houses.

Again, for the observation of seasonal variation due to thoron concentration for both RCC and Assam type houses, a figure has been plotted.

Fig.6 shows the maximum value of thoron concentration during winter and minimum during summer. Similar variations were reported by P.C.Deka et al., (2003); K.K.Dwivedi et al., (2001); R.C.Ramola et al., (1989). Poor ventilation system is considered to be the main cause of high radon or thoron concentration during winter.

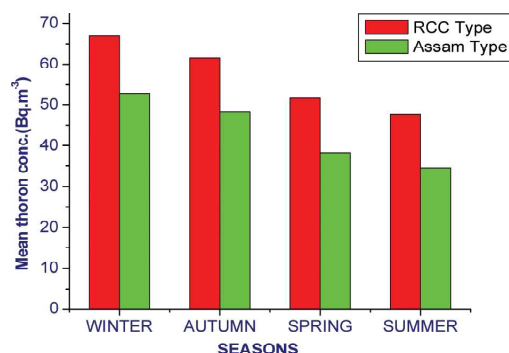


Fig. 6 Seasonal variation of mean thoron concentration in RCC and Assam type of houses

For the comparison of level of radon and thoron concentration in RCC and Assam type of houses, it can be readily observed that RCC type of houses accumulate more radiation exposure as compared to Assam type being maximum during winter and minimum in summer.

From the data it is observed that the level of indoor radon concentration is higher in Bokajan subdivision as compared to other two subdivisions.

All the dwellings have higher annual effective dose in RCC type of dwellings as compared to Assam type. Therefore, observing all the reports, it can now be placed that Assam types of houses are more suitable from the radiation exposure point of view.

REFERENCES:

- BARCReport (2003): No. BARC/2003/E/026, pp.1-43.
- Chakraborty, D., Chanda, C.R., Samanta, G., Chowdhury, U.K., Mukherjee, S.C., Paul, A.B., Sharma, B., Mahanta, K.J., Ahmed, H.A. and Singh, B. (2000). *Current Sc.*, 78(12), pp. 1421-1423.
- Deka, P. C., Sarkar, S., Sarma, B. K., Goswami, T. D., Ramachandran, T. V., Nambi, K. S. V. (2003). *Ind. and Built Env.* 12, pp.343-349.
- Dwivedi, K. K., Mishra, R., Tripathy, S. P., Kulshreshtha, A., Sinha, D., Srivastava, A., Deka, P., Bhattacharjee, B., Ramachandran, T.V. and Nambi, K.S.V., (2001). *Rad. Meas.* 33, 7-11.
- EPA (2007-08-08). United States Environmental Protection Agency: Radon. Retrieved on 2007-08-17.
- Francesco, S.D., Tommasone, F.P., Cuoco, E. and Tedesco, D. (2010). *Rad. Meas.* 45, 928-934.
- Ghosh, D., Deb, A., Patra, K.K. (2004). *Radiation measurement*, 38, pp 19-22.
- Henshaw, D.L., Eatough, J.P., Richardson, R.B. (1990). *Lancet*, 355, pp.1008-1015.
- ICRP publication 65 *Annals of the ICRP* 23(2) (OXFORDUK) (1993).
- Jha, G. and Raghavayya, M., (1988). *Proc. of 5th National Seminar on SSNTD held at Saha Institute of Nuclear Physics, Calcutta*, pp. 171-176.
- Mehra, R., Singh, S., Kumar, S. (2009). *Ind. J. Phys.* 83(8) pp.1191-1196.
- Manousakas, M., Fouskas, A., Papaefthymiou, H., Koukoulidou, V., Siavalas, G. and Kritidis, P. (2010). *Rad. Meas.* 45, pp. 1060-1067.
- Nikezic, D. and Yu, K.N., (2009). *Ind. J. of Phy.* 83 (6), pp.759-775.
- Ramachandran, T.V., Sheikh, A.N., Eappen, K.P., Nair, N.B., and Nambi, K.S.V. (1997). *Proc. of the 3rd Int.Collocuium on rare gas Geochemistry held at GuruNanakDevUniversity*, pp.364-372.
- Ramola, R.C. (1989). Ph.D. thesis submitted to GNDU, Amritsar, India.
- Ramola, R.C., Rawat, R.B.S, Kandari, M.S. and Choubey, V.M. (1997). *Radian. Prot. Dosim.* 74(1&2), pp.103-105.
- Reddy, M.S., Reddy, Y.P., Reddy, K.R., Eappen, K.P., Ramachandran, T.V. and Mayya, Y.S. (2008). *Radiat. Prot. Dosi.* 132(4), pp.403-408.
- Sannappa, J., Chandrashekara, M.S., Sathish, L., Paramesh, L. and Venkataramaiah, P. (2003). *Rad. Meas.* 37, pp.55-65.
- Saliah, I., Backstrom, M., Karlsson, S., Lund, E., Pettersson, H.B.L. (2004), *Appl. Rad. and Iso.* 60, pp.99-104.
- Sen, M., Mishra, R., Tripathy, S. P., Sinha, D., Kulshreshtha, A., Dwivedi, K.K., Deka, P. C., and Bhattacharjee, B., (1998). *J. Assam Sci. Sco.*, 39(3), 105- 116.
- Singh, S., Kumar, A. and Singh, B. (2002). *Environ. Inter.* 28, 97-101.
- Singh, S., Kumar, A. and Singh, B. (2005). *Rad. Meas.* 39, pp.81-85.
- UNSCEAR, (1993). *Sources and Effects of Ionizing Radiation. United Nations, Scientific Committee on the Effects of Atomic Radiation, United Nations. New York.*
- UNSCEAR: (1999). *United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and Effects of Ionizing Radiation, United Nation. New York.*
- UNSCEAR: *United Nations Scientific Committee on the Effects of Atomic Radiation, (2000). Sources and Effects of Ionizing Radiation, United Nation. New York.*
- WHO, World Health Organization, 1996. *Guidelines for Drinking- water Quality, vol.1. Recommendations, WHO, Geneva.*