GIAP Journals
Green Chemistry & Technology Letters
Vol 2, No 4, December 2016, pg. 171-176
eISSN: 2455-3611, DoI: 10.18510/gctl.2016.241

STUDY OF RADON AND THORON CONCENTRATION IN ENVIRONMENT OF MORADABAD DISTRICT OF UTTAR PRADESH, INDIA

Indu Singh[a*], Anil Kumar[b], R B S Rawat[c]
[a] Department of Physics, IFTM , University, Moradabad
[b] Department of Physics, S S (P.G.) College, Shahjahanpur, Uttar Pradesh, India.
[c] Department of Physics, M S (P.G.) College, Saharanpur, Uttar Pradesh, India.
Corresponding author email id: indusinghmoradabad@gmail.com

Article History: Received on 30th March 2016, Revised on 10th October 2016, Published on 10th December 2016

Abstract

Purpose: A study of indoor radon and thoron has been carried out in dwelling of Moradabad, Uttar Pradesh, India. Radon is an invisible radioactive gas that occurs naturally in the indoor atmosphere. It comes from the naturally breakdown of uranium in soils and rocks.Lung cancer risk depends upon the concentration of radon, thoron and their decay product in air.

Methodology: The measurements of radon, and thoron concentration were carried out by using LR-115 type II plastic track detectors (SSNTD Technique).

Findings: In the present study the value of radon concentration from10.5 Bq/m^{3}to 30Bq/m^3 with an average19.9Bq/m^{3}and thoron concentration from 5.6 Bq/m^3 to 24 Bq/m^3 with an average of 14.9 Bq/m^3. It is observed that radon and thoron concentration is maximum in winter and minimum during summer. The maximum concentration in winter is essentially influenced by the intense temperature inversion, which generally occurs in winter season, when the wind velocity is low. The maximum concentration in winter is also the result of decreased ventilation because in this season the houses are closed for long time and radon/thoron accumulated inside the room and a weak positive correlation was observed between radon and thoron.

Social Implications: There are some difficulties in assessing the exact risks of radon in the home. Most studies have used data from miners who will have had far more exposure to radon than is likely in any building.

Radon kits (Dosimeter) include a collector to be left in the lowest habited room of the house for 2-7 days; this is then sent off to a laboratory for evaluation. If the radon readings are high, there are a number of ways to deal with the issue. The most common of which are the following:

- Sub-slab depressurization
- Improving ventilation
- Radon sump system
- Positive pressurization

Originality/ Novelty: This study is done at Moradabad City and Research Lab present in S.S.P. G. College Shajhanapur. Data of radon and thoron concentration has been taken from twin cup radon thoron Dosimeter and Spark Counter.

Keywords: Indoor radon, thoron, Seasonal variation, Western Uttar Pradesh & correlation

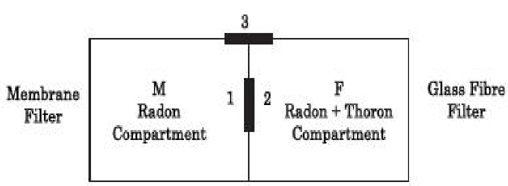
INTRODUCTION

Radon and its short-lived decay products in the environment play the most important role to human exposure from natural sources of radiation. Radon is an important natural source and is the largest contributor to the effective dose received from natural sources. It has been estimated that radon and its progeny contribute 75% of the annual effective dose received by human beings from natural terrestrial sources and are responsible for about half of the dose from all the sources (Ramachandran, et al., 2003). Indoor inhalation dose due to 222Rn, 220Rn and their progeny is to be estimated about 1.2m S v.y-1 of the total 2.4 S v.y-1 background dose UNSCEAR(2000). The possibility of cancer induction due to indoor radon has been attracting attention in the scientific community during the past decades The U.S. Environmental Protection Agency (EPA) and the U.S. Surgeon General acknowledge radon as the second leading cause of lung cancer overall and the number one cause of lung cancer among non-smokers. Residential radon is attributed to 21,000 (13.4%) annual lung cancer deaths in the United States, 2,900 of which are among non-smokers. It is demonstrated that radon is a human lung carcinogen even at concentrations commonly encountered in the residential setting. Because of the significant health risks related to residential radon exposure, the World Health Organization (WHO) instituted an international initiative in 2005, the International Radon Project, to reduce indoor radon risks (Fiel, et al., 2011) It is well known that inhalation of the short lived decay products of radon and their subsequent deposition along the walls of the various airways of the bronchial tree, provides the main pathway for radiation exposure to the lungs (BEIR, 2006). Studies from deferent parts of the world show that well planned and systematic measurements of indoor radon activity concentrations for all seasons during a calendar year are necessary to calculate the actual dose due to exposure to indoor radon devices. Radon is present in trace amounts almost everywhere on the earth, being distributed in the soil, the groundwater and in the lower atmosphere. Radioactive radon can migrate from soils and rocks and accumulate in surrounding enclosed areas such as homes and underground mines (Kumar, et al., 2014). It is important that sources of radon as well as radon infiltration mechanisms be understood before making attempts to control the indoor radon. The radon in the indoor is balanced by the rate of entry from source and the rate of removal, primarily by ventilation. Thus to understand the occurrence of high indoor radon concentration, one must understood the source material, transport mechanics and rate of removal. It has been estimated that the radon, largely in homes, constitutes about 50% of the dose equivalent received by general population from all sources of radiation, both naturally occurring and manmade (Milic, et al.,2013). The concentration of radon in the atmosphere varies depending on the place, time, and height above the ground and meteorological conditions.

METHODOLOGY

The measurements of radon, and thoron were carried out by using the LR-115 Type II, plastic track detector affixed inside the radon dosimeter along with a film attached outside for bare mode. The radon dosimeter consists three different mode holders, namely bare mode, filter mode and membrane mode (Rawat, et al., 2011). The bare mode gives the values of radon/thorn concentration and their progeny while the filter and membrane modes give the values of radon/thoron gases and pure radon gas, respectively. Three small pieces of LR-115 Type II plastic track detector of size 2.5 cm x 2.5 cm are fixed in twin chamber radon dosimeter for the measurement indifferent mode (Eappan, et al., 2004). The dosimeter is kept at a height of 2 m from the ground and care was taken to keep the bare card at least 10 cm away from any surface. This ensures the errors due to tracks from deposited activity from nearby surfaces are avoided, since the ranges of alpha particles from radon/Thoron progeny fall within 10 cm distance. After the exposure period of 90 days, the SSNTD films were retrieved and chemically etched in 2.5N NaOH solution at 60oC for 70 min with mild agitation throughout (Srivastava et al., 1995; Miles, 1997; Ramachandran, 1998; Singh, et al., 2015). The tracks recorded in all the three SSNTD films were counted using a spark counter. The measured track densities for indoor radon and progeny were then converted into working levels (WL) and activity concentrations ($Bq/m3$) using the following calibration factors (Ramola et. al., 1997, 1998, 2005).

1. 125 tracks $cm^{-2}.d^{-1}$=1 WL
2. 3.12x10^{-2} tracks $cm^{-2}\ d^{-1}$= 1 Bq/m^3



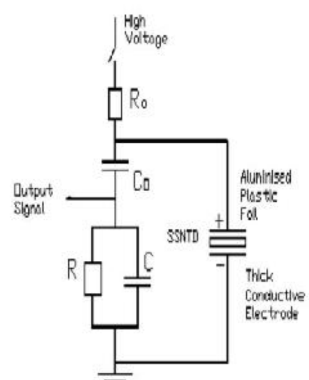


Figure 1 (a): Twin cup radon dosimeter   Figure 1 (b): Circuit Diagram of Spark Counter

AREA FOR STUDY

Moradabad districts are situated in Western Uttar Pradesh state of India. Moradabad district (Figure 3) forms a part of genetic alluvial plain and lies between 28020' and 29 0 North latitudes and 78024' and 790 East longitudes covering an area of about 3759.79 sq. km (Mishra. P., 2014). The area of the Moradabad can be divided into two broad geological unities namely Younger Alluvium and Older Alluvium. The measurements of indoor radon, Thoron and its progeny were made in houses of Moradabad district of western Uttar

GIAP Journals

Green Chemistry & Technology Letters
Vol 2, No 4, December 2016, pg. 171-176
eISSN: 2455-3611, DoI: 10.18510/gctl.2016.241

Pradesh. The houses in study area are well, as well as poorly ventilated. Buildings are constructed of concrete, cement, bricks and blocks. Some houses, having glass doors and glass windows are also included in study.

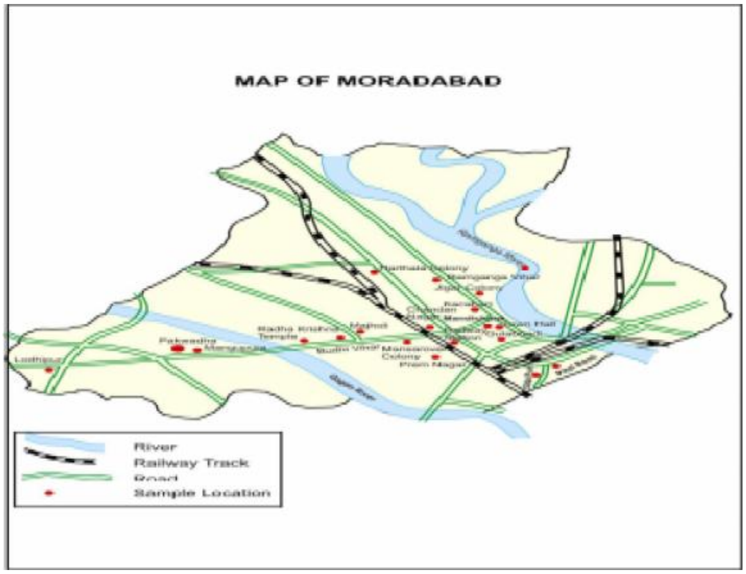


Figure 3: Map of Moradabad City

RESULT AND DISCUSSION

Table 1: Variation of Indoor Radon and Thoron Concentration in Different Seasons

S. No	Sample Location	Autumn		Summer		Rainy		Winter	
		Radon Concentration	Thoron Concentration	Radon Concentration	Thoron Concentration	Radon Concentration	Thoron Concentration	Radon Concentration	Thoron Concentration
1.	Lodhipur	18.5	14	15	10.67	17	13.5	20.1	18.5
2.	Pakwara	17.5	12.5	14.75	10	15	11	21.75	19
3.	Mangupura	18	13.5	13	11.5	14.5	12	27	20.5
4.	RadhaKrishan Mandir	20	14	15.3	11	18.6	14.5	22	20
5.	Manjholi	17.5	12	16	9	16	13.5	21	18
6.	Mansrover Colony	17.25	14.5	17	7.5	18.75	15	22.5	17.66
7.	Budhi Vihar	20.3	10.76	17.5	8.5	23.75	10.5	25	17.5
8.	Prem Nagar	19.25	14	18.5	7.6	19	12	22.25	18
9.	Chowki Basti	23.5	17.5	17.5	14	22	17.8	29.5	24
10.	Gulab Bari	20.6	14	15.75	10.75	19	21.33	21.75	19.5
11.	Petal Basti	22.6	18.33	14.5	11	21	18.33	24	20.5
12.	Sita Puri	20.5	14	18	10.67	20	14	23	21
13.	MandiChawk	21	13.8	19.5	12.5	24.5	13.5	27	22
14.	Jigar Colony	22.5	10.5	10.5	5.6	20	10.75	21.5	17
15.	Harthala colony	19.6	15	16.75	12.5	21.75	14.5	24.5	20

Green Chemistry & Technology Letters
Vol 2, No 4, December 2016, pg. 171-176
eISSN: 2455-3611, DoI: 10.18510/gctl.2016.241

16.	Chandan Nagar	20	15.67	17.5	13	18	15.8	25	22
17.	Ram Ganga Vihar	19.75	14.5	18	11.65	23	14	26.6	21.5
18.	Town Hall	20.2	12	19.25	10.5	20	12.5	23.3	19.5
19.	Gaytri Nagar	18	16.2	15	6.5	17.5	14.66	22	17.66
20.	Rati Muhala	20	18.5	18.5	14	19.5	19.5	27	24
21.	Hanuman Nagar	23.5	15	20	13	23	16.5	24.5	21.5
22.	Vikas Nagar	14	16	13.5	13.5	14.5	16.5	22	23.75
Minimum Concentration		14	10.5	10.5	5.6	14.5	10.5	20.1	17
Maximum Concentration		23.5	18.5	20	14	25	21.3	29.5	24
Average Concentration		19.72	14.37	16.42	10.67	19.37	14.6	23.7	20.13

The measurement values of radon concentration and Thoron in indoor atmosphere in Moradabad district. The houses chosen for installing dosimeters are new as well as old one and Poor ventilation. The results of systematic study are obtained by considering the room as a space in which the radon and Thoron levels are directly to the dynamic and static parameters. The minimum radon concentration (10.5Bq/m3) was recorded in Jigar Colony in summer while the highest concentration (30.0 Bq/m3) is recorded in Chowki Basti in winter with average value (19.8 Bq/m3). The least concentration in summer was due to increase in temperature which results virtual mixing and rising of aerosol and dust particles to higher altitude, so there will be the reduction in aerosol and dust particles near the earth surface and hence the radon concentration decreases. The maximum concentration in winter is essentially influenced by the intense temperature inversion, which generally occurs in winter when the wind velocity is low. The maximum concentration is found in winter is also the result of decreased ventilation because in winter season the houses are closed for long time and radon accumulated inside the room. The minimum Thoron concentration (5.6 Bq/m3) was recorded in Jigar colony in summer while the highest concentration (24 Bq/m3) is recorded in Rati Muhala in winter. The average value of Thoron concentration in study area was found (14.9 Bq/m3) for the complete year.

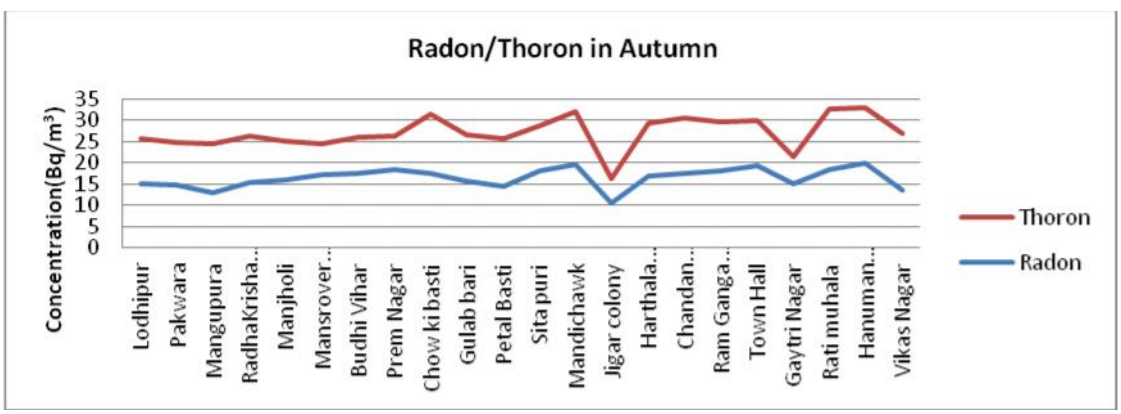


Figure 3: Radon, Thoron Concentration in Autumn Season

It is also found that radon concentration is higher in comparison of thoron in all four seasons which is graphically shown in fig.3.4.5.6. The observed values of radon concentrations in mud houses were found comparably higher than that in other houses. Since the ground floor of mud houses allow more radon to diffuse inside the house because of high porosity of the material used. In mud houses, local soil and stone are used for construction purposes. The emanation of radon from building materials (local soil and stone) is higher than that for normal building material and thus contributes additional radon inside the house. The concentration of radon and thoron in study area were observed below the recommended action level set by various organizations. In a national radon survey done by BARC, Mumbai and published by Head, Library and information services Division in September 2003, the minimum and maximum concentration of radon and thoron in India was reported 4.6 Bq/m and 147.3 Bq/m3, 3.5 Bq/m3 to 42.8 Bq/m3 respectively.

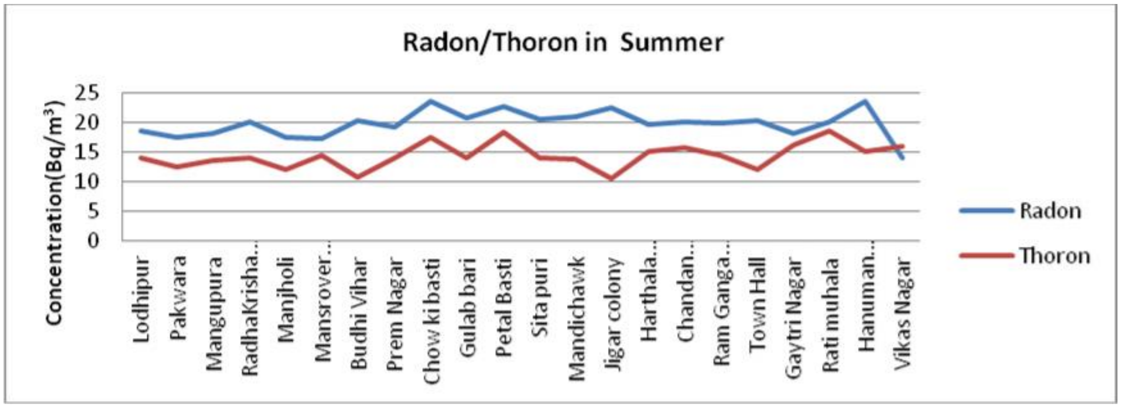


Figure 4: Radon, Thoron Concentration in Summer Season

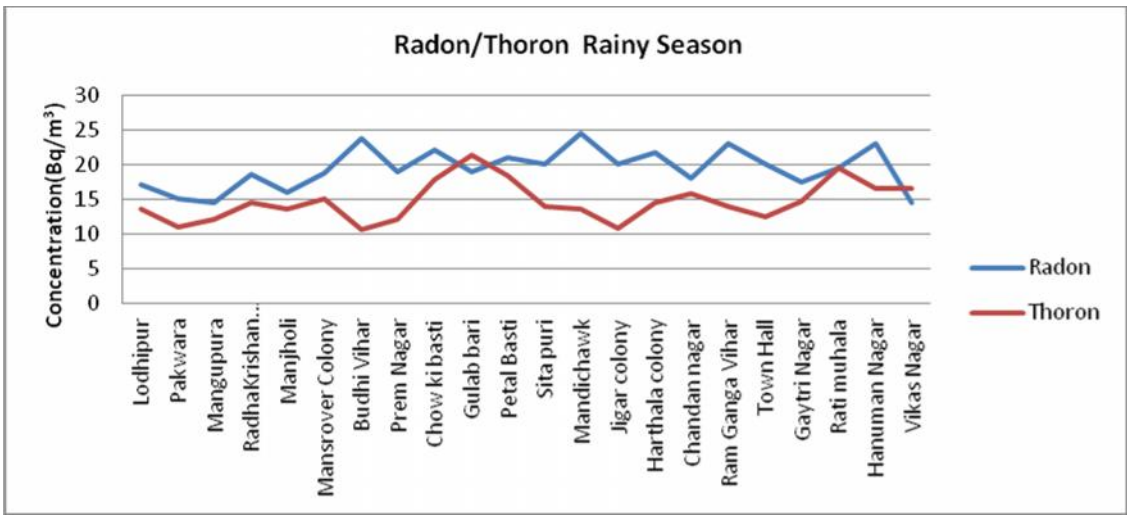


Figure 5: Radon, Thoron Concentration in Rainy Season

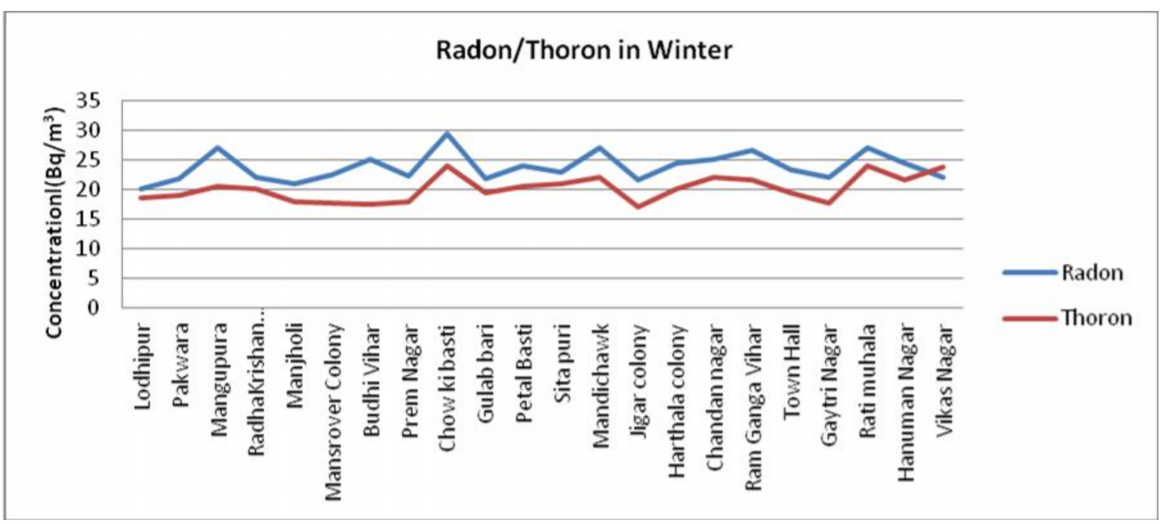


Figure 6: Radon, Thoron Concentration in Winter Season

Green Chemistry & Technology Letters
Vol 2, No 4, December 2016, pg. 171-176
eISSN: 2455-3611, DoI: 10.18510/gctl.2016.241

CONCLUSIONS

Based on the results obtained from the study area, the activity concentrations of Radon in the houses of Moradabad district of Uttar Pradesh is studied for all four seasons. However the recorded values of radon and thoron and resulting doses are well below internationally recommended levels (BEIR2006). This clearly indicates that the houses in areas in Moradabad district of Western Uttar Pradesh are quite safe from the radiation protection point of view.

The building materials can slightly influence the indoor radon concentrations. Brick and concrete houses show increased radon levels, while wood and adobe houses present low radon concentrations. Moreover, the floors have also an impact on radon concentrations as well as the existence of concrete floor capping (Armencea Mutoiu), et al., 2012).

ACKNOWLEDGEMENT

Authors are thankful to the house owner's for their co-operation during this work.

REFERENCES

1. Armencea (Mutoiu), E.S., Armencea, A., Burghele, B.,Cucos (Dinu)A., Malos,C., Dicu,T. (2012). Indoor radon measurements in Bacau County. Rom. Journ. Phys., 58.
2. BEIR (2006) Health Risks from Exposure to Low Levels of Ionizing Radiation ISBN 978-0-309-09156-5.
3. Eappen K.P., Mayya Y.S. (2004). Estimation of seasonal variation in Radon, thoron and their progeny levels in some dwellings Radiation Measurements., 38 pp.5 -17.
4. Fiel, R.W.(2011).Radon: An Overview of Health Effects, Encyclopedia of Environmental. Health,pp.745-753.
5. Kumar, A., Saxena,A.. Rawat, R.B.S. and Sharma.D.(2014). Natural Radioactivity levels in some village in Shahjahanpur Uttar Pradesh,India.IJRSI), 32(12),pp1-3.
6. Miles, J.C.H. (1997).Calibration and standardization of etched track detectors,In Radon measurements by etched track detectors, applications in radiation protection. Elesvier., Second edition pp.38-44.
7. Milic, G., et al.(2013).Indoor radon mapping: a survey of residential houses of Kosovo and Metohija. Rom. Journ. Phys., 58, pp.S180–S188.
8. Mishra,P., Rawat,R.B.S., Sharma, V.K. and Saxena,A.(2014). Concentration of Radon and its Progeny levels in air in the Dwelling of Moradabad of western U.P, India.(IJSR),5(2).
9. Ramola,R.C., Rawat,R.B.S., Kandari,M.S., Ramachandran,T.V., Eappen E.P.and Subba Ramu, M.C.(1997).Calibration of LR-115 Plastic Track Detectors for Environmental Radon Measure. Indoor Built Environ., 5,pp.364-366
10. Ramola,R.C. Rawat, R.B.S., Kandari,M.S., Ramachandran,T.V., & Choubey,, V.M.(1998)A study of seasonal variation of radon levels in different types of houses., Jour. Environ. Radioactivity. 39(1)pp.1-7.
11. Ramola,R.C., Negi, M.S. and Choubey,V.M. (2005).Radon, Thoron and their Progeny Concentrations in Dwelling of Kumaun Himalaya-Survey and Outcomes., Environ. Radioactivity.,79 (1), pp.85-92.
12. Rawat, R.B.S., et al.,(2011). A comprative study of environment indoor radon and thoron in Shahjahanpur and Hardoi district of Central Uttar Pradesh. Recent Research. Sci.Techn.,3(6),pp.19-21.
13. Ramachandran, T.V., Eappen, K.P., Nair, R.N., Mayya, Y.S. and Sadasivan, S., (2003).Radon Thoron Levels and Inilation Dose Distribution Patterns in Dwelling, Environ. Assessment division., (BARC),
14. Srivastava, D.S., Singh, P., Rana, N.P.S., Naqvi, A.H., Azam, A., Ramachandran, T.V., Subba Ramu M.C., Muraleedharan T.V. and Shaikh A.N.(1995).Measurements of Indoor Levels of Rn222 and its Daughters, BARC Rep. No. 1390.
15. Singh, P., Singh,S., Shaoo,B.K., Sapra,B.K., Bajwa, B.S.(2015).A study of indoor radon, thoron and their progeny measurement in Tosham region Haryana. India. Journ.Rad. Rese. App. Sci., 8(2),-233.
16. UNSCEAR (2000). United Nations Scientific Committee on the Effects of Atomic Radiation, Sources, Effects and Risks of Ionizing Radiation, Report to the General Assembly, (United Nations, New York)