MEASUREMENT OF INDOOR RADON AND THORON LEVELS IN ENVIRONMENT OF ROOPNAGAR DISTRICT, PUNJAB

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ABSTRACT

Radon is naturally occurring radioactive gas produced by the decay of uranium and thorium. The major sources of radon gas in environment are soil or rock and ground water that contain uranium and thorium. Radon is carcinogen or cancer causing agent and is responsible for many types of health hazards among human beings. Being aware of hazardous effects of radon, it was necessary to conduct survey of measurement of radon gas in environment. The present study deals with the measurement of concentration of indoor radon, thoron and annual effective dose by using pin hole dosimeter cups in environment of Roopnagar district. . Indoor radon concentration varies from 13.72 Bq/m^3 to 98.04 Bq/m^3 with an average of 42.29 Bq/m^3. The value of thoron concentration varies from 17.78 Bq/m^3 to 172.22 Bq/m^3 with an average of 80.56 Bq/m^3. The measured values of radon and thoron were well within the recommended action level. The observed annual effective dose due to radon and thoron varies from 0.40 mSv to 2.84 mSv with average of 1.22 mSv and 0.44 mSv to 4.34 mSv with average of 2.03 mSv which lies within safe limits recommended by ICRP.

Keywords: Radioactivity, indoor radon, thoron, annual effective dose

I INTRODUCTION

Radon is present in earth crust in varying concentration, emanates from soil and rocks and then concentrate in enclosed space. After uranium, thorium, radium and polonium, radon was discovered as 5th radioactive element on, which is highly radiotoxic and carcinogen by inhalation [1]. More than 80% annual dose is due to natural background radiation, out of which more than 50% is contributed by radon/thoron decay products. The level of radon and its decay products in the atmosphere varies over a considerable range depending upon soil porosity, temperature, relative humidity, radium content and atmospheric conditions. In indoor air in houses, other buildings

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and in water from underground sources, it is found in higher level, while in outdoor air and in drinking water from river and lakes it is found at low level. Radon concentration accumulation to higher level can be the major contributor to long term dose exposure to human population.

Unlike other members of noble gas family, radon has no stable isotopes. Out of all known isotopes only three are supported by decay of radionuclides. These three are: (i) Radon-222 (^{222}Rn): It is most stable isotope of radon with half life ($t_{1/2}$) of 3.8235 days. ^{222}Rn is decay product of radium (^{226}Ra), which is decay product of ^{238}U series. Radon emits alpha radiation of energy 5.48 MeV. (ii) Radon-220: ^{220}Rn also known as 'Thoron' is decay product of Thorium series with half life ($t_{1/2}$) of 55.6 sec. It emits alpha radiation of energy 6.28 MeV. ^{220}Rn is less prevalent than ^{222}Rn because of its short half life and therefore is spread less from the source as compared to ^{222}Rn. (iii) Radon-219: ^{219}Rn also known as 'actinon' is decay product of ^{235}U series with half life ($t_{1/2}$) of 3.96 sec. it also emit alpha radiations of energy 6.82 MeV [2].

II MATERIALS AND METHODS

The measurement of indoor radon level in dwellings will be done with Solid State Nuclear Track Detectors (SSNTDs), which is one of the most widely technique used for indoor radon survey. LR-115, type II plastic strippable thin cellulose nitrate films [3] will be used as solid state nuclear track detectors because of their high durability and stability. Detectors will be used in pin hole dosimeter (Fig.1) for the detection of alpha particles emitted by radon and its decay products. Alpha particles originated from radon and decay products forms tracks in the detector. After the exposure of three months, the detectors will be retrieved and subjected to chemical etching in 2.5N NaOH solution at a temperature of 60°C so that tracks formed will be enlarged. The tracks then will be counted using spark counter (Fig.2).

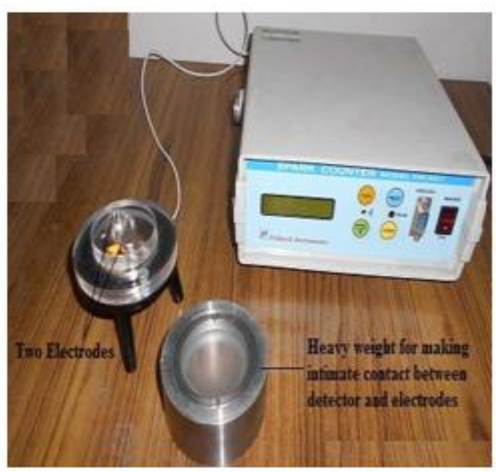

Fig.1: Pin Hole Dosimeter **Fig.2: Spark Counter**

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The recorded tracks will be then converted in Bq/m^3 by using appropriate calibration factors and concentration of indoor radon, thoron and their decay products will be find out. From concentration of radon and thoron annual effective dose will be calculated as:

- Annual effective dose for radon

$C_R(Bq/m^3)*0.46*7000\ h*9nSv\ (Bq.h.m^{-3})^{-1}$

- Annual effective dose for thoron

$C_T(Bq/m^3)*0.09*7000\ h*40nSv\ (Bq.h.m^{-3})^{-1}$

III RESULTS

The concentration of indoor radon and thoron in some dwellings of Roopnagar district is measured by using pin hole dosimeters. The results are given in Table 1 along with latitude and longitude of the location.

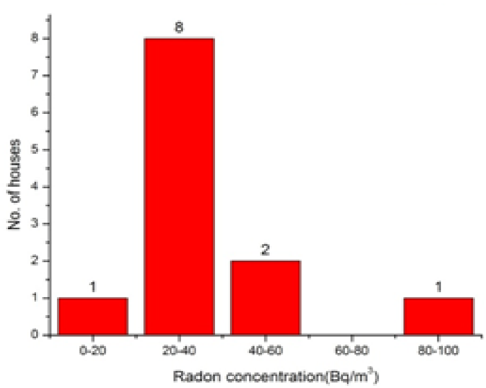
Table 1. Radon and Thoron concentration from different locations in Roopnagar district

S.No.	Location	Radon concentration (Bq/m^3)	Thoron concentration (Bq/m^3)	Annual effective dose (mSv)	Annual Effective Dose (mSv)
1.	Location 1	30.718	98.889	0.89	2.49
2.	Location 2	27.450	142.22	0.79	3.58
3.	Location 3	33.334	23.334	0.96	0.58
4.	Location 4	13.725	35.556	0.39	0.89
5.	Location 5	41.830	84.445	1.21	2.12
6.	Location 6	35.294	43.334	1.02	1.09
7.	Location 7	39.215	93.334	1.13	2.35
8.	Location 8	38.562	60	1.11	1.51

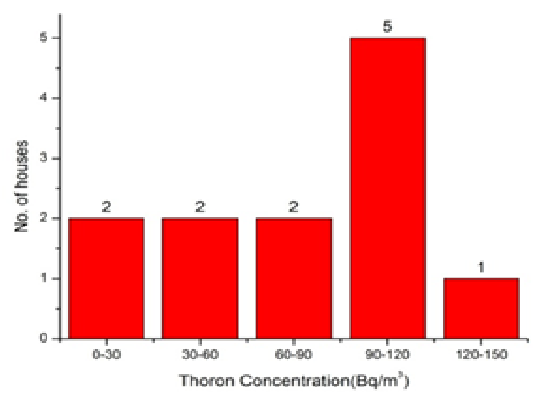
9.	Location 9	25.490	101.11	0.73	2.54
10.	Location 10	31.372	114.44	0.90	2.88
11.	Location 11	92.156	17.778	2.67	0.44
12.	Location 12	47.712	107.77	1.38	2.71

Frequency Distribution Graphs

The Graphs from I-IV shows distribution of radon concentration, thoron concentration, annual effective dose due to radon and annual effective dose due to thoron verses number of houses respectively.



(I)



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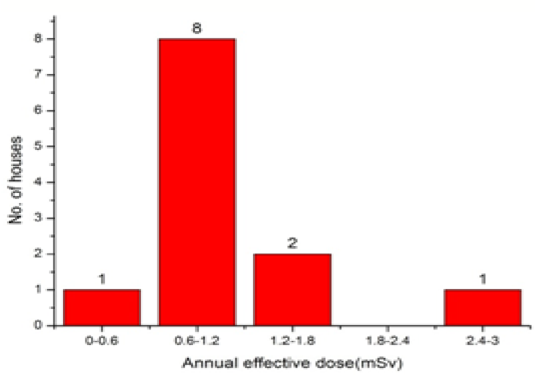
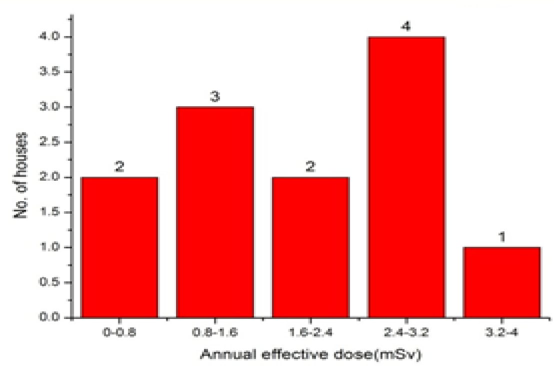


(III)



(IV)

IV CONCLUSION

It is clear from table 1 that indoor radon and thoron concentration vary from 13.725 Bq/m^3 to 98.039 Bq/m^3 with an average of 42.287 Bq/m^3 and 17.777 Bq/m^3 to 172.22Bq/m^3 with an average of 80.555 Bq/m^3 respectively. The measured values of radon and thoron were well within the recommended action level. The average values of observed annual effective dose due to radon and thoron are 1.225mSv and 2.03mSv which lies within safe limits recommended by ICRP [4].

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