MEASUREMENT OF INDOOR RADON AND THORON IN EAST KHASI HILLS DISTRICT OF MEGHALAYA, INDIA

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Abstract: Indoor concentrations of radon (^{222}Rn) and thoron (^{220}Rn) were measured (June of 2017 - August of 2017) in sixty (60) houses of three (3) different types (wooden, semi-concrete and concrete) in the selected sites of East Khasi Hill district, Meghalaya, India. Pin-hole based single entrance ^{222}Rn/^{220}Rn discriminating dosimeters with LR-115 Type2 films have been used to measure ^{222}Rn and ^{220}Rn concentrations.

1. Introduction:

Radon (^{222}Rn) is a unique natural gaseous element exhibiting peculiar properties such as mobility, inertness and radioactivity; the last fact facilitates its measurement with remarkable sensitivity. Apart from ^{222}Rn, the isotopes ^{220}Rn also called thoron and ^{219}Rn occur in nature, however the isotope ^{19}Rn due to its short half-life (3.89 s) and the low isotopic abundance of its primordial precursor ^{235}U, does not pose any significance radiological concern [1] and as such is not included in health related studies such as the present one. Inhalation of these elements contribute more than 50% of the natural background radiation dose to humans [2]. The outdoor concentration level of radon is usually low; however, it tends to build up higher concentrations in indoor environment when it is unable to disperse. In dwellings the typical sources of radon are: radon exhaled from the building materials and from the soil/rock beneath the floor and the inflow of radon containing air [3]. The present study focusses on measurement of radon and thoron concentrations in East Khasi Hills district of Meghalaya, India. This district forms a central part of Meghalaya and covers a total geographical area of 2,748 sq.kms. It lies approximately between 25°07” and 25°41” N Lat. and 91°21” and 92°09” E Long [4, 5].

On the basis of its geological and seismic characteristics, the north eastern region of India is expected to have higher concentration of radon [6]. Thus it is imperative to assess indoor level of radon, thoron and their progenies in order to evaluate the dose to the population [7]. House structure can also have an effective impact on the indoor concentration of radon. With reference to our study area, three types of houses have been categorized, *viz*.

- **Wooden house**: flooring and walls are completely wooden and the roof comprises of wood and tin sheets.
- **Semi-concrete house**: either floor or walls are made of concrete/brick/wood or both floor are wooden/concrete and roofs are combination of wood and tin sheets.
- **Concrete house**: floorings, walls and ceilings are completely made of concrete cemented bricks.

2. Experimental Technique:

A new “pin-holes based twin cup dosimeter” with single face entry has been used for the measurement of indoor ^{222}Rn and ^{220}Rn concentrations. The new design of this dosimeter system has two chambers separated by a central pin-holes disc, acting as ^{220}Rn discriminator. Each chamber is cylindrical having a length of 4.1cm and radius 3.1cm. The interior of the chamber is coated with metallic powders to have neutral electric field inside the chamber volume so that the deposition of progenies formed from gases will be uniform throughout the volume. LR-115 detectors are pre-fixed in these chambers, and concentrations are estimated on the basis of tracks registered on these detectors [8, 9].

After three months of exposure, detectors were removed and subjected to chemical etching in 2.5N NaOH solutions at 60°C for about 90 minutes. These films were then washed and dried. The alpha tracks formed on the films are counted by using the standard spark counter (Model PSI-SC1) with operating voltage (~500 V) and pre-sparking voltage (~900 V), and simultaneously the track density was obtained.

The radon (C_r) and thoron (C_t) concentration in the filter and pin-hole compartments respectively, is calculated by using the formulae below:

$$C_r \text{ (Radon conc.)} = \frac{T_1}{D.k_r} \tag{1}$$

$$C_t \text{ (Thoron conc.)} = \frac{T_2 - D.C_r k_r}{D.k_t} \tag{2}$$

where T_1 and T_2 represents track density of radon and thoron respectively, D represents the number of days of exposure, k_r (0.0170 ± 0.002 tr. Cm^{-2} per $Bq.d.m^{-3}$) and k_t (0.010 ±0.001 tr. Cm^{-2} per $Bq.d.m^{-3}$) are the calibration factors of radon and thoron in 'radon+thoron' compartment [8].

3. Results and discussion:

The results of the measurement exercise are given in Figures 1 and 2 respectively in the form of a histogram of values. The maximum number (~ 23 %) of houses (14 in numbers) studied are found to have radon concentration in the range 25-50 $Bq.m^{-3}$. 18% of houses studied (11 in number) are found to have thoron concentration in the range of 40-80 $Bq.m^{-3}$.

Bar-graph representation of radon and thoron for different types of house under the study area are shown in figure3. The results revealed that, for radon concentration the trend was seen as; (wooden) < (semi-concrete) < (concrete), and the average concentration for concrete and semi-concrete house type is almost the same. Higher radon concentration in the case of concrete houses may be attributed to source term and poor ventilation patters. For thoron concentration the observed order was; (concrete) < (wooden) < (semi-concrete). The observed indoor radon concentration in the present study was found to be lower than the recommended value of 300 $Bq.m^{-3}$ [13].

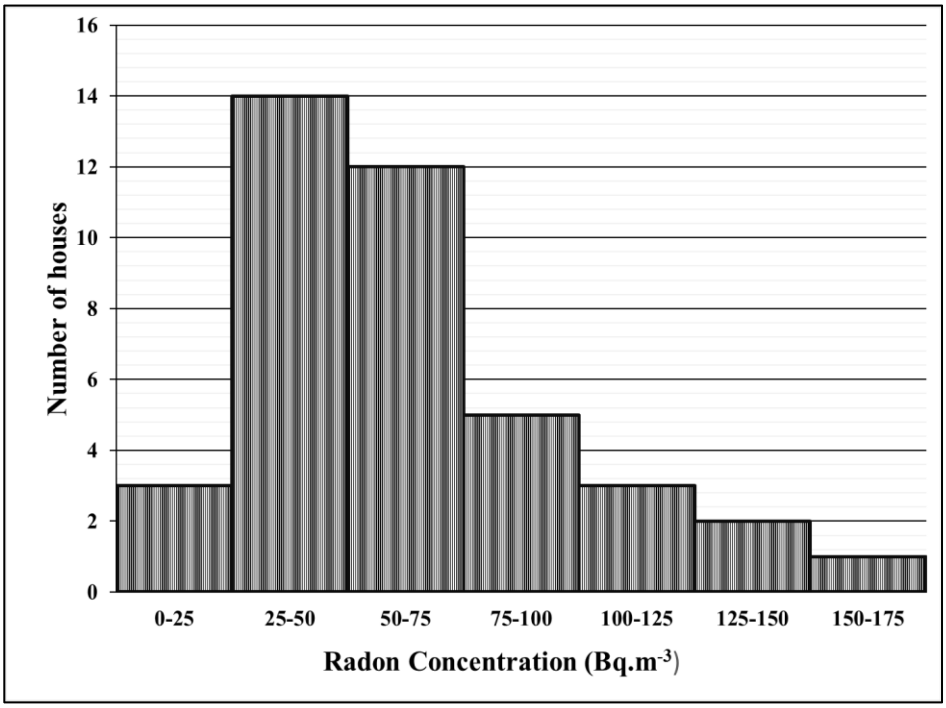

Figure 1: Frequency distribution graph of radon.

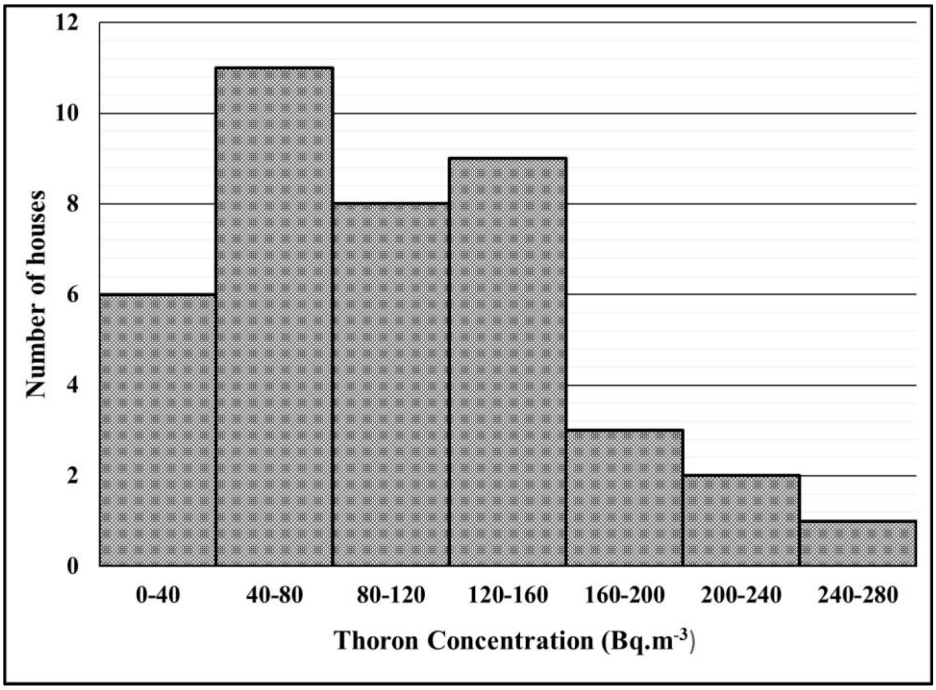

Figure 2: Frequency distribution graph of thoron.

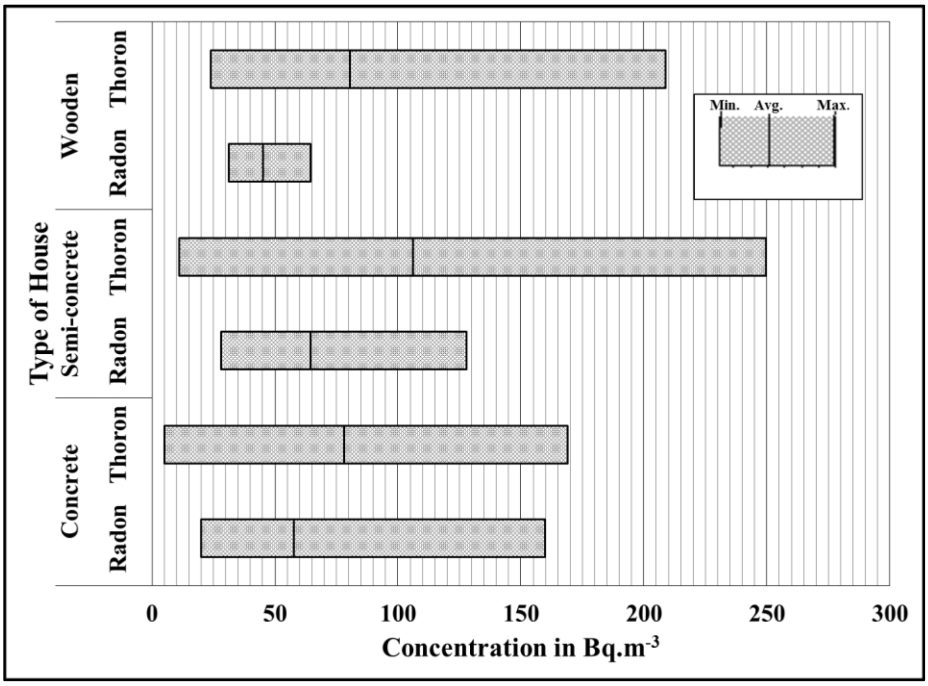

Figure 3: Bar - graph representation of radon and thoron in different house types.

4. Conclusion:

On comparison amongst the sites under study, it was found that the maximum concentration of radon (~71.93 $Bq.m^{-3}$) was measured in Mawsmai, and the minimum value of radon (34.48 $Bq.m^{-3}$) was measured in Shillong. In the case of thoron, the maximum concentration was measured in Mawkdok (121.25 $Bq.m^{-3}$) and the minimum values were measured in Pyndenglitha (45.52 $Bq.m^{-3}$).

On comparing the house-types investigated, higher radon concentration was observed in the case of concrete and semi-concrete type of houses and lower in wooden houses, this suggests that the radon exhaled from building materials used for construction play a significance role in the contribution to indoor radon concentration and also differences in the ventilation rates of the different types of houses can have an effect on the amount of radon accumulated inside houses *viz.* wooden house are expected to have better ventilation in comparison to concrete houses. In the case of thoron concentration, no convincing trend was observed with respect to house types. The average radon and thoron concentrations for the study region were found to be 68.70 $Bq.m^{-3}$ and 52.57 $Bq.m^{-3}$ respectively.

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