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ORIGINAL ARTICLE

Residential ^{222}Rn and ^{220}Rn Levels and Associated Effective Dose Rate

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ABSTRACT

The measurement of residential radon, thoron and their daughter products was carried out in about fifty houses of Shajahanpur District of Central Uttar Pradesh, India by using LR-115 plastic track detectors. The measurements were made in residential houses of the study area by hanging twin cup radon dosimeter at a height of 1.5-2m from ground level. The twin cup radon dosimeter can record the values of radon, thoron and their decay products separately. The measurement was repeated on a time integrated four quarterly cycles to cover all the four seasons (summer, rainy, autumn &winter) of the calendar year. The graphs were plotted for radon concentration versus number of houses, thoron concentration versus number of houses and dose rate versus number of houses for different seasons. The radon concentration was found minimum in summer season and maximum in winter. In winter most of the values observed were between 30 Bq/m^3 and 40 Bq/m^3, in rainy season the values observed between 25Bq/m^3 to35Bq/m^3.in autumn season the values observed between17.20Bq/m^3 to30.5Bq/m^3 and in summer season values observed between 10 Bq/m^3 and 20 Bq/m^3. The associated resulting dose rates due to radon, thoron varied from 0.04 Sv/h to 1.46 Sv/h. The observed radon and thoron concentration inside the dwellings of study area were found to be lower than the ICRP recommended value of 200 Bqm^{-3} and thus the study area is quit safe from radiation protection point of view.

Key words: *Radon, Thoron, SSND, Environment, Effective dose rate*

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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 a naturally available radioactive gas, which is the decay product of radium. The possibility of cancer induction due to indoor radon has been attracting attention in the scientific community during the past decades. It is now widely recognized that indoor radon is a largest single source of exposure to ionizing radiation in the environment. For the population as a whole, the average effective radiation dose from radon is estimated to be greater than the dose from all other natural sources of radiation combined, greater than the dose from industrial activities including nuclear power and the dose from medical treatments including x-ray. The contribution of indoor thoron concentration is generally considered negligible because of its short half-life. It is well known that inhalation of the short lived decay products of radon and, to a lesser extent, the decay products of thoron 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 [1, 2] Studies from deferent parts of the world show that well planned and systematic measurements of indoor radioactivity concentrations for all seasons during a calendar year are necessary to calculate the actual dose due to exposure to indoor radon.

The activity concentrations of indoor radon/thoron and their progeny are largely influenced by factors such as topography, type of house construction, building materials, temperature, pressure, humidity, ventilation, wind speed, and even the life style of the people living in the house [3,4,5]. To estimate the annual average equivalent dose, a number of indoor radon surveys have been carried out around the world [6]. Due to recent surveys in Dehradun and nearby towns of U.P. suggest a little higher concentration of radon than the normal one, hence radon concentration survey was required for different regions of the state. So Shahjahanpu District of central Uttar Pradesh is chosen as study area. The aim of proposed investigation is to carry out the systematic study of radon and their daughter products in relation to their application in radiation protection.

EXPERIMANTAL TECHNIQUE

The radon, thoron and their daughter products in the indoor environment were measured in 50 houses of the Shahjahanpur district of central Uttar Pradesh using alpha sensitive LR-115 type II plastic track detectors. It is a 12 micrometer thick film red dyed cellulose nitrate emulsion coated on inert polyester base of 100 micrometers thickness and has maximum sensitivity for alpha particles. The small Pieces of detector film of 2.5 cm x 2.5 cm. will be fixed in a twin cup radon dosimeter having three different mode holders' namely bare mode, filter mode and membrane mode. The bare mode detector registers track due to radon, thoron gases and their progeny concentrations while the filter made detector records tracks due to the radon and thoron gases, membrane made records tracks only by radon gas. The dosimeters fitted withLR-115 plastic track detectors are suspended inside the selected houses in field area at a height of about two meters from the ground floor. When alpha particles strikes on LR-115 film it creates narrow trails called Tracks. The detectors were exposed for about three months and, after retrieval, were etched and scanned in the laboratory for the track density using spark counter. The measured track densities for indoor radon and progeny were then converted into working levels (WL) and activity concentrations (Bq m^{-3}) using the following calibration factors.

$$125 \text{ tracks cm}^{-2} \text{ d}^{-1} = 1\text{WL}$$
$$3.12\text{x}10^{-2} \text{ tracks cm}^{-2} \text{ d}^{-1} = 1 \text{ Bqm}^{-3}$$

Measured track densities for thoron and progeny were converted into appropriate units using the calibration factor obtained in the form of a computer programme developed by the Environmental Assessment Division of Bhabha Atomic Research Centre, Mumbai, for the use of various Indian radon research groups under collaborated research programme of the Department of atomic Energy [7, 8 and 9].

RESULT AND DISCUSSION

Measured values of radon and thoron for four different seasons of a calendar year are shown in figures 1&2. Radon concentrations were found to be highest in winter and lowest in summer. In winter most of the values observed were between 30 Bq/m^3 and 40 Bq/m^3 while in summer maximum values were between 10 Bq/m^3 and 20 Bq/m^3. This may be due to ventilation condition in summer and winters are quite different. However, no systematic seasonal variation was observed for thoron concentrations (Fig. 2) which were found to be evenly distributed within different ranges for all seasons. The resulting estimates of dose due to the presence of radon and thoron are shown in Fig. 3.Most of the values observed are between 0.2 and 0.6 Sv/h with high values in winter and low in summer. A large variation in the activity concentrations of radon and its progeny was observed for different seasons of the year. Since the area remains cold during winter, doors and windows are kept closed to conserve energy, thus allowing an accumulation of radon, thoron and progeny inside the houses. However, the recorded values of radon, throng and progeny and resulting doses are well below internationally recommended levels. This clearly indicates that the houses in the study area are quite safe from the radiation protection point of view.

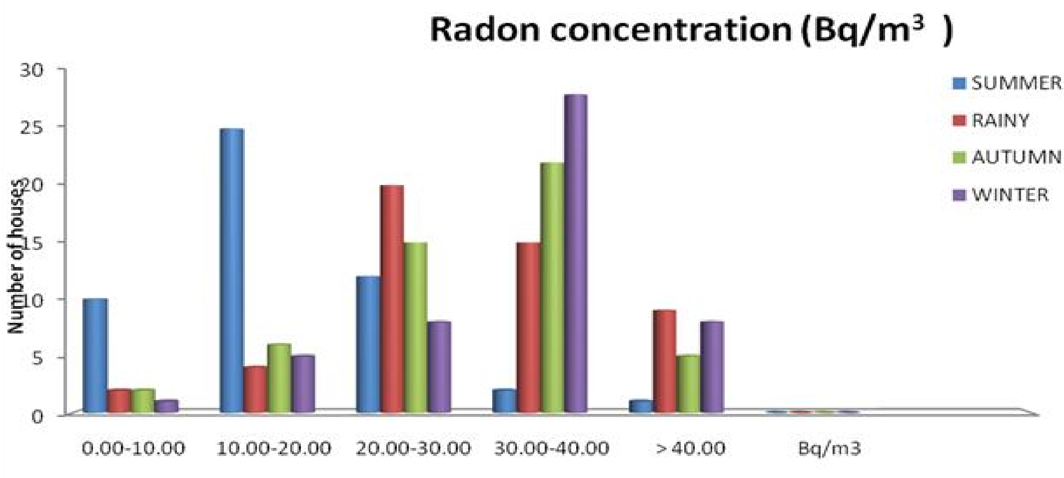

Fig. 1: Variation of radon concentration with number of houses

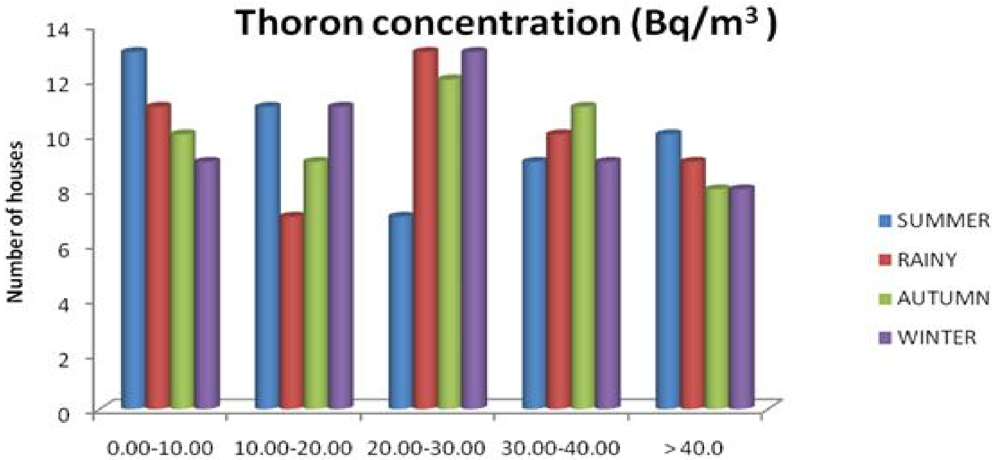

Fig. 2: Variation of thoron concentration with number of houses

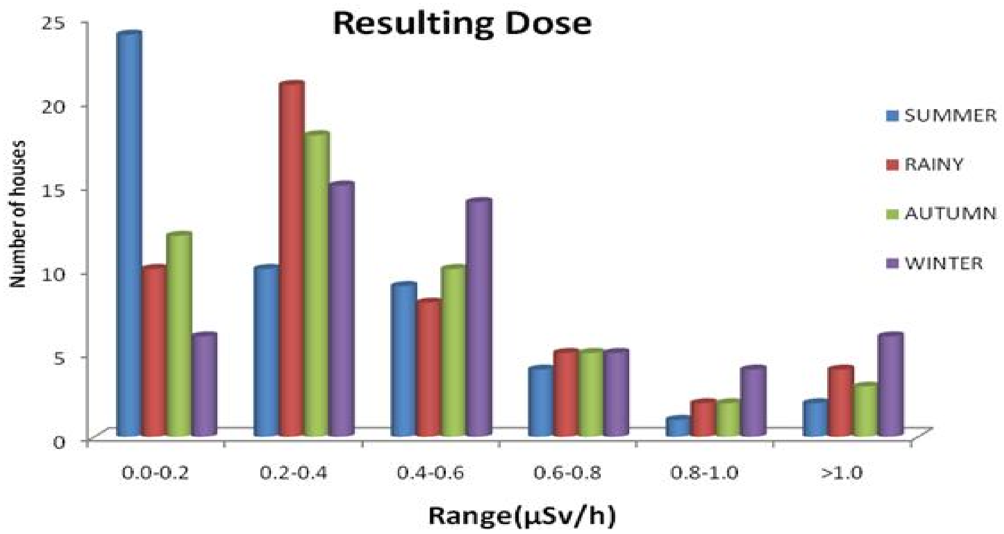

Fig. 3: Variation of resulting dose with number of houses

CONCLUSION

Based on the results obtained from the study area, the activity concentration of Radon and thoron in the dwellings of the study area is studied for all four seasons. The radon concentration was found minimum in summer season where as maximum in winter season. In winter most of the values observed between 30 Bq/m^3 and 40 Bq/m^3, in rainy season the values observed between 25Bq/m^3 to35Bq/m^3, in autumn season the values observed between17.20Bq/m^3 to30.5Bq/m^3 and in summer season values observed between 10 Bq/m^3 and 20 Bq/m^3. The associated resulting dose rates due to radon, thoron varied from 0.04 Sv/h to 1.46 Sv/h. From the results obtained it can be concluded that values of radon, thoron concentration and the resulting dose in the dwellings of the study area fill within the safe limit. Poor ventilation, construction materials and radon exhalation from the ground are the main reasons for the relatively high radon concentrations in lower levels. The observed radon and thoron concentration and the resulting dose inside the dwellings of study area were found to be lower than the ICRP recommended value of 200 Bqm^{-3} and 3-10 Sv/h. Hence, it is not necessary to undertake any kind of action to mitigate the radon in these dwellings.

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