C-P-6

RADON, THORON AND THEIR PROGENY LEVELS IN DWELLINGS OF MYSORE, KARNATAKA

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Abstract

The concentrations of radon and thoron were measured in few buildings that had for a period of 1 year using solid state nuclear track detectors (SSNTDs). The dosimeters containing the detector (LR-115 Type II Film) used in each buildings were fixed 2m above the floor. After an exposure time of 90 days films were etched to reveal tracks. From the track density determined using a spark counter; the concentrations of radon and thoron were evaluated. The concentrations of radon, thoron and their progeny are generally higher during winter compared to summer/rainy seasons. The estimated annual dose for Mysore city is 0.2 $\mu Sv h^{-1}$ and is well within the prescribed limit of global average value.

1 Introduction

The problem of radon has drawn the attention of many scientists all over the world, particularly in the last decade. The main research goal has been the evaluation of the indoor radon concentration essentially because the most relevant source of the population exposure is radon.

The radon in the dwellings has been of interest because sometimes in these environments the concentrations reach high values. Rather large number of investigations has been carried out all over the world, from the point of view of both research on radon behaviour in indoor environment and radiation protection. Since the early studies, the material and methods adopted have changed extensively and at the same time more attention has been given to the role of radon in the total dose delivered to people. Sometimes the fear of the consequences to radon exposure has been emphasized too much.

Radon is a radioactive noble gas. The concentrations of radon, thoron and their progeny differ from indoor to outdoor atmosphere. Among the possible sources of radiation dose to man, inhalation of radon and its progeny play a vital role compared to the other radiations in the atmosphere. High concentrations of radon, particularly in mines, have led to an increase in the number of lung cancer among mine workers. The enhanced risk among lung cancer for the workers in mines was found to be correlated with exposure to radon in non-uranium mines. In the present work, an attempt has been made to study the variation of radon, thoron and their progeny levels in the dwellings for a continental location Mysore (12N, 76E and 760m above mean sea level) covering a wide area.

2 Methodology

The concentrations of radon, thoron and their progeny are measured in dwellings of some parts of Mysore city using SSNTD, which are thin sheets of dielectric materials such as Cellulose Nitrate (CN) and polycarbonates. They are sensitive to alpha but not to beta and gamma radiations. They are unaffected by moderate humidity, heat and light. For indoor measurements normally LR-115 TYPE II (Kodak Pathe, France) plastic track detector is preferred. Each chamber has a length of 4.5cm and a radius of 3.1cm. The SSNTDs used

are 12μm thick. The $SSNTD_1$ placed in compartment 1 measures only radon, which diffuses into it from the ambient air through a semi-permeable membrane. These membranes have permeability constants in the range of 10^{-8} - 10^{-7} $cm^2.s^{-1}$ and allow more than 95% of the radon gas to diffuse and suppress thoron gas to less than 1% (Ramachandran et al., 1987). On the other hand, the glass fiber filter paper in compartment 2 allows both radon and thoron gas to diffuse in and hence the tracks on $SSNTD_2$ are related to the concentration of both gases. The $SSNTD_3$ exposed in the bare mode registers alpha tracks attributable to the air borne concentrations of both the gases and their progeny (Mayya et al., 1998). These dosemeters are suspended from the mid-point of the house at a height of 2 meters from ground level. At the end of the stipulated period of exposure, usually about 90 days, the dosemeters are retrieved and all the three SSNTDs are etched with 10% of NaOH solutions for 1hr at a bath temperature of about 60 °C. The track density of alphas in the film was determined using a spark counter. This exposure cycle has been extended in a time integrated four quarterly cycles to cover all the four seasons of a calendar year to evaluate the annual radon / thoron and their progeny levels. The radon/thoron levels and their progeny working level concentrations are calculated by the following relations (Mayya et al., 1998).

$$C_R(Bqm^{-3}) = \frac{T_m}{dS_m} \quad and \quad C_T(Bqm^{-3}) = \frac{T_f - dC_R S_{rf}}{dS_{rf}}$$

where T_m is track density of the film in membrane compartment, d the Period of exposure(days), S_m the Sensitivity factor of membrane compartment, T_f the track density of the film in filter compartment, S_{rf} and S_{tf} the sensitivity of radon and thoron filter compartment, respectively.

$$R_n(mWL) = \frac{C_R F_R}{3.7} \quad and \quad R_T(mWL) = \frac{C_T F_T}{0.275}$$

where R_n is the radon Progeny Concentration, R_T the thoron Progeny Concentration,

$$F_R = 0.104 f_{RA} + 0.518 f_{RB} + 0.37 f_{RC} \quad and \quad F_T = 0.91 f_{TB} + 0.09 f_{TC}$$

where f_{RA}, f_{RB}, f_{RC}, f_{TB} and f_{TC} are activity fractions with respect to parent gas. F_R and F_T are the equilibrium factors for radon and thoron progeny respectively, corresponding to the extracted ventilation rate (Mayya et al, 1998).

3 Results and Discussion

A number of measurements have been made during the period 2000-01. The average season wise concentrations of ^{222}Rn, ^{220}Rn and their daughter products and the dose rate are shown in Figure 1. It can be seen that the seasonal variation of ^{222}Rn and its daughter concentrations show maximum during winter and minimum during summer for all the locations. This could be due to temperature inversion that can generally be expected to be in winter (Subbaramu 1978, Ramachandran 1990). It may also be due to the poor ventilation in houses because most of the time the windows and doors are closed in this season. The concentration gradually decreases and is lowest in summer. Turbulent transfer during summer causes low concentration of ^{222}Rn and its daughter products at lower atmosphere. The decreases of ^{222}Rn concentration and also exhalation from soil in rainy season have been observed. During rainy season soil becomes saturated with water and hence less concentration is exhaled (Subbaramu 1978, Ramachandran et al 1989). The average concentration of ^{222}Rn, ^{220}Rn and their progeny during winter are 44.33 Bq m^{-3}, 19.40 Bq m^{-3} and 0.64 mWL, 0.20mWL respectively. For summer the values are 15.26 Bq m^{-3}, 13.38 Bq m^{-3} and 0.18mWL, 0.10mWL respectively. Sathish et al (2001) have measured the concentration of Radon, thoron and their progeny in different types of

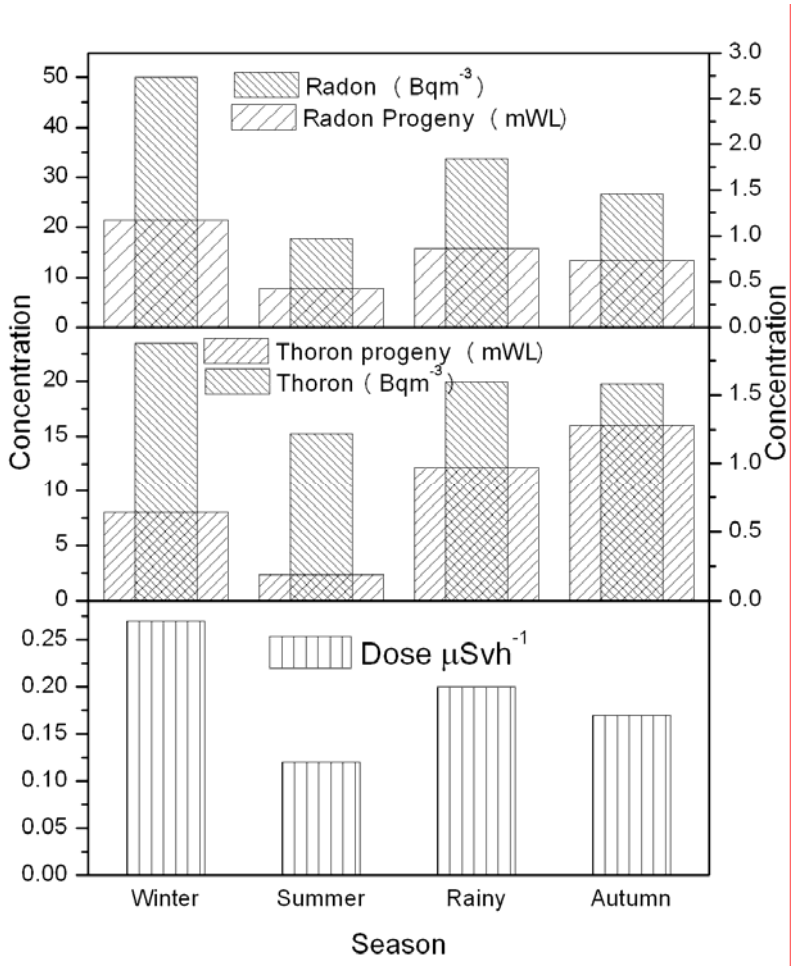

Figure 1: Seasonal variation of Radon, thoron and their progeny and the dose for Mysore

buildings at various locations in Mysore city using Solid State Nuclear Track Detector method. They have reported the arithmetic mean values of concentrations of radon and thoron in indoor atmosphere ranged from 9.20 to 58.02 Bq m^{-3} with a median of 34 Bq m^{-3} and 7.21 to 59.27 Bq m^{-3} with a median of 33 Bq m^{-3}, respectively. The arithmetic mean of progeny concentrations varied from 0.033 mWL to 2.52 mWL with a median of 1.29 and 0.074 mWL to 47.04 mWL with a median of 20.7, respectively. The reported dose to the selected population of Mysore city was 1.58 mSv y^{-1}. The results obtained are of the same order as observed by Sannppa et al (1999) and Nagaraja et al (2003) for the outdoor atmosphere. The annual dose due to ^{222}Rn, ^{220}Rn and their progeny is 0.2 μSvh^{-1}. Nagaraja et al (2006) have reported 0.55 mSv of annual dose due to radon and its progeny for the environment of Pune. The annual average concentrations of ^{222}Rn and its progeny for all the seasons in the city of Mysore are 32 Bq m^{-3} and 0.8 mWL with their GM, Median, SD being 29 Bq m^{-3}, 28.4 Bq m^{-3}, 14.3 Bq m^{-3} and 0.3 mWL, 0.4 mWL, 0.8 mWL respectively. Similarly annual average concentrations of thoron and its progeny are 19.6 Bq m^{-3} and 0.7 mWL with their GM, Median, SD being 17.5 Bq m^{-3}, 17.3 Bq m^{-3} 10.3 Bq m^{-3} and 0.3 mWL, 0.2 mWL, 2.0 mWL respectively. It is indicated that dwellings of Mysore city, Karnataka, India, in general characterized by low ^{222}Rn exposure dose and consistent with UNSCEAR 1993 recommendation.

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