MEASUREMENT OF RADON, THORON AND THEIR PROGENY CONCENTRATIONS IN MIZORAM WITH SPECIAL REFERENCE TO AIZAWL, CHAMPHAI AND KOLASIB DISTRICTS

Abstract

The study presented in this thesis details the measurements of the concentrations of indoor radon, thoron and their progeny and status of the exhalation of these gases from soil in the north-eastern part of India, covering three districts, viz., Aizawl, Champhai and Kolasib Districts in the state of Mizoram. This area covers the northern part of the State of Mizoram, India. It also includes the study of the contribution of the building materials used for dwellings to the radon, thoron and their progeny concentrations besides the atmospheric air and also the determination of the activity content of radioactive elements in building materials and around the dwellings. It reflects the actual abundance of the studied radionuclides in the study area based on the results of the experimental measurements. These constitute the bulk of the studies carried out in this thesis.

The experimental work involves the measurements of time-integrated concentrations of indoor radon and thoron using solid state nuclear track detector (SSNTD) based pin-hole dosimeters (BARC type). Direct measurement of indoor radon progeny and thoron progeny concentrations have been done using recently developed direct progeny sensors (DPS). The radioactivity content of soil and building materials were measured using NaI(Tl) detector link with 1K Multichannel Analyzer. The experimentally determined value of annual average concentration of radon in the study area ranges from 26.91 Bq/m$^3$ to 84.81 Bq/m$^3$ with a geometric mean (GM) of 48.69 Bq/m$^3$ and geometric standard deviation (GSD) of 1.23. In case of thoron, the annual average concentration in the whole study area ranges from 8.56 Bq/m$^3$ to 66.35 Bq/m$^3$ with GM 23.06 Bq/m$^3$ and GSD 1.54. In measuring indoor radon and thoron concentrations, we have found that the results obtained in this study area are low, which lies in the range covered by nationwide survey results as well as the ICRP regulations. The investigation shows no significant radiological risks for the inhabitants and is well within the limits prescribed by UNSCEAR.

We have found that radon has higher concentrations as compared to thoron. Among the three districts, maximum annual average indoor concentrations of radon has been
observed in Champhai District which has the lowest average annual temperature. Maximum average indoor thoron concentration has been found in Kolasib District and minimum in Champhai District. Indoor radon concentrations were found to be highest in winter season and lowest in summer. But, in case of thoron, indoor levels were found to be lowest in rainy season while it was highest during winter. The concentrations of progenies are determined through Equivalent Equilibrium Concentrations of radon as well as thoron (EERC & EETC) respectively. The geometric mean of the annual average value of EERC and EETC were obtained to be 9.01 Bq/m$^3$ with GSD 1.71 and 0.91 Bq/m$^3$ with GSD 1.75.

Comparing results of indoor concentrations in different types of building shows that RCC type of building has higher values of indoor radon as well as thoron levels as compared to other types in the whole study area. From the results obtained regarding types of materials used in construction of building and comparing with the radioactivity content we can conclude that due to higher pseudo-ventilation rates, even with the observation of maximum radioactivity content and contribution for asbestos, indoor radon concentration in concrete buildings were found to be highest. In case of thoron, we can conclude that indoor thoron levels depend strongly on the entry rate from soil into dwellings apart from the contribution of building materials used.

Comparison of the annual average of indoor radon and thoron levels among each of the selected geological areas shows that among the three areas, viz., fossil, fault and unrepresented areas, annual average indoor radon concentration is maximum in fault region. The calculated annual average value of equilibrium factor for radon ($F_R$) is 0.32 and that for thoron ($F_T$) is 0.05. The geometric mean of annual average of radon inhalation dose rate is obtained to be 624.89 µSv/y with 1.67 GSD and that for thoron is 278.75 µSv/y with 1.72 GSD.

The present study finds that indoor radon levels of dwellings present in the study area depends not only on the ventilation rate, but also on the rate of exhalation of radon in the vicinity of the dwellings. In the study area the average value of measured radon content in soil gas is lower as compared to previous research findings in other areas. We can also conclude that regarding background gamma radiation level in the study area, terrestrial source is slightly dominant as compared to cosmic source. The measured background gamma levels do not provide us good and clear cut assumption or prediction for the levels of radon as well as thoron.