Studies on Radon Exhalation

EXECUTIVE SUMMARY

The gaseous radioactive isotope of Radon, from natural sources has a significant share in the total quantum of natural sources of exposure everyone has been subjected to. Regulatory guides recommend a lower action level of 200 Bq/m² for the concentration of Radon in the dwellings. Hence accurate, reliable and easy measurement techniques for the estimation of radon exhalation rate from the building materials are of paramount importance. For the estimation of radon exhalation rate from materials of different matrices, a dedicated experimental facility has been designed and commissioned at IGCAR one of the four nodal centers in India.

OUTLINE

The members of public, in general, are more concerned about the miniscule addition of radiation they receive from nuclear installations but are unaware of the radiation exposure they are constantly subjected to, from different natural sources. The average annual dose received by a member of public due to natural background radiation has been estimated to be 2.4 mSv. Radon-222, the radioactive gaseous daughter product of natural uranium series, which is ubiquitous in nature, is the major source of internal exposure from the natural background. It is reported that indoor exposure due to radon and its progeny is responsible for more than 50% of the dose to humans. It is now well established that exposure to higher levels of radon and its progenies poses a significant health hazard to humans. Presence of uranium, a long-lived natural radionuclide in the building materials such as cement, clay bricks, fly ash, soil, granite stones and gypsum is the main source of indoor radon levels. Lack of adequate ventilation in the houses results in buildup of radon, the gaseous daughter product of natural uranium, thereby increasing the exposure potential further.

ICRP, in its publication 65 has stipulated an action level of 200 Bq/m² for radon concentration in dwellings. In order to comply with this, it is necessary to estimate the indoor radon levels through measuring the radon exhalation rates from different types of building materials. A dedicated facility with state of art equipment has been setup at Radiological Safety Division, IGCAR to carry out R&D works related to the measurement of radon/radioactivity content in various materials. As part of development of radon measurement methodologies, a radon exhalation chamber was designed and fabricated.

A small radon exhalation chamber (Fig. 1) of volume 0.7 m³, with provisions for gas collection was designed and fabricated. This chamber was mainly used for the estimation of radon exhalation rates from small quantities of powder samples. Subsequently, a bigger chamber, of volume 0.125 m³ made of MS was fabricated in order to evaluate the radon exhalation rate from large size fly ash bricks, granite tiles etc.

The samples to be analyzed are kept in the chamber for a known amount of time and the accumulated radon gas collected in the Lucas cell. The content of the cell is counted in a scintillation cell assembly consisting of photo multiplier tube and a counting system. The radon gas concentration is calculated and the radon exhalation rate (RER) is estimated using the standard methodology (Table 1).

![Fig. 1 : Radon exhalation chamber (0.7 m³) along with scintillation cell assembly](image1)

![Fig. 2 : Radon concentration in fly ash brick houses](image2)

<table>
<thead>
<tr>
<th>Station</th>
<th>Radon Exhalation Rate (Bq/m²/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orissa</td>
<td>2.5</td>
</tr>
<tr>
<td>Neyveli</td>
<td>1.6</td>
</tr>
<tr>
<td>Vindhyachal</td>
<td>1.3</td>
</tr>
<tr>
<td>Delhi</td>
<td>0.9</td>
</tr>
<tr>
<td>Manuguru</td>
<td>1.3</td>
</tr>
</tbody>
</table>
The sources of exposure of general public to radiation are (i) natural (87%) and (ii) man-made (13%). Cosmic radiation, which interacts with the earth’s atmosphere and magnetic field to produce a shower of radiation, is one of the components of natural radiation. Traces of primordial radio nuclides, such as natural Uranium, Thorium and Potassium-40, present in earth’s crust are the other sources of natural radiation. Radon-222 and Radon-220, the gaseous daughter products of U-238 and thorium respectively, accounts for more than 50% of the exposure (internal) due to natural radiation. In addition, radio nuclides such as Potassium-40 and Carbon-14 that are present in our body gain entry from food chain also form part of exposure due to natural sources. Consumer products such as tobacco, building materials, smoke detectors, combustible fuels etc., form part of man-made sources. The most significant exposure due to man-made source is from medical procedures (12%), such as diagnostic X-rays, nuclear medicine, and radiation therapy. Some of the major isotopes used in medical procedures are Iodine-131, Cobalt-60 and Cesium-137. Of very less magnitude, members of the public are exposed to man-made radiation from nuclear industry. Occupation in a nuclear industry and ‘fall out’ from nuclear weapon testing are also sources of man-made radiation to general public, though insignificant.

**RADIATION EXPOSURE**

![Image](image.png)

Fig. 3: The defect production rate by different projectiles (Ion beams produce displacement damage at a much faster rate than neutrons)

**SIGNIFICANT ACHIEVEMENT**

The mandatory requirement of estimating and certifying the radon exhalation rates from Indian granite tiles, imposed by several countries was complied with. Estimation and certification of radon exhalation rate from granite tiles, exported from India, was done on chargeable basis. The project of creating a comprehensive database on natural radioactivity content in fly ash, after extensive analysis of various samples collected from major thermal power stations situated across the country, was completed and a report has been submitted.

**PUBLICATIONS ARISING OUT OF THIS STUDY AND RELATED WORK**


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