

ORIGINAL ARTICLES

Study of Indoor ^{222}Rn Concentrations in Different Classes in Faculty of Science - Jazan University

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ABSTRACT

Indoor radon measurements by nuclear track detectors CR-39 and application of the method in different classes in faculty of science - Jazan University were performed in 2011. The basic idea is to remove, after exposure, a surface layer, thicker than the range of the α -particles of the ^{222}Rn or ^{220}Rn progenies, and to study the track density of the electrochemically etched tracks at that depth. It has been estimated that the total effective dose received by human beings from all building materials of ionizing radiation is attributed to ^{222}Rn and its short-lived progeny. CR-39 detectors were exposed to the classes with bad- ventilation and well-ventilated. After exposure, the CR-39 detectors were etched in a 6N NaOH at 70°C for 6 hours. The results show that the mean average of radon concentrations was 496.98 Bq/m³ in bad ventilation classes while it was 25.30 Bq/m³ in case of good ventilation ones. The range of annual effective doses varies from 0.7 mSv/yr in office 2 to 13.31 mSv/yr in bathroom3 in poor ventilation and from 0.29 to 0.61 mSv/yr in good ventilation.

Key words: ^{222}Rn , In door measurements, Jazan university and SSNTDs.

Introduction

Monitoring of environmental hazardous are a world wide problem especially in closed areas Ibrahim, M. *et al* (2009), Ibrahim, M. (2009) Ibrahim, M. (2008). Hazardous of radiation origin are of great interest according to its adverse impacts. Inhaled radon (^{222}Rn) progeny are the most important source of irradiation of the human respiratory tract. Epidemiological studies of underground miners of uranium and other minerals have provided reasonably firm estimates of the risk of lung cancer associated with exposure to radon progeny. Radon is a chemical element with symbol Rn and atomic number 86. It is a radioactive, colorless, odorless, tasteless noble gas, occurring naturally as the decay product of uranium or thorium. Its most stable isotope, ^{222}Rn , has a half-life of 3.8 days. It consists of three isotopes, namely: ^{222}Rn (called radon, belongs to ^{238}U decay series); ^{220}Rn (called thoron, belongs to ^{232}Th decay series) and ^{219}Rn (called actinon, belongs to, ^{235}U decay series). ^{222}Rn has 3.82 days half-life, where as ^{220}Rn (55.6 s) and ^{219}Rn (3.96 s) have much shorter half-lives than ^{222}Rn Sahoo B.K. *et al*, (2011), Muhammad R. *et al*, (2011).

Noble gas, Radon-222, Radon-220 or Radon-219 play important roles in transporting natural radioactivity from place to another. Radon radioactivity, at high concentrations, may cause harm to human. It is considered the second reason for lung cancer Al-Jundi J. *et. al*, (2011), Harb, (2004). Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.

Natural levels of ^{222}Rn in open space are usually below 10 Bqm⁻³. This concentration does not present a significant radiation hazard. However, in closed space, like indoor environments, ^{222}Rn is accumulated due to poor ventilation. The ^{222}Rn concentration can reach a very high level if the source strength is large and the ventilation is poor. High radon concentrations in the order of a few hundreds of Bqm⁻³ or more can represent significant radiation hazard.

Variations of ^{222}Rn concentrations in the air influence seasonal and diurnal variations of the ambient dose equivalent rate ADER. The latter depends on the intensity of ionizing radiation of radio-nuclides in the atmosphere and on the ground surface as well as on cosmic radiation. The value of ADER in the ground level air is mostly caused by ionizing radiation of 40K Lebedyte, *et al*. (2003).

The ^{222}Rn exhalation is influenced by alteration of meteorological conditions: the snow-cover thickness; the freezing depth; the air and soil temperatures, their difference, the precipitation amount, etc. Grasty, (1994). The ^{222}Rn concentration in the ground level atmosphere depends on the rate of the ^{222}Rn exhalation from soil and the intensity of turbulent air mixing. Its diurnal and seasonal variations depend on meteorological conditions Merrile and Akbar, K. (1998).

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In this work we used Solid State Nuclear Track Detectors (SSNTDs) to measure the concentrations of indoor radon because of its good sensitivity, stability against environment factors and high degree of optical clarity.

Solid State Nuclear Track Detectors (SSNTDs) CR39:

A solid-state nuclear track detector or SSNTD is a section of a solid material (photographic emulsion, crystal, glass or plastic) uncovered to nuclear radiation (neutrons or charged particles, intermittently as well gamma rays), etched, and inspected microscopically.

In the last few years, the CR-39 track detector has become a popular method to measure charged particle emissions in cold fusion experiments. The use of CR-39 is quite simple and cheap, but this technique demands some special conditions. As shown below, the observance of these conditions allows the researcher to not only detect charged particles, but also to identify their types and estimate their energy spectrum. On the other hand, when these conditions are not met, the method can fail, mainly because of problems with radioactive nuclides contained in the surrounding materials (electrolyte, air, cathode etc.), mechanical defects, and the development process after etching.

Materials and Methods

Measurements:

For the measurement of indoor radon levels in different laboratories of CR-39 films (1.5 × 1.5) were used. Films were fixed at the bottom of plastic cups measuring 5 cm in diameter and 8.5 cm in height. The top of the cup was covered with a semi-permeable membrane. These films were placed in different laboratories and different offices in faculty of science in Jazan University. The detectors exposed at each location for a period of one month. After exposure, films were etched in 6.25 N NaOH solution at 70 °C for 6 h. Following etching films were washed with distilled water and dried, with alpha tracks subsequently counted under a microscope.

Radon concentration and exhalation rate:

The value of soil radon concentration (Bqm⁻³) has been obtained from the expression Surindef, S. *et al* (2005).

$$C = \rho / KT \quad (1)$$

Where C, ρ and T are the radon concentration, the sensitivity factor which calculated by Saeed, D. *et al*. (1997), K = 0.168 tracks m⁻² d⁻¹/Bqm⁻³ of radon and is the effective exposure time respectively. The surface exhalation rate of the soil sample for the release of radon can be calculated by

$$E = \frac{C V \lambda}{A [T + \frac{1}{\lambda} (e^{-\lambda T} - 1)]} \quad (2)$$

Where E, A, V, λ, T are the radon exhalation rate in terms the area of can (m²), effective volume of the can in m³, decay constant for radon in h⁻¹, and the exposure time in hours, respectively.

Results and discussions

The results for the average indoor radon concentration for good and poor ventilation of the recorded values in different places of Jazan college building are reported in Table 1.

The range of indoor radon concentration varies from 40.6 Bq/m³ in office2 to 773.37 Bq/m³ in bathroom3 with geometric mean value of 496.985 Bq/m³ in poor ventilation. The highest value of radon concentration for poor ventilation is found slightly higher than the recommended level (ICRP-2007). In about 46% of concentration of radon was higher than the recommended level and 54% was below. All values of radon concentration for good ventilation are found lower than the recommended level (ICRP-2007).

The average value of annual effective dose in study area was 8.55 mSv/yr with poor ventilation while it was 0.43 mSv/ye with good ventilation. The radon exhalation rate varies from place to another with variation of radon concentration. The variation of radon concentration may be classified in terms of different types of floorings and ventilation. The radon concentration in different location is shown in fig.1. It is evident that dwelling with mud flooring and varying ventilation from one space to another.

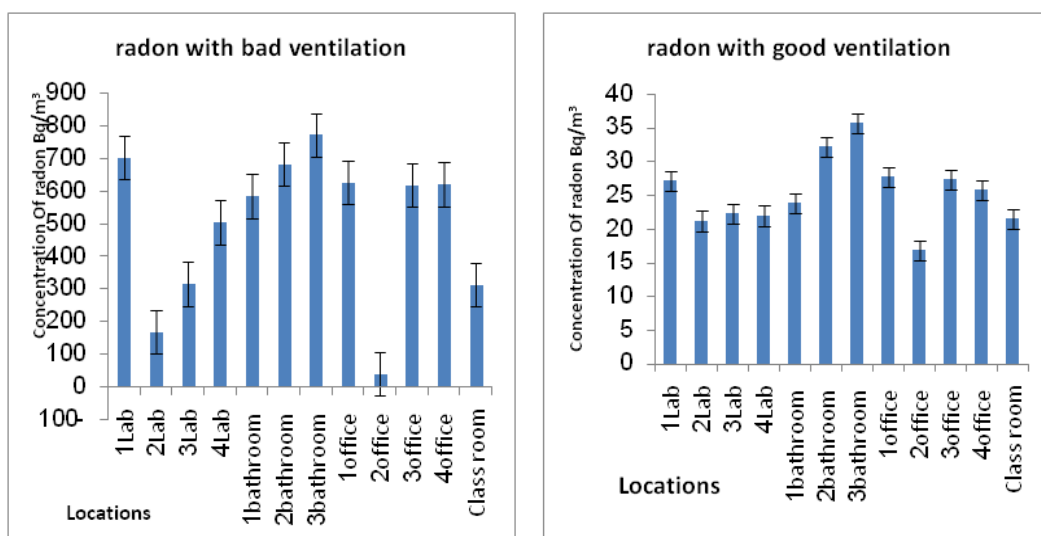
Table 1: The average indoor radon concentration, the annual effective dose and radon exhalation rate for good and poor ventilation in different places of Jazan.

a) radon with poor ventilation

No of location	Concentration Of radon Bq/m ³	Dos from radon mSv/yr	Exhalation rate mBq/m ² .d
Lab1	704.37	12.12	145.92
Lab2	168.65	2.90	34.94
Lab3	316.47	5.44	65.56
Lab4	505.95	8.70	104.82
bathroom 1	585.32	10.07	121.26
bathroom 2	684.52	11.77	141.81
bathroom 3	773.81	13.31	160.31
office 1	627.48	10.79	129.99
office 2	40.67	0.70	8.43
office 3	620.04	10.66	128.45
office 4	622.02	10.70	128.86
Class room	314.48	5.41	65.15

b) radon with good ventilation

Concentration Of radon Bq/m ³	Dos1 from radon mSv/yr	Exhalation1 rate mBq/m ² .d
27.13	0.47	5.62
21.18	0.36	4.39
22.32	0.38	4.62
21.96	0.37	4.67
23.81	0.41	4.93
32.24	0.55	6.68
35.71	0.61	7.40
27.78	0.48	5.75
16.87	0.29	3.49
27.28	0.47	5.65
25.79	0.44	5.34
21.53	0.37	4.46

**Fig. 1:** The variation of radon concentration in different location in Jazan collage with poor and good ventilation.

The percentage distribution of Rn concentration with poor and good ventilation in studied locations is illustrated in Figure 2. The Figure shows that the concentration of radon is distributed evenly in the places careless.

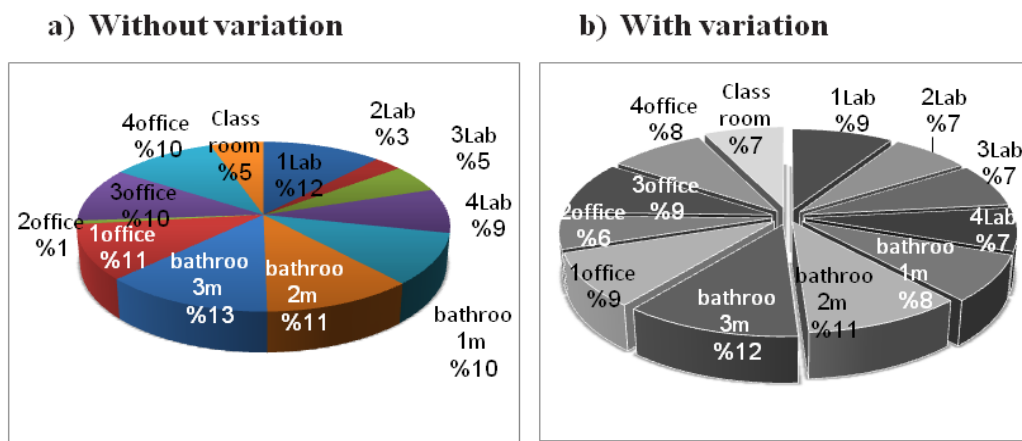


Fig. 2 Distribution of Rn concentrations between different locations

Conclusion:

The present work is out attempt to introduce some important data about the in door Radon concentrations in some study areas in Jazan University. From the measured data one can conclude that, the radon concentration in 54% of the study location lies in the range of the recommended level in case poor ventilation but in case good ventilation all value lies in the range of recommended level.

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