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MEASUREMENTS OF INDOOR ^{222}RN CONCENTRATION IN TWO ART GALLERIES

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ABSTRACT

It is point out that radon and their decay products in environment give high dose to human lung. Studies indicate that the indoor radon inhalation by humans has been considered probably the second most important cause of lung cancer after of smoking. A passive-type radon detector was used for measuring indoor radon concentration in two art galleries at Rio de Janeiro city during 90 days January to March, 2009. The aim of this study is to evaluate the occupational and public radon exposure in art galleries and museums. This paper shows the preliminary results of samples collected at two art galleries located in Gávea, Rio de Janeiro city. 30 LEXAN (GE) track detectors were exposed in the air (indoor as well as outdoor). The samples were collected in the same building which is a construction of XIX century. The analysis of the results suggests that the ^{222}Rn concentration levels are different in both sampling site, in closed environmental, demonstrating that, although the construction materials are the same the absence of circulating air is a factor very important to increase the concentration of indoor Rn.

1. INTRODUCTION

Numerous studies and reports indicate that the indoor radon inhalation by humans has being considered as the main source of radiological hazard and probably the second most important cause of lung cancer after smoking [1,2].

During the last decades, many countries have placed considerable efforts into direct monitoring of ^{222}Rn and its progeny in order to evaluate the risk due to radon inhalation. The average annual dose for public due to natural exposure is about 2.4 mSv and Rn contribution is about 50% [2].

Several building materials contain ^{232}Th and ^{238}U associated to the crystal lattice. ^{222}Rn is gas and it is decay product from U and ^{220} Rn is decay product of ^{232}Th, they can escape through the wall surface. In close area can occur high radon concentration due to ventilation condition [3].

Studies show that there is correlation between radon exposure and lung cancer occurrence and radon is classified as carcinogenic class I by the IARC (International Agency for Research on Cancer) [4].

Art galleries and museums are closed areas with temperature and humidity controlled resulting in a low rate of air renovation. These areas are visited by individuals of public mainly students that during the visit period are exposure to radon. The workers in these areas usually spend long period of time in closed areas and are occupationally exposed to radon. So, in order to evaluate the risk due to radon inhalation it is necessary to monitory the radon indoor in these areas.

The aim of this study is to evaluate the occupational and public radon exposure in art galleries and museums.

2. METHODS

The measurement was performed in two galleries at Gávea, Rio de Janeiro during the summer period (January-April). They are located in the same old build (about 100 years old). The gallery 1 is located at the second floor surrounding and the gallery windows usually are open during the day period. The second one is on the floor and the windows remained closed all time without any natural ventilation, at gallery 2 the temperature and humidity are controlled by an air conditioning system. About 30 detectors (indoor and outdoor) were distributed in both galleries.

Indoor, the detectors were located on the wall. Measurement outdoor was performed in order to compeer to indoor Rn concentration. The samples were collected at the same period of indoor samples. However, in gallery 1, outdoor samples were collected in wall faced to the balcony (it surround the second floor) and at gallery 2, the outdoor samples were collected on wall and on the window glass. The indoor control samples were collected in a build at the same area. The transport contamination was estimated using a specific detector and it was negligible, because they were exposed two days after the preparation.

The exposure time of the detectors was set to be 90 days considering previous calibration performed at the Instituto de Engenharia Nuclear (IEN/CNEN), where the efficiency was obtained for the density of alpha particle track about 13.8 cm^{-2} per exposure day and per kBq/m3 of radon concentration. In other words, such tracks density in the developed (etched) detector guarantees that 70% of the detected events will not be superposed and could be easily identified and counted. Following this recommendation and considering expected radon concentration levels in air within 200 Bq/m^3 and 2000 Bq/m^3 the exposition time had been estimated.

For the purpose of track revelation (two-step electrochemical etching), an electrochemical cell has been developed which permits to work simultaneously wit 24 polycarbonate passive alpha track detectors.

Exposed LEXAN detectors were chemically pre-etched (1000 V at 100 Hz) during 40 minutes and after that was etched (800 V at 3000 Hz) at 30º in a solution of 6N KOH + 80% of C_2H_5OH during 3 hours. Such pre-ecthing timing have been chosen to obtain the size of alpha particle track about 100 μm, which could be easily identified and visualized by computer scanning within 1200 dpi resolution.

Developed LEXAN detectors were scanned and the obtained images were analyzed by computer using software developed at laboratory.

Details of radon detector structure are shown in Fig. 1.

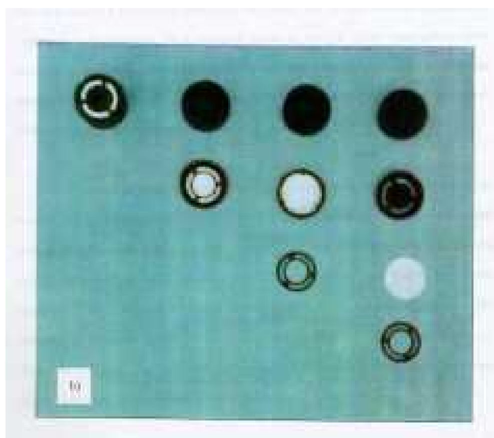

Figure 1 : Details of radon detector structure.

3. RESULTS

The indoor and outdoor radon air concentrations in both galleries (1 and 2) are shown in Fig, 2 and 3, respectivaly. The values of Rn concentrations in two galleries were compared using a statistical test (type t) and 95% confidence level. The results show that there is no statistical difference in the group of values. Although, the gallery 1 be an open area and gallery 2 a closed area both present the same Rn indoor concentration. This result suggest that the main source of radon are building material.

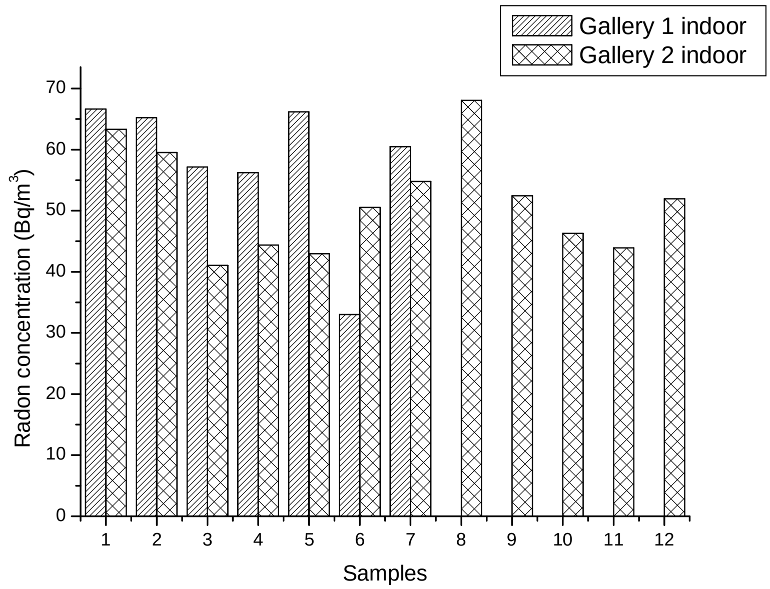

Figure 2: Indoor radon air concentrations in two galleries

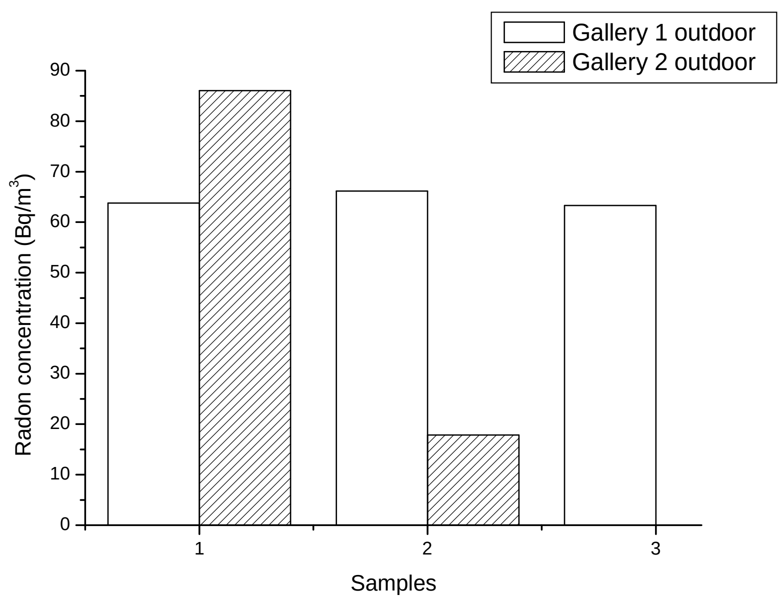

Figure 3: Outdoor radon air concentrations in two galleries

The half-live of ^{220}Rn and ^{222}Rn are 55.6 seconds and 3.82 days, respectively. The varaiation observed in outdoor concentration in galleries 1 and 2 suggest that problably the radon air concentration can be due to ^{222}Rn.

The indoor and outdoor Rn concentrations at each of the galleries are shown in Fig. 4 and 5, respectively. The indoor and outdoor Rn concentrations at each of the galleries were compared using a statistical test (type t) and 95% confidence level [5]. The distribution of radon concentration in gallery 1 do not present a statistical difference in the group of values (indoor and outdoor). However, the data from gallery 2 show that there is statistical difference in the group of values. The outdoor samplers in gallery 2 were located on the window glass. This result confirms that the source of Rn is from building material.

The indoor radon average concentrations are shown in Table 1. These values are in the range of indoor radon average concentrations in Brazilian residencies [6,7].

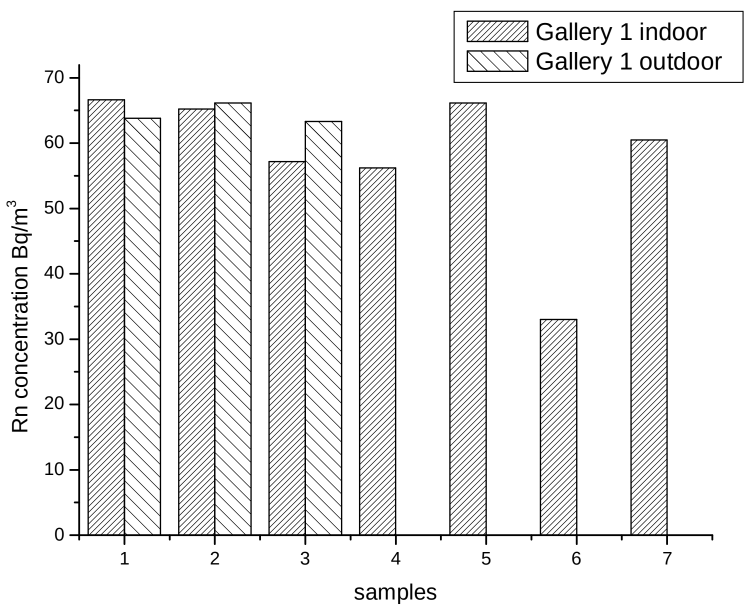

Figure 3: Indoor Rn concentrations and outdoor Rn concentration in gallery 1.

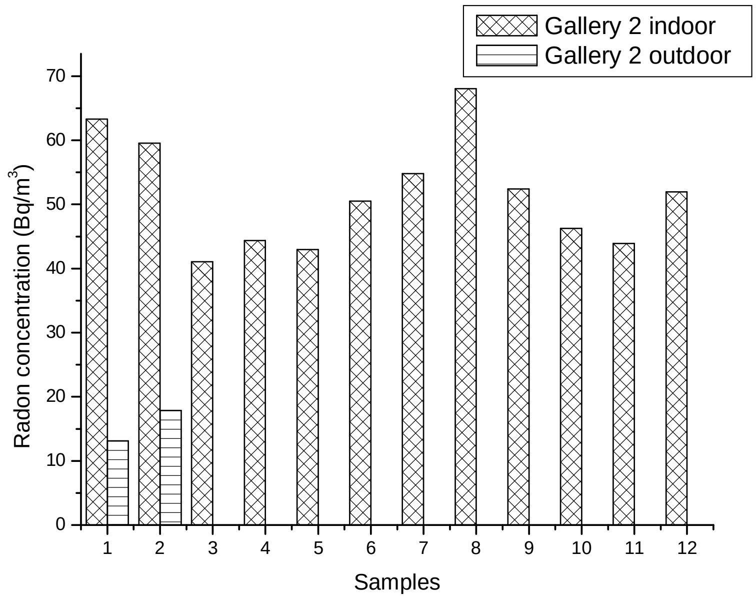

Figure 4 : Indoor Rn concentrations and outdoor Rn concentration in gallery 2.

Table 1: Indoor radon average concentrations

	Gallery 1		Gallery 2	
	Indoor	Outdoor	Indoor	Outdoor
Concentration (Bq/m³)	57.842	64.428	53.081	15.487
SD	11.74	1.52	10.02	3.35

Table 2: Indoor radon average concentrations in Brazilian residencies

	Rn average (Bq/m³)
Magallhães et al.	< 5 - 200
Geraldo et al.	56 - 168

4. CONCLUSIONS

The indoor radon values concentrations in 2 galleries are in the same range of indoor radon concentration in Brazilian residences. These values are below the intervention levels recommended by the International Comission on Radiological Protection (ICRP) for radon indoor concentration [3].

In gallery 2, the ventilation system reduces the temperature and humidity inside the gallery. The low humidity inside the gallery reduces the probability of Rn attachment. By other hand the gallery 1 is an open area, and in Gávea the humidity is height (about 75%).

Gallery 2 is connected to gallery 1 by an inside stair, this connection causes an air flow between the galleries and probably due this air flow it was not observed any difference among the values of radon concentrations in both galleries.

The values of outdoor Rn concentration compared to indoor concentrations in gallery 2 suggest that radon source can ^{232}Th present in building materials.

Further studies are necessary to identify the source of radon air concentration and if there is season variation.

ACKNOWLEDGMENTS

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