Exposure of LR-115 detectors at different distances from a wall

Julio Montoya Janampa*, Daniel Palacios Fernandez, Cesar Guevara Pillaca

Physics Section, Sciences Department, Pontifical Catholic University of Peru, Lima, Peru

*montoya.juliom@pucp.edu.pe

This work presents the results of the radon (Rn-222) measurements made with LR-115 type II detectors in bare mode at different distances from two opposite walls within two rooms in a home located in the north of Lima. The rooms differ by the ventilation rate, during this work one of them remains closed and in the other a window was kept open. The exposure time was 2 months. Later, all the detectors were chemically etched in NaOH 2.5 M solution at 60°C for 90 minutes and later read automatically by Politrack system. The results show that the radon concentrations have an oscillating behavior that decreases as the distance from the wall increases. Specifically, the highest radon concentrations are observed at 15 cm and 20 cm away from the wall. Lowest radon concentrations are observed at 30 cm and 45 cm away from the wall.

INTRODUCTION

Radon (Rn-222) is naturally occurring radionuclide formed from alpha disintegration of radium (Ra-226) in Uranium-238 decay series. Radon, thoron (Rn-220) and their decay products contribute more than half of the background radiation [1]. Indoor radon exposure has been linked to lung cancer cases in several studies. Most exposure to radon and their progeny occurs indoors where they can accumulate due to poor ventilation. This is ascribed to the fact that most building materials and the soil contain a certain amount of radium, which is a source of radon isotopes [2]. The aim of this study is to measure the radon concentrations at different distances from two opposite walls inside two rooms with different ventilation rate using LR-115 type II detectors in bare mode.

METHODOLOGY

The house is in a residential area in the north part of Lima. The two rooms, under study, are on the first floor and their dimensions are shown in Figure 1 (a). Besides, they have partially painted walls and ceilings, majolica floors, wooden doors, a glass window, and are accumulated with dust. Moreover, during this work, they differed by the ventilation rate, one of them remained completely closed and in the other a window was kept open. The walls materials (brick) have high porosity and can exhale radon, in addition to soil [1]. The measurements of radon concentration inside the two rooms were made with a display of LR-115 detectors in bare mode at different distances from two opposite walls. In each room, a group of eight detectors were located as indicated in Figure 1 (b). The procedure was repeated on the opposite wall. Finally, the total exposure time to indoor radon was 2 months.

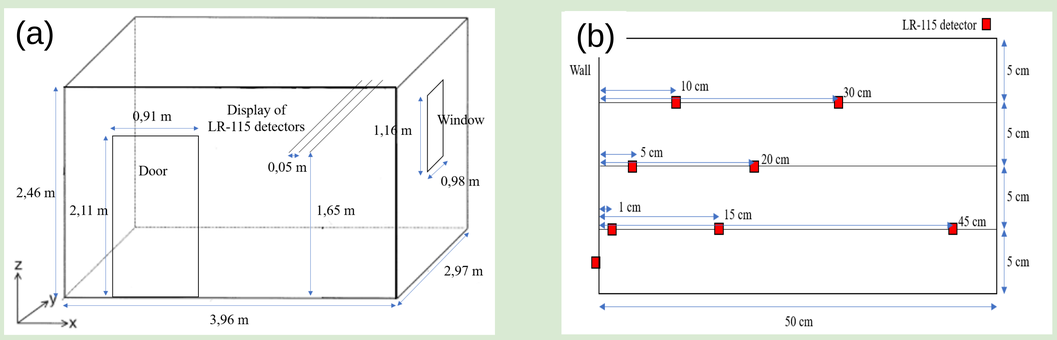

Figure 1. (a) Room dimensions, (b) Arrangement of detectors.

CHEMICAL ETCHING AND ITS READOUT PROCESS

After the 2 months of exposure time, the detectors were removed and chemically etched, all together, under the same conditions, for 90 minutes in a 2.5 M NaOH solution at 60˚C, in a thermo-controlled regulated bath, as is shown in Figure 2 (a). After the chemical etching, the LR-115 detectors with the formed tracks caused by alpha particles were read with Politrack system to obtain the average track density in each of them, as can be observed in Figure 2 (b). Subsequently, the radon concentration of each detector was calculated using the calibration factor for LR-115 detector type II in bare mode suggested by Mamta et al., 2011 [3].

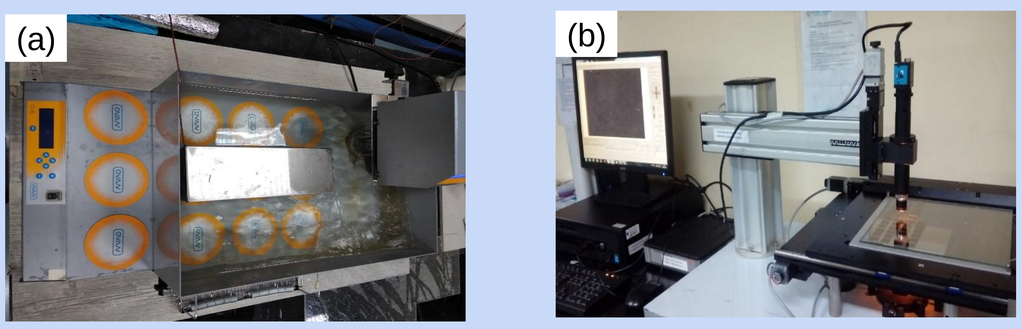

Figure 2. (a) Detector etching system, (b) Politrack system.

RESULTS

Radon concentrations were obtained at different distances inside the two rooms. Besides, it is shown that the detectors located at 1 cm and 20 cm away from the second and fourth walls respectively exceeded the barrier recommended by the Peruvian Institute of Nuclear Energy (IPEN).

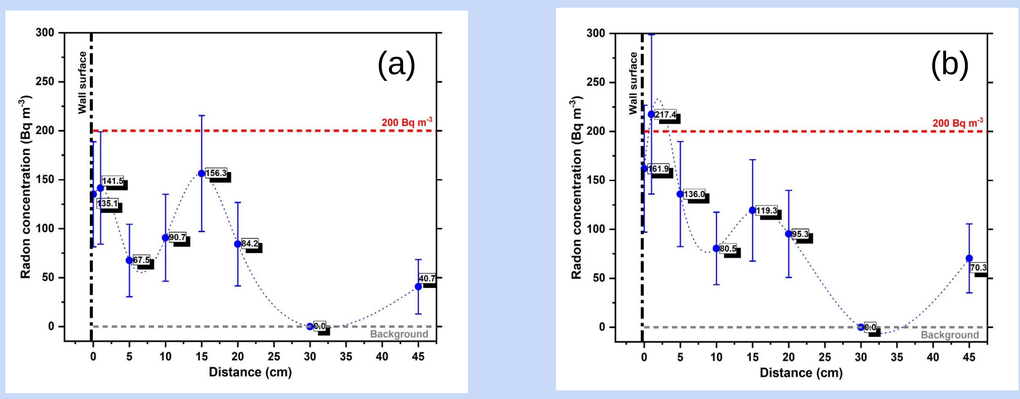

Figure 3. Radon concentration from the (a) first wall and (b) second wall (opposite to the first) in the room with high ventilation rate.

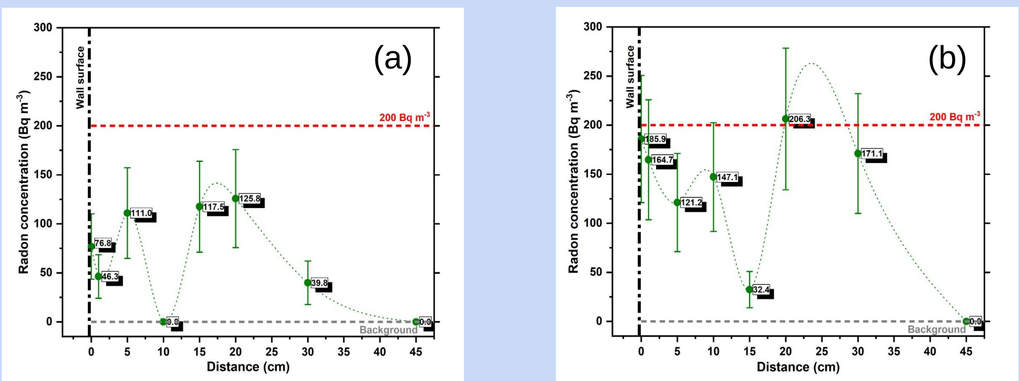

Figure 4. Radon concentration from the (a) third wall and (b) fourth wall (opposite to the third) in the room with low ventilation rate.

CONCLUSIONS

The radon concentration (Rn-222) inside the two rooms has an oscillating behavior that decreases as the distance from the wall increases and differ due to different ventilation rate, but the average radon concentration in each room was similar. Furthermore, the oscillating behavior of radon concentration could be because the source that contributes the most to radon exhalation is the soil in comparison to the walls. However, it is possible that in higher floors, this decrease is more clearly shown since it would only exhale radon from the walls.

ACKNOWLEDGEMENTS

Special thanks to all members of the Research Group on Techniques of Nuclear Tracks.

REFERENCES

[1] Chauhan, N., Chauhan, R. P., Joshi, M., Agarwal, T. K., Aggarwal, P., & Sahoo, B. K. (2014). Study of indoor radon distribution using measurements and CFD modeling. *Journal of environmental radioactivity*, *136*, 105-111.

[2] Espinosa, G., Golzarri, J. I., Román-Sedano, A. M., & Castillo, F. (2019). Mapping of Radon (220 Rn and 222 Rn) Concentration Distribution in a Microclimate Condition Cellar Using Nuclear Track Methodology. *Journal of Environmental Protection*, *10*(07), 919.

[3] Mamta, G., Mahur, A. K., Sonkawade, A., & Verma, K. D. (2011). Monitoring of indoor radon and its progeny in dwellings of Delhi using SSNTDs. *Journal of Advances in Applied Science Research*, 2(5), 421-426.