v. 2, n. 28, 2022

Journal of
Engineering
Research

MEASUREMENTS OF RADON GAS INTENSITY DURING 2022 AT THE ITA CAMPUS IN SÃO JOSE DOS CAMPOS, SP, BRAZIL

Inácio Malmonge Martin
Department of Physics, Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo, Brazil

Mauro A. Alves
Department of Physics, Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo, Brazil

Abstract: The objective of this article was to explain the monitoring of intensity of the radon gas in the soil / air interface of earth in ITA campus, São José dos Campos region of Brazil. The physics laboratory of electromagnetism experiments at the Technological Institute of Aeronautics (ITA) have been choose like monitoring site. During the period of 28/07/2022 to 14/11/2022 monitoring was made each minutes in that region continuously. Radon gas is present on every land surface of earth, accounting for approximately half of the ionizing radiation exposed to human. To monitor the intensity of radon gas the detector used was a RadonEye RD200, where the intensity was obtained in the range of 0 to 111[Bq /m^3] Becquerel of m^3 air, each hour. The results obtained from these experimental observations system, as well as discussions, correlations and suggestions, are presented in this article.

INTRODUCTION

Radon gas near the surface of the Earth can be measured through its radioactive decay products (alphas particles and gamma photons). It is estimated that about 48% of the ambient ionizing radiation dose at this (soil / air) interface is from radon gas exhaling from Earth (1).

Starting from the radioactive current series of Earth of the Uranium-238 (^{238}U) disintegrates in the order of 1600 years in Radium-226 (^{226}Ra) and arrives to Radon-222 (^{222}Rn) that in 3.82 days realized emission of alphas particles of 5,49 MeV of energy. Radon is a noble gas, alpha emitter, produced in the natural decay series of uranium and thorium, which occur at varying concentrations in geological materials, especially rocks, soils and water. By diffusion and convection, radon migrates from rocks and soils into the atmosphere through cracks, holes and pipes, entering homes and other constructions. Thus an easy way to measure radon gas variation at any location is to monitor the presence of alpha particles of that energy in the desired region. This can be done with the **RadonEye RD200** portable ionization chamber (2).As shown in the decay series, these radionuclides come from series originating from ^{238}U, ^{235}U, ^{232}Th, respectively. Although they are continuously produced in rocks and minerals by the decay α of ^{226}Ra, ^{224}Ra and ^{223}Ra, since they are inert noble gases, these radionuclides do not form chemical compounds and can be detected by their radioactive properties: well defined energy and a sequence of short half-life decay products. In practice, only the isotopes radon (^{222}Rn) are relevant from the point of view of radiological protection or environmental and geological interest.

Radon (^{222}Rn) has a half-life of 3.82 days, which allows significant mobility to escape from the rock in which it was generated. Radon occurs naturally in soils in the typical range of 4.0 to 40 kBq / m^3 and in the atmosphere not very close to the earth in the typical range of 4.0 to 50 Bq/m^3. It is estimated that in Brazil the average annual concentration of ^{222}Rn in air varies from 0.6 to 30 Bq/.m^3 (3-14).

According to the authors, for daytime variations, there are high levels of radon in the morning, at which point the atmospheric turbulence is accentuated, maximizing in the seasonal scale; high concentrations of radon tend to occur in the autumn and winter). However, the radon intensity at the soil-air interface varies with temperature, rainfall time, winds and cold fronts from southern Brazil.

MATERIAL AND METHODS

To monitor the variation of radon at the soil / air interface, the detector consisting of a RadonEye RD200 portable ionization chamber were used. Manufactured in South Korea, the RD200 has sensitivity 20 times

higher than other radon detectors and has the system in which it releases dual-structure pulses and a highly accurate detection circuit designed by Ftlab's own technology. A first reliable 1-hour data view is required, where its sensitivity is 1.35 counts per minute equivalent to 0.5 Becquerel / m^3. The measurements were performed from the ground and at the physics laboratory, both located at the Technological Institute of Aeronautics (ITA). Data acquisition is possible through the available Radoneye application, only on smartphones. Power was supplied via a 12 vdc source connected to the detector where the setting starts automatically. With a smartphone device, the data generated by the Radoneye Rd200 detector was transferred through the iTunes software and the Origin 1.5 software was used to graph the measurements of the radon intensity versus time on ITA campus. The rainfall variation in mm / min was measured by a scraper type rain gauge and a data logger for data acquisition developed in the ITA, in accordance with international recommendations.

RESULTS AND DISCUSSIONS

During the period from July 28, 2022 to November 16, 2022, the radon gas intensity were monitored at the (soil / air) interface in campus of ITA in the region of São José dos Campos, Brazil.

Figure 02 shows the monitoring of radon gas as a function of time during the analysis period carried out in the ITA physics electromagnetism laboratory. In which it is possible to analyze the radon gas intensity variation on the ground level interface at each hour.

In parallel with the monitoring of the intensity of radon gas in the surface in the electromagnetism laboratory of ITA, in the same type and time of measurements was made with another RadonEYE RD200 placed at 3 meters long in same room showed now in Figure 03.

It can be noted that in Figure 3 there are two days more measurements than those shown in Figure 2. Although it is another detector used from the same manufacturer and type, the measurements are identical, thus proving the good functioning of the detectors.

In Figure 4, the same measured data as in Figure 3 is plotted, but a 2500-hours smoothing is added, which is represented by the red curve.

Figure 5 shows the same series plotted in Figure 2 but now adding a smoothing of 1000 hours also presented here in a red curve.

Although these measurements of radon gas intensity per hour are shown, it is clear that with the two types of smoothing shown in figures 4 and 5, there was a tendency for intensity to decrease as a function of time measured in these periods.

CONCLUSION

This paper presents the analysis of the radon gas that exists on the surface of the earth in the region. Having as origin from the soil, through the decay of the radioactive elements Uranium and Thorium. For this measurements was used a fully portable equipment alpha ionizing chamber the RadonEye RD200, in which it allows to monitor the intensity of radon gas per cubic meter in the place. Where it connected to a smartphone in order to acquire and collect the data. It is used a rain pluviometer sensor, of the tip type, to collect data of rainfalls in the place. Through this measurement system, it is possible to present the relationship between the intensity of radon gas and the intensity of rainfall in the region of the ITA campus in São José dos Campos, Brazil.

Analyzing the 4 final figures, it can be seen that the first month of measurements, the intensity of radon gas radiation was higher,

Fig.01-Data collection of RadonEye RD200 with a Smartphone in 11/14/2022(author)

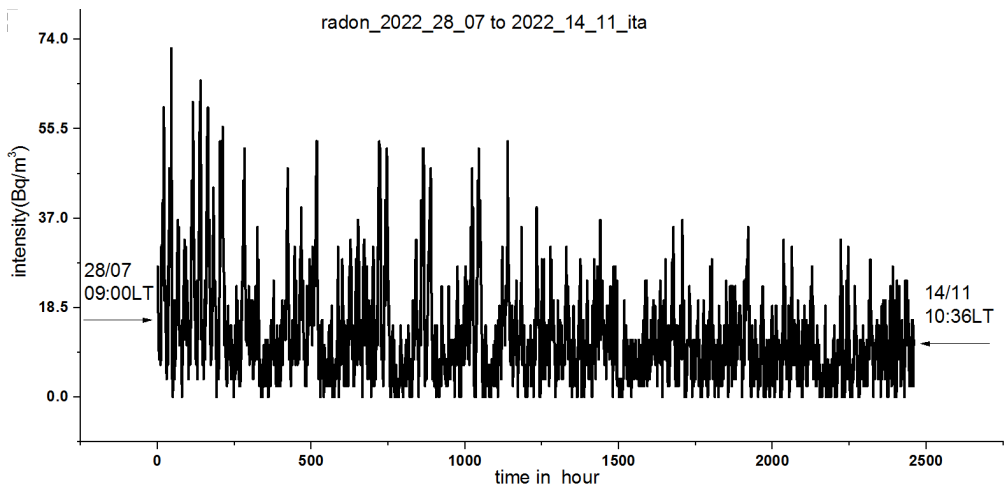

Fig. 02 - Variation of radon gas intensity versus time in hours from 28/07/2022 to 14/11/2022 in ITA laboratory.

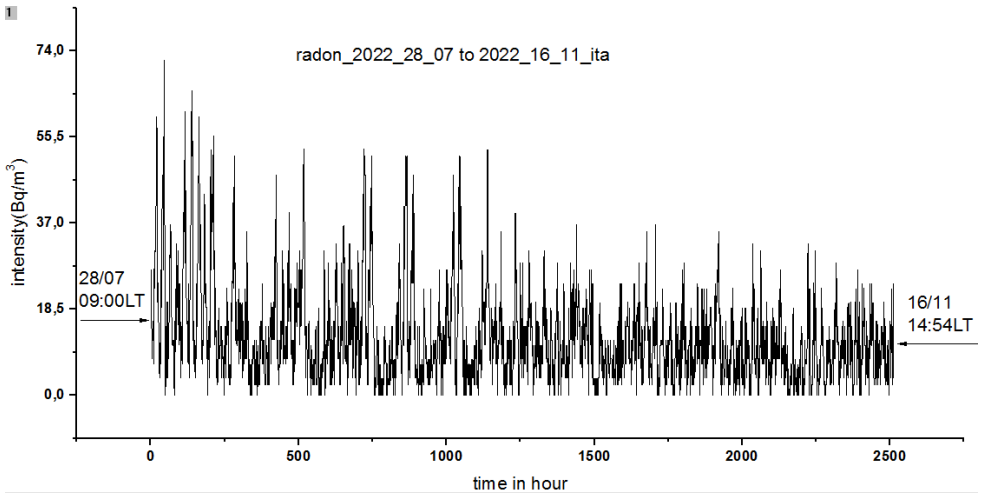

Fig. 3 - Variation of radon gas intensity versus time in hours from 28/07/2022 to 16/11/2022 in ITA laboratory (author).

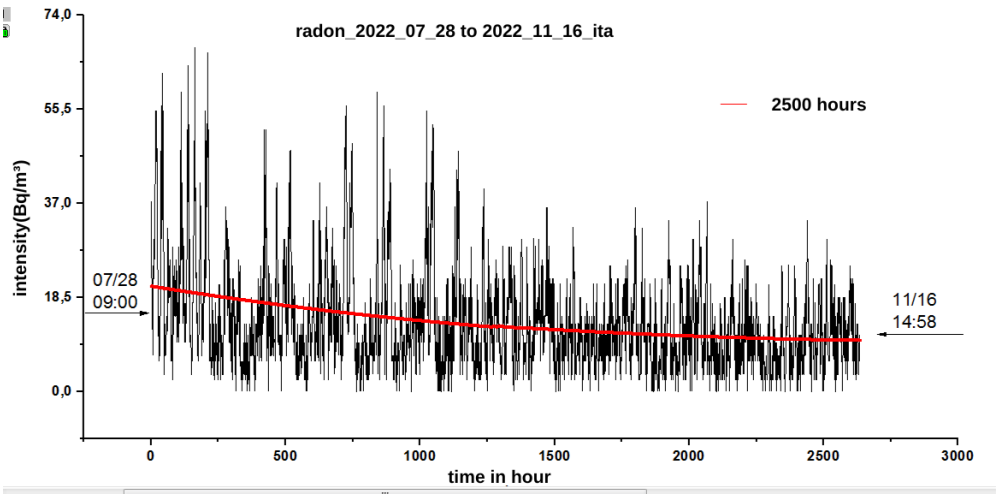

Fig.04 – Variation of radon gas intensity versus time in hours from 28/07/2022 to 16/11/2022 in ITA campus. Weak black color is one hour and strong black color one day. Red line showed 2500 hours smoothing (author).

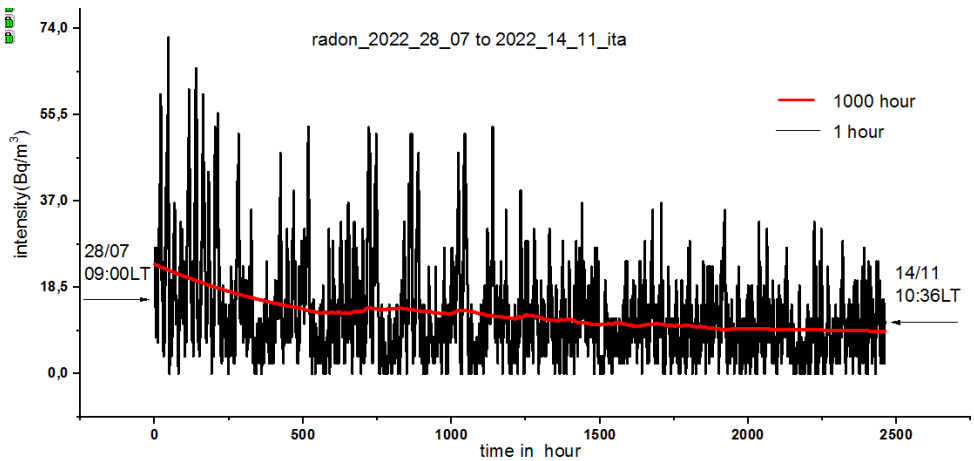

Fig. 5 - Variation of radon gas intensity versus time in hours from 28/07/2022 to 14/11/2022 in ITA laboratory. Red curve corresponding 1000 hours smoothing (author).

tending to decrease until the last observed day, 11/16/2022. This is because most of the time the region remains cloudy and without rain, blocking solar radiation for extracting less radon gas from the Earth's surface. The presence of radon gas measured in the ITA laboratory showed daily variation (day/night), variation with closed clouds in the sky, variation with local intense rains. During all this period the maxima intensity arrives near 74 Bq/m^3 and the minimum value stay about 10 Bq/m^3 .

ACKNOWLEDGEMENTS

Thanks to CNPq (National Counsel of Technological and Scientific Development) and CAPES (Coordination for the Improvement of Higher Education Personnel) by the fellowships grants support to the group's researchers and the ITA Division of Fundamental Sciences for supporting this research. Thanks also to INCT-FNA-ITA to support this research at ITA.

REFERENCES

[1]. EPA- https://www.epa.gov/radon/health-risk-radon acessed in january 2019.

[2]. RD200 RadonEye - https://www.amazon.com/Radon-Detector-Home-Owner-Plus/dp/B07864XVBH accessed in January 2019.

[3]. Magalhães MH[1], Amaral EC, Sachett I, Rochedo ER, Radon-222 in Brazil: an outline of indoor and outdoor measurements. Journal of Environmental Radioactivity. (2003), vol. 67, serie 2, pg 131-143.

[4]. Da Silva, A. A. R. and Yoshimura, E.M. Radon and progeny in the city of São Paulo—Brazil, Radiation Measurements 40(2) 678-681, (2005) DOI 10.1016/j.radmeas.2005.06.034.

[5]. Tameshige Tsukuda- Radon-gas monitoring by gamma-ray measurements on the ground for detecting crustal activity changes – Bull. Eartq.Research Institute, University of Tokyo, vol (83), (2008), pg. 227-241, Japan.

[6]. N. A. Bui Van, I. M. Martin and A. Turtelli Jr. – Measurements of natural radioactivity at different atmospheric depths. Revista Geofísica, IPGH, numero 28, enero-junio 1988, México.

[7]. Martin, I. M, Measurements of natural radioactivity in Poços de Caldas, Brazil, Revista Ciência e Cultura, 34(8), 1065, 1982, Brazil.

[8]. Matheus Carlos Silva1, Douglas Carlos Vilela1, Victor G. Migoto1, Marcelo P. Gomes1, Inácio M. Martin1 and Silvério J. Germano1, Ionizing radiation measurements using low cost instruments for teaching in college or high-school in Brazil published to Physics Education, may 2017 see http://iopscience.iop.org/journal/0031-9120.

[9]. Yajima, K., Yasuda, H., Takada, M., Sato, T., Goka, T., Matsumoto, H., Nakamura, T. 2010. "Measurements of Cosmic-Ray Neutron Energy Spectra from Thermal to 15 MeV with Bonner Ball Neutron Detector in Aircraft." *Journal of Nuclear Science and Technology* 47 (1): 31–39.

[10]. Boardman, B. J.: User's Page. 2015. Aware Electronic Corp. https://www.aw-el.com/Accessed in 07 September 2018.

[11]. Inacio M. Martin, Anatoli A. Gusev and Franklin A. Silva; " Dynamics of Radon Gas Near Ground Level in São José dos Campos Region During April-May 2018" Global Journal of Engineering Science and Researches, Vol. 5 pag. 117-120, DOI: 10.5281/zenodo.1288483, June 13, 2018.

[12]. EISENBUD, M.; GESSEL, T. *Environmental Radioactivity.* San Diego, Califórnia,1997.

[13]. FIOR, Loriane. *Analysis of the Concentration of Radon from construction*. Dissertation (Master's Degree in Mechanical Engineering and Materials Engineering) - Federal University of Minas Gerais, Department of Research and Post-graduation, UTFPR, Curitiba, 2008.

[14]. Santos, Talita. *Distribution of the Radon Concentration in Residences and Other Constructions of the Metropolitan region and other Constructions of the Metropolitan Region of Belo Horizonte* - RNBH (Master's Degree in Nuclear Sciences and Techniques) Federal University of Minas Gerais, Department of Nuclear Engineering, UFMG, Minas Gerais, 2010.