Radon exposure at Rafael Dieste: a center that avoids radiation

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1. Abstract

In this work we evaluate the presence of radon in the IES Rafael Dieste and analyze the role of ventilation in reducing its concentration. Considering that Galicia is a region with a natural risk of radon due to its geology, we decided to measure the levels of this gas in several classrooms and spaces of the center. The measurements were carried out both with adequate ventilation (open windows and doors) and with conditions of low air circulation. We used detectors provided by the Galician Institute of High Energy Physics (IGFAE) of the USC, thanks to an educational program in collaboration with CERN. The results show low radon levels in all the measured areas. Ventilation has proven to be fundamental in reducing the levels, confirming that even lower concentrations can be achieved with simple measures.

2. Introdución

Radiation is the emission, propagation and transfer of energy in the form of electromagnetic waves or particles. There are several of them: ionizing (alpha, beta and gamma rays, X-rays and radon, among others) and non-ionizing (radio waves, visible light, microwaves...). On the other hand, we have radioactivity, a spontaneous phenomenon in which an unstable nucleus disintegrates into a stable one, losing energy through the emission of ionizing radiation.

Radon is a colorless, odorless and tasteless carcinogenic gas that is produced by the natural radioactive decay chain of thorium and uranium found in the soil and rocks (mainly granite) that tend to accumulate in unventilated and closed spaces. For all this, radon emerges from the soil and disintegrates in the air with the emission of alpha rays, which have energies between 4.5 and 7.2 MeV[1].

In Galicia, 170 municipalities are presented as areas of high risk of radon gas concentration[2]. These are mostly found in the provinces of Pontevedra and Ourense, but there are also areas of A Coruña with a high percentage of this gas.

The problem appears despite a publication in 2005[3] that directly links the high presence of radon with the development of lung cancer de facto. So much so that, after tobacco, it is the second cause of this cancer in the Galician community. 7% of deaths from lung cancer are due to exposure to radon in the home.

This event is the basis for the research and measurement of radon gas at the Rafael Dieste Institute in the city of A Coruña.

3. Experimental Setup

3.1. Equipment Used

To detect particles emitted from radon decay, the following materials were used:
▪ **MiniPIX Detector** [4] (model CO4-WO283, sn 1575): a compact particle detector based on Timepix technology, connected via USB to a computer. It allows the identification of different types of radiation (alpha, beta, gamma) through real-time trace visualization.
▪ **PixetPro Software**: used to configure data acquisition, visualize images and spectra, and export results for later analysis.
▪ **Laptop**: required to operate the software and store the acquired data.
▪ **Samples placed near the detector** to observe particle emissions: granite, floor tiles, and low-intensity radioactive materials.

3.2. Data Acquisition Procedure

1º. Connect the MiniPIX detector to the computer via USB.

2º. In the PixetPro software, configure the following parameters:

▪ Mode: Tracking (allows particle trace tracking).

▪ Frames: 1800 (one image per second for 30 minutes).

▪ Exposure: 1s (exposure time per image).

▪ Enable the **Sum** option to accumulate events.

▪ In the "Histogram" section, choose **Spectra** and **Energy (keV)** to

represent the energy of the detected particles.

3º. Press **START** to begin sampling and **STOP** when the 1800 acquisitions are completed.

4º. The data is saved in `.txt` format and later imported into Excel for graphical analysis.

3.3. Espazos

The building under study has three floors and a basement. Measurements were taken in various rooms with different characteristics: an auditorium and a gym in the basement, both very large spaces; a spacious classroom on the ground floor; and a laboratory on the top floor, which has a regular-sized space.

4. Results

The data collection is based on the average values of alpha particles attributed to radon relative to the total particle count in the air. Results are divided by each room where measurements were taken:

- In the physics lab (third floor) **with ventilation**, the average radon level is **5.854241%**. However, **without ventilation**, the average increases to **20.75889%**.[5]

- In the **auditorium** (basement), the average radon level is **10.816214%**.[5]

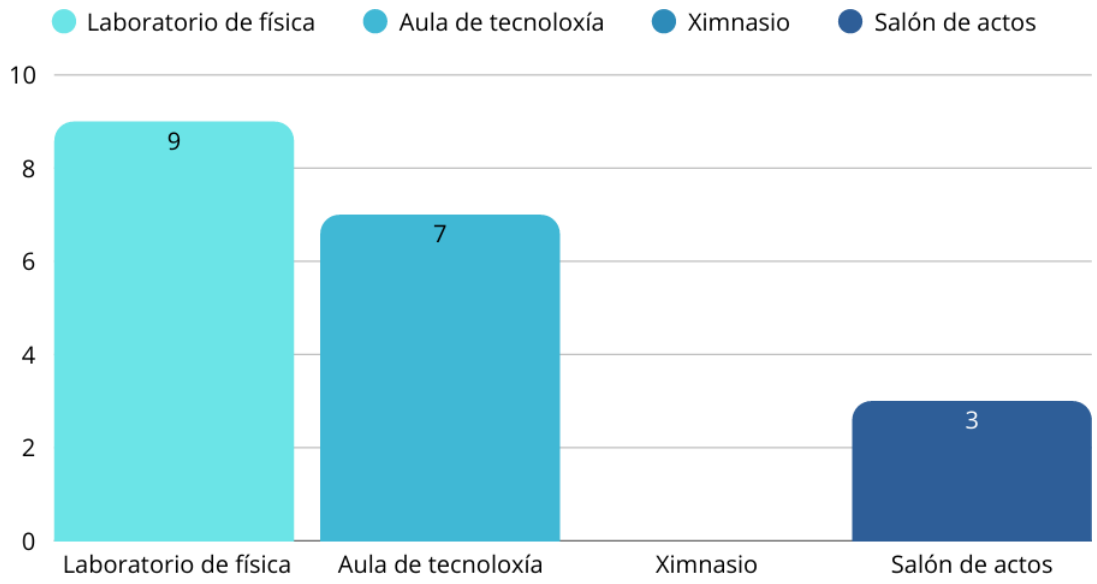
- In the **gym** (basement), the radon level averages **6.25% with ventilation**, and decreases to **2% without ventilation**.[5]

- In the **technology classroom** (ground floor), the average radon level is **3.7037% with ventilation**, and rises to **10.21705% when the windows are closed**.[5]

	MEDIA DE PARTÍCULAS DE RADÓN
PHYSICS LABORATORY WITHOUT VENTILATION	9%
VENTILATED PHYSICS LABORATORY	1,33%
UNVENTILATED TECHNOLOGY CLASSROOM	7%
VENTILATED TECHNOLOGY CLASSROOM	1%
UNVENTILATED GYM	0,5%
VENTILATED GYM	1%
EVENTS HALL	3%

É visíbel un aumento porcentual relevante da presenza de radón cando o espazo non está ventilado.

	AUMENTO PORCENUAL AO NON VENTILAR
PHYSICS LABORATORY	576,69%
TECHNOLOGY CLASSROOM	600%
GYM	100%



Logo, you would see in this taboa-summary the levels of radon present in the different spaces in ventilation. None of the three rooms present potentially dangerous values for health.

5. Conclusion

In conclusion, radon levels at the Rafael Dieste Institute are not harmful to health; On the other hand, ventilation in classrooms is crucial for children to stay under control. Test this or the percentage increase in non-ambient radon, which can result in a rate six times higher when there is no ventilation or space compared to when it is. According to WHO[6], radon starts to be alarming above 100 Bq/m³, even allowing up to around 300 Bq/m³. It is important to emphasize that the measurements presented low levels even in underground areas, in the technology classroom and in the gym, which are supposed to be the ones with the most alpha particles due to being more precisely alone. The room with the highest number of particles is the physics laboratory which, surprisingly, is found on the third step of the building. There is no clear explanation for the increase in radon gas in this classroom; Therefore the data continues to be alarming. The assembly hall presents difficulties in its ventilation and, even so, can be maintained at levels not prejudicial to human health. Finally, note that none of the measurements or the number of particles was 0, drastically lowering the radon average.

6. Thanks

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