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RADON LEVEL STUDIES AND CLIMATE CHANGE

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Abstract:
Radon is a radioactive gas, not detectable by human senses as it is without smell, taste and color. It can leave the ground and enter into dwellings, ocasionally also in larger concentrations when presenting real threat to human health as the lung cancer can be also one of the consequences of its regular breathing in. Regular radon level controls are important in both living and working environment. Some global radon level studies show that climate changes can negatively influence radon level in houses, leading to its increased values. We monitored for few years radon concentrations at Technical College of Applied Sciences in Zrenjanin and at Technical Faculty "Mihajlo Pupin" in Zrenjanin in order to control radon concentration level.

Keywords: *Heat pump, energy efficiency, heating costs*

Introduction

Radon radioactive radiation represents more then half of the total ionizing radiation on the Earth coming from natural sources [1]. As uranium is present in rocks and soil everywhere on Earth, also is radon as one of uranium decay product. The most important radon isotope is ^{222}Rn [1] which originates from radium (coming from ^{238}U). Radon can leave the ground and enter the atmosphere, but can also enter the houses and buildings through cracks and holes in the ground. Usually it is accumulated in highest concentration in the lowest parts of the dwellings unless it is coming from building materials wich is rarely the case. On the contrary to houses where radon can be accumulated in larger amounts when ventilation is poor, radon concentrations in the atmosphere are rather low.

Studies show that breathing in radon is bad for people as it can also cause lung cancer [2] when its concentrations in closed spaces are large

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(and is much more dangeerous for smoking than for non-smoking population). It is important to monitor radon level at home, work, school, kindergarten. Our National legislation [3] permits less than 400 Bq/m^3 in old buildings and 200 Bq/m^3 in new buildings., while World Health Organization [4] is more severe and recommends less than 100 Bq/m^3.

Some global studies [5] show that as a consequence of a climate change radon level concentrations in dwellings grow, and these studies will also be partly presented in this paper.

We monitored radon level concentration for the last few years at Technical College of Applied Studies in Zrenjanin (TCAS) and also at Technical Faculty Mihajlo Pupin in Zrenjanin (TFZR) in order to check its levels. These analyses will be described in this article.

1. Climate changes and radon level

As the radon level depends on: temperature fluctuations, precipitation patterns and extreme weather events, influences of climate changes on indoor radon concentration have been studied globally (detailly described in paper [5]) and part of these analyses will also be shown in this paper.

With high outdoor temperatures (due to the climate changes), also grows the rate at which radon emanates trough soil and enters houses and the atmosphere, so the increased indoor concentrations are the result of these chages. During very low temperature period homes are closed and islolated from the cold, with poor ventilation, thus causing growing indoor radon concentrations, too. The same is the case in other parts of the world with very warm summers, where indoor spaces are air-conditioned and sealed from the heat, with no air exchange outside-inside out.

Precitipation patterns impacted by climate changes can cause changes in soil moisture and thus also in radon movement. During heavy rains and high moisture in soil, radon movement is slowed down, but then during dry periods after the rains, radon is realesed very fast into the dwellings. Also, after long droughts soil becomes more permeable and radon moves easily from the ground into the houses. Energy efficient dwellings are well insulated with very low air leakage, which leads to larger indoor radon concentrations, becuase there is no air circulation.

Climate caused soil and geological changes can also influence radon emission. In nord regions close to Arctic thawing permafrost can release trapped radon from below permafrost into the buildings. The result is growing radon indoor concentrations. Erosion and other geological changes can also influence radon movement in the ground and its emission, causing the same effect of growing radon concentrations.

2. Radon level measurements in Zrenjanin

For radon level measurements we used CR39 passive detectors (Fido track radon detectors [6] produced by Niton company). Detectors are made of plastic and heavy charged particles leave tracks in diffusion chamber when passing through it. These detectors are few centimeters long and wide and have cylindrical shape. They are shown on Figure 1 (taken from the Niton website [6]).

Figure 1. *Fido track radon detector produced by Niton*

We measured radon continuously for one year via two consecutive six-months long measurements at TCAS (July 2023.-June 2024.) and also at TFZR (January-December 2024.). We selected four rooms at TCAS and six rooms at TFZR, where the highest radon levels had been detected during previous short-term tests. Detectors were placed at tables far from walls, doors, windows and heating bodies and rooms were in standard use during the measurement period.

The results of the yearly radon concentration measurements at TCAS [7] shows rather low values (presented in Table 1 [7]). The minimum measured radon concentration at TCAS is 26 Bq/m^3 and the maximum radon concentration is 39 $Bq/m^{3,}$ (mean value: 35 Bq/m^3).

Table 1: *Yearly radon concentrations at TCAS measured with CR39 detectors during the period July 2023-June 2024.*

No.	Room	Radon concentration (Bq/m³)	Estimated error (Bq/m³)
1.	Creativity studio(ground floor)	38	9
2.	Library (ground floor)	26	7
3.	Storage for technical equipment (basement)	37	9
4.	Office 138 (ground floor)	39	9

Source: Ref. [7]

The obtained yearly radon levels at TFZR are shown in Table 2. The maximum obtained radon concentration is 217 Bq/m^3, while the minimum value is 46 Bq/m^3. Mean value is 87 Bq/m^3. All the measured values at TFZR are below our national threshold and only one value is above WHO recommended level.

Table 2: *Yearly radon concentrations at TFZR measured with CR39 detectors during 2024.*

No.	Room	Radon concentration (Bq/m³)	Estimated error (Bq/m³)
1.	Office 5-Dean (ground floor)	217	35
2.	Office 5-ProDean (ground floor)	86	17
3.	Office 1 (ground floor)	60	14
4.	Office 2 (ground floor)	62	14
5.	Office 22 (first floor)	49	12
6.	Office 23 (first floor)	46	13

Previous measurements of radon concentration level performed during Vojvodina radon mapping [8] showed that medium radon concentration in the city of Zrenjanin (where TCAS is placed) were in the range between 100 Bq/m^3 and 120 Bq/m^3.

3. Conclusions

Understanding the connection between climate changes and radon concentration level is crucial for making good public health strategies. It is important to connect climate studies, building engineering and health studies to find solutions to reduce indoor radon.

Checking indoor radon concentration level in dwellings is very important issue. At TCAS and TFZR we did long-term (one year long) radon concentration measurement. As a result we observed that obtained values are within safe ranges. There is no need to perform measures of radon elimination, except regular daily ventilations.

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