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ACTIVITY CONCENTRATION OF RADON-222 IN THE BUILDINGS OF THE OPOLE UNIVERSITY

AKTYWNOŚĆ RADONU-222 W BUDYNKACH UNIWERSYTETU OPOLSKIEGO

Abstract: Rn-222 activity concentration is on average several times higher in confined spaces than outside. Given that approx. 75% of the time we spend indoors, there is a need to draw attention to the activity concentration of Rn-222 in rooms in which we live. The paper presents the results of measurements of Rn-222 activity concentration in the period September-October 2014, in the buildings of the Opole University. The measurements were performed using a portable spectrometer AlphaGUARD. In the tested buildings Rn-222 activity concentrations differs in the ranged from 4 to 38 Bq/m^3. These differences may be related to the local properties of the soil, the properties of the materials used in buildings construction and the method of building ventilation. The measurements of Rn-222 activity concentrations in the buildings of the Opole University showed no potential health risks resulting from radon.

Keywords: Rn-222 activity, AlphaGUARD spectrometer

Radioactivity is an integral part of the natural environment [1]. Statistical Polish resident receives annually from all sources of radiation effective dose average of 3.35 mSv, of which 74.2% comes from natural sources. Much of this dose (about 1.36 mSv/year) is caused by the radioactive gas radon [2].

Radon is a chemical element with atomic number 86 and is in 6th period and 18 group (helium group) of the periodic table of chemical elements. It is the heaviest gas from helium group, about 8 times heavier than atmospheric air with an average composition under normal conditions [1, 3, 4]. Entirely filled electron shell, making a noble gas radon, very poorly chemically reactive [5, 6]. Radon gas is non-flammable, tasteless and odorless [3, 4]. It has 33 isotopes, all of them are radioactive, and four of them occur naturally in nature and belong to the three natural radioactive series - uranium - radium (Rn-222 and Rn-218), thoron (Rn-220 - thoron) and uranium - actin (Rn-219 - actinon). The most important in environment is the isotope Rn-222, primarily because of its longest half-life (3.8224 days) [3].

Radon atoms formed in rocks and soil by spontaneous nuclear transformation emit during the decay an alpha particle, which is accompanied by a low-energy gamma rays [3].

In soil, the mineral grains release up to 70% of radon. The rate of radon transfer to the surface depends on porosity and soil moisture, atmospheric pressure and other meteorological factors. Radon migration processes is also affected by geological terrain, sediments structure, tectonic and erosion of the substrate, which manifests all sorts of gaps and cracks [5, 6].

The radon concentration is much greater inside the building than outside. In Poland, the mean activity concentration of radon in homes is about 40 Bq/m^3 and is, unlike in the

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fresh air, larger in winter than in summer, which probably stems from the frequent airing of rooms in summer than in winter [5, 6].

Radon infiltrates from the soil substratum and construction materials into the interior of buildings, what causes increase in his concentration inside the closed rooms. It penetrates into the cellars throughout the cracks of foundations, during the leaks in basing of water-supply tubes and sewerage as well as the system of drainage. The little differences of pressure between the ground under foundation and interior of accommodation, evoked by winds and differences of temperatures, cause that the house "sucks" the radon coming from the ground [7, 8].

The International Commission on Radiological Protection gives two reference values (for dwellings), above which action must be taken to reduce radon concentrations: 400 Bq/m^3 - for houses already built and 200 Bq/m^3 for newly built homes [9]. Recent recommendation of International Commission on Radiological Protection for the reference level for radon gas in dwellings is 300 Bq/m^3 [10].

Table 1 shows the mean values in many countries with recommended in these countries limit values of radon both in existing buildings and new build.

Table 1
Mean values calculated in many countries with recommended in these countries, radon concentration limit values for both existing buildings and new-build [11]

Country	The average concentration of radon [Bq/m^3]	Recommended radon concentration limits [Bq/m^3]	
		existing buildings	new build
Poland	38	400	200*
Finland	120	800	200
Germany	40	-	-
USA	65	150	10
Slovakia	-	500	500
Sweden	800	800	140
Switzerland	60	800	800
United Kingdom	28	400	80

* European Commission recommendation

The aims of this study were the analysis of the risk arising from the activity of Rn-222 in the buildings of the Opole University.

Material and methods

In this study the results of Rn-222 activity concentration measurements, in the period September-October 2014, in different buildings of the Opole University (UO): Collegium Biotechnologicum (CB), building on Dmowskiego str. (D), building on Kominka str. (K), building of Department of Physics (F), were presented. In each building the measurements were carried out on floors 0-III (Table 2).

Determination of radon activity concentrations in air were performed using the portable spectrometer AlphaGUARD, located at about 1.5 m above the ground level.

Table 2

Location of Rn-222 activity concentration measurements

Location			
The old building at Kominka street	K0	Collegium Biotechnologicum	CB0
	KI		CBI
	KII		CBII
	KIII		CBIII
Building at Dmowskiego street	D0	Department of Physics	F0
	DI		FI
	DII		FII
	DIII		FIII

Results and discussion

The results of measurements in each building are shown in Figure 1. The highest values were recorded in the building at Kominka street, which is a small building equipped with limited air exchange system. The relatively high activity concentrations of Rn-222 in the air were recorded on the lower floors, as a result of radon specific density bigger than that of air.

The results obtained Rn-222 activity in the buildings of the Opole University were used to estimate the effective doses from radon, received by UO students, within 1 academic year.

The calculations assumed the following:

1. 1-hour exposure to radon 1 Bq/m^3, with a balance factor F = 0.4 corresponds to an effective dose of 3.2 nSv ($3.2 \cdot 10^{-6}$ mSv) (equilibrium factor F is defined as the ratio of the radon concentration to potential radiation energy of shortliving α decay products of radon) [12].
2. Students spend 800 hours (full time), 500 (part-time studies) at the university in one year.

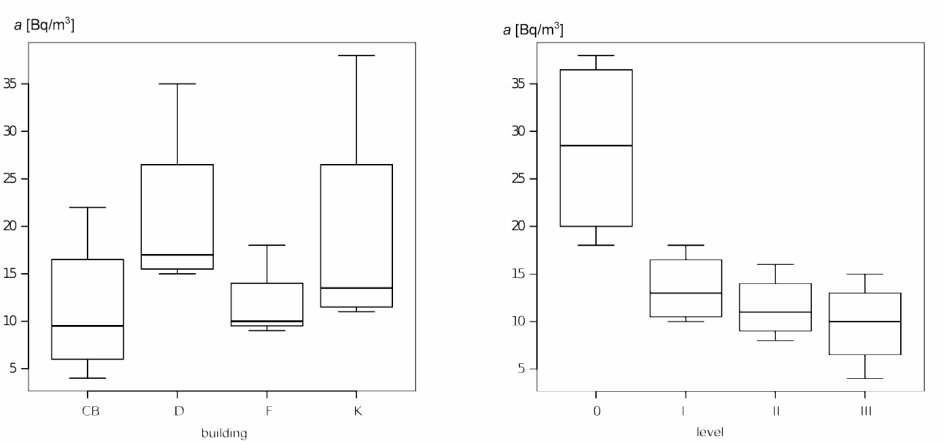

Fig. 1. The concentration of Rn-222 in the particular measurement places and on different floors

Annual dose of radon exposure in relation to full time and part time students presents Figure 2.

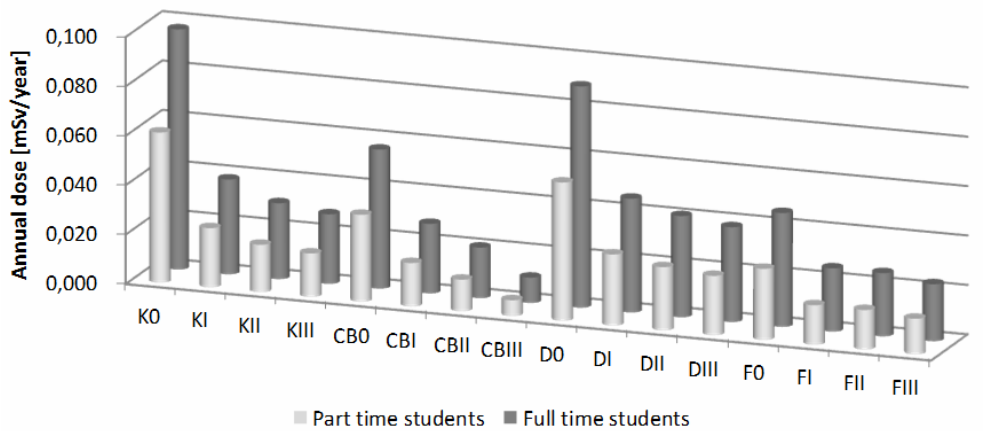

Fig. 2. The radiation dose from Rn-222 inhaled with air

Conclusions

Can be seen from the graph that the annual dose exposure to radon is the largest in the old buildings of the Opole University, on the lowest floors. Full-time students, due to the greater number of hours spent at the university are more exposed to radon than part-time students. However, the calculated doses do not exceed the standards adopted by an International Atomic Energy Agency.

The Rn-222 activity measurements performed using a portable spectrometer AlphaGUARD in buildings of Opole University showed no potential health risk from radon contamination. Based on the research it was observed that humans staying on the lower floors are more vulnerable to radiation associated with Rn-222 decay, due to the physical properties of the element.

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Abstrakt: Aktywność Rn-222 w pomieszczeniach zamkniętych jest średnio kilkakrotnie większa niż na zewnątrz. Ponieważ ok. 75% czasu spędzamy w pomieszczeniach zamkniętych, istnieje potrzeba zwrócenia uwagi na aktywność Rn-222 w pomieszczeniach, w których przebywamy. W pracy przedstawiono wyniki pomiarów aktywności Rn-222, w okresie wrzesień-październik 2014 r., w budynkach Uniwersytetu Opolskiego. Pomiary wykonano za pomocą przenośnego spektrometru AlphaGUARD. Zaobserwowano zróżnicowane aktywności Rn-222 w badanych budynkach, które mieściły się w przedziale od 4 do 38 Bq/m^3. Różnice te mogą być związane z lokalnymi właściwościami gruntu, właściwościami wykorzystanych materiałów budowlanych, a także sposobem wentylacji. Pomiary aktywności Rn-222 w budynkach Uniwersytetu Opolskiego wykazały brak potencjalnego zagrożenia zdrowia, wynikającego z zanieczyszczenia radonem.

Słowa kluczowe: Rn-222, aktywność, spektrometr AlphaGUARD