RADON CONTENT OF INDOOR AIR IN CRAIOVA MUNICIPALITY

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Abstract. Radon is a radioactive gas that does not participate in chemical reactions and it is found in soil, rocks, water, building materials and indoor air. The study was carried out in 2008-2009 period in Craiova municipality and consisted in monitoring several buildings in town (houses, apartments), built from different materials. It was observed a higher radon content at the lower levels of the buildings, which does not exceed the maximum admissible concentration and does not endanger the human health.

Keywords: indoor radon, radioactive pollution, monitoring, health impact, Craiova city.

Rezumat. Conţinutul în radon al aerului în interiorul clădirilor din municipiul Craiova. Radonul este un gaz radioactiv care nu participă la reacţii chimice, ce se găseşte în sol, roci, apă, materiale de construcţii şi în aerul din interiorul locuinţelor. Studiul a fost efectuat în perioada 2008-2009 în municipiul Craiova şi a constat în monitorizarea mai multor clădiri din oraş (case, apartamente), construite din materiale diferite. S-a constatat un conţinut în radon mai ridicat la nivelele inferioare ale clădirilor, care însă nu depăşeşte concentraţia maximă admisă şi nu pune în pericol sănătatea oamenilor.

Cuvinte cheie: radonul din interior, poluare radioactivă, monitorizare, impactul asupra sănătăţii, Craiova.

INTRODUCTION

Highlighting the concentrations related to the radon isotopes (Rn-222 and Rn-220) took place after establishing the dependence of lung cancer deaths and exposure to radon of the workers who worked in uranium mines or indoors, where they found high concentrations of radon and their descendants. Thus, the first research studies have been conducted in the U.S. and Canada and, in the last three decades, there were discussed among EU countries as well (PURGHEL, 2006). The U.S. has found that between 15,000-25,000 people die annually due to cumulative exposure to radon and its descendants. The research in the last years has shown that radon contributes in proportion of 55% to the natural radiation of population; in some areas, it may reach a contribution of over 90%, cases where the exposure to radiation is more than 5-6 times higher than the world average exposure (COSMA & TURCUŢ, 1996).

Radon is a radioactive gas that was studied in our country especially in the areas where there were uranium mines. From the conducted research, it was found an increased incidence of lung cancer to the inhabitants of these areas (DINU, 2009). Being a noble gas and not participating in chemical reactions, radon is present everywhere in rocks, soils, surface, and deep waters; it is generated from solid and liquid materials, being present in the air, in the atmosphere of caves and mines, in the outer atmosphere and inside homes and also in gas, in very different concentrations. In many waters and natural gases it occurs even without the presence of radium parent, due to the process of diffusion or transport, through rock cracks and fissures, dissolving itself into groundwater. It reaches the atmosphere by disseminating itself from the soil to the soil surface, this exhalation forming the radon flux of the earth's crust (COSMA & TURCUŢ, 1996).

The radon in homes requires a special attention because both the individual and the collective doses due to it and its descendants are higher than those from any other source. Lately, it was highlighted the link between the increasing radon concentrations and earthquake occurrence (values of approx. 15-20 times higher than the MAC) (OGRUŢAN et al., 2010). In the outdoor air, the radon concentration is about 4-8 Bq/m3 depending very much on the meteorological and geological conditions. However, indoors, by accumulation, it reaches values of 20-80 Bq/m3 (TREVISI et al., 2010). The water use in food, as well as the sewage and some cooking and heating fuels generally make more modest contributions to indoor radon; however they can not be ignored especially in the case of water supply with high radon content, or for the use of geothermal water in the treatment rooms of the spas (COSMA & POP, 1995).

MATERIAL AND METHODS

The study was carried out in 2008-2009 period and aimed at determining the indoor radon content in Craiova municipality (Brazdă, 1 Mai, Vasile Conta), in buildings made of different construction materials (concrete, brick, wood, insulation materials). In the same building the radon was measured at the basement, ground floor, first floor and second floor level. The measurements were made using RAD 7 device, during winter.

RESULTS AND DISCUSSIONS

The main source of indoor radon is the soil, or more correctly said the existing material under and around the building. The Ra-226 concentrations in soil can vary within very wide limits (10-105 Bq / kg), the average value being of 40 Bq / kg.

The emanation power is a measure for the amount of radon (formed by decomposition of radium) able to migrate from the soil and is characterized by the emanation coefficient the average value of which is 0.4.

The area where a building is placed, i.e. the radium concentration of that place, the local soil characteristics and the material from the building foundation influence decisively the radon concentration inside the building. In the normal soil, the radon diffusion length (the distance on which it diffuses before it decomposes) is about 1.6 m, while for concrete and brick, this length is only of 0.1 m. The partitions and cracks in the building materials or the leakage around pipes will be the main access routes of radon in buildings.

A second major source of radon in homes is given by the used building materials: wood, brick, concrete, plaster, tile, plastics, and insulation materials (Fig. 1).

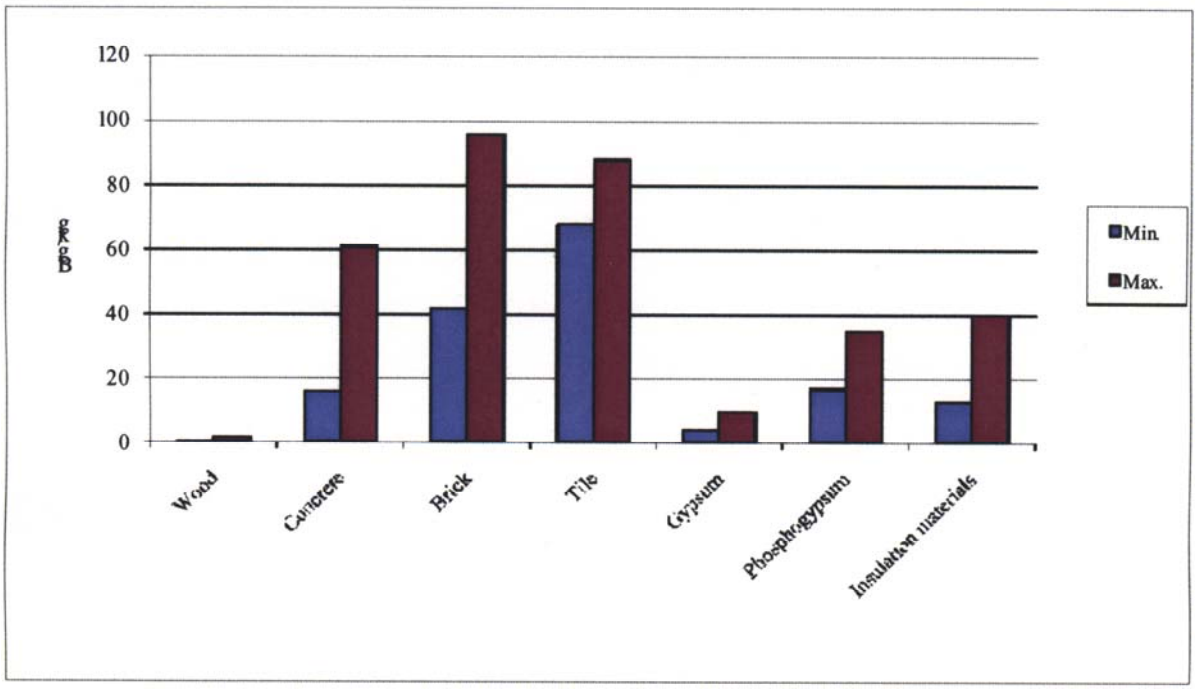

Figure 1. The Ra-226 content of main building materials.
Figura 1. Conținutul de Ra-226 al principalelor materiale de construcții.

The gypsum and phosphogypsum used as coating materials to interior walls can contribute significantly to the indoor radon because they can easily spread before disintegrating in thin layers of plaster.

Based on these concentrations it could be calculated the average radiation dose due to radon and thorium exhalation in the dwellings from Craiova, estimating an 1.21 mSv / year value in rural areas (the Valea Stanciului village) and 1.01 mSv / year in urban areas (Craiova).

The results of the experimental measurements on building materials show values in accordance with the calculations for normal concrete and ordinary clay bricks, but appreciably lower for natural gypsum.

These differences may be due to the fact that the measurements on samples of relatively small volume and with a proportion of surface / volume much larger than in reality, the obviously lower values are obtained due to the lower supply with radon atoms coming from the inside of the sample material (COSMA & TURCUȚ, 1996).

In the case of a house situated in Vasile Conta Street, there is a lower quantity of radon in the bedroom due to the migration of radon in soil through a single source, in comparison to the living room where there are several locations of its migration (Fig. 2).

Regarding the monitoring of radon in the living room of this house (average values), there are shown higher values during the cold season (January, February, and March) and lower values in June and July. Both in the living room and the bedroom, the radon levels oscillate likewise. The maximum values are affected during cloudy days and high rainfall regime may fade completely this behavior (Fig. 3).

The building materials have an important role, especially those contained in the floor. For example: the concrete with a thickness of 20-25 cm will reduce the rate of entry through the floor with 3 Bq/m3/hour, being comparable with the contribution from a ceiling or wall element. The floors may not be completely intact and the holes and cracks facilitate the entry of radon.

The differences between the concentrations of radon in a house situated in Brazdă Neighborhood in comparison with one situated in 1 Mai Neighborhood, both consisting of basement, ground floor, first floor, and second floor, are shown in figure 4.

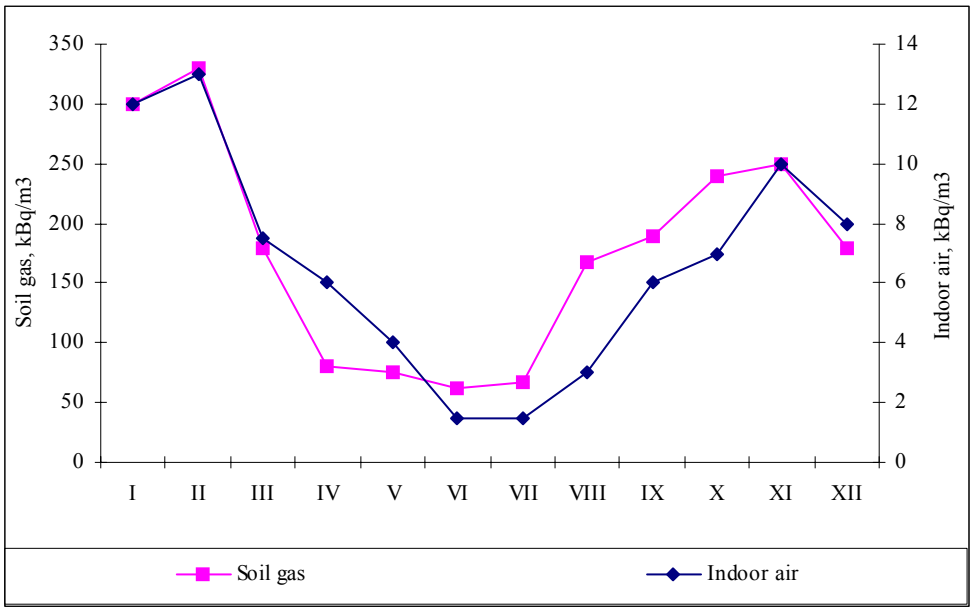

Figure 2. The radon in soil and the indoor radon.
Figura 2. Radonul din sol şi cel din interior.

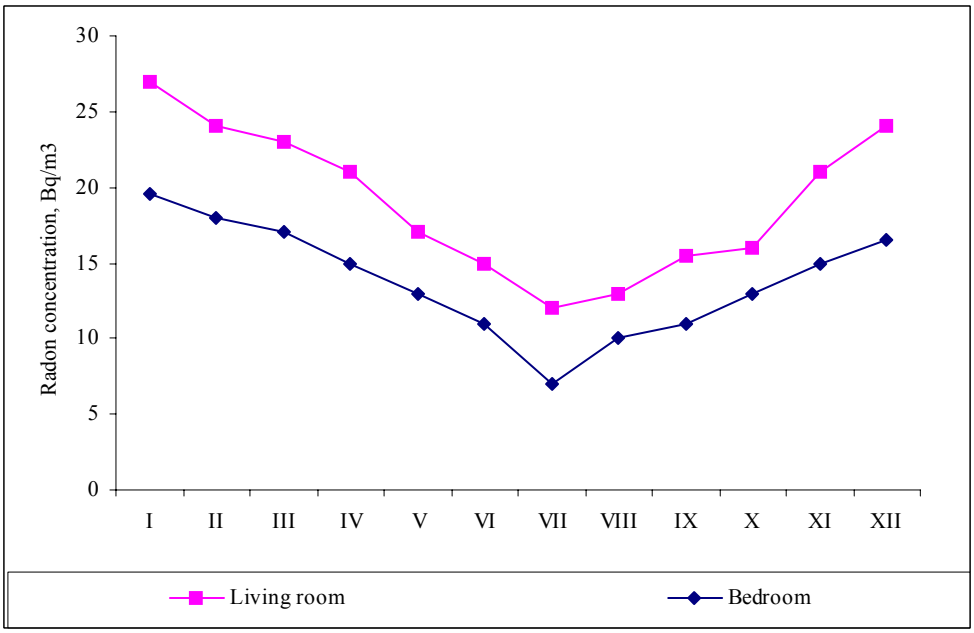

Figure. 3 The annual variation of indoor air radon concentration.
Figura 3. Variația anuală a concentrației de radon în aerul din încăperi.

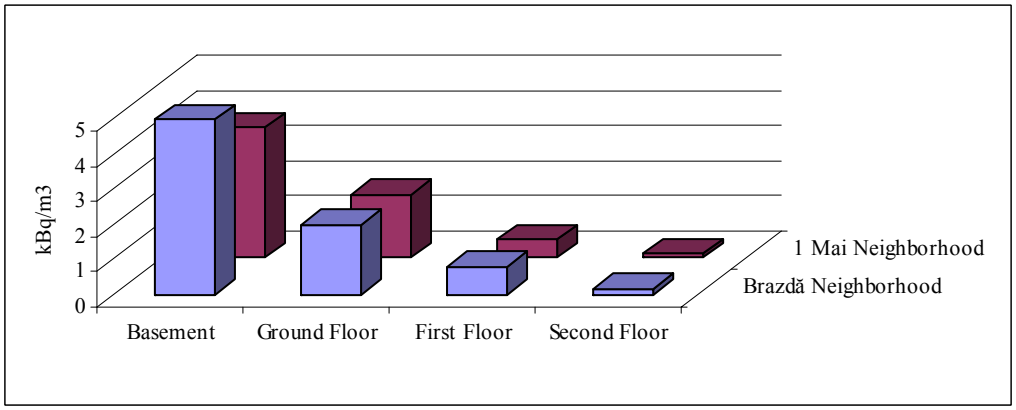

Figure 4. Radon content in different locations.
Figura 4. Conținutul în radon în diferite locații.

The radon concentrations are presented in figure 5, observing that the highest amount of radon is found in the garage, bedroom and living room; outside this element was not reported.

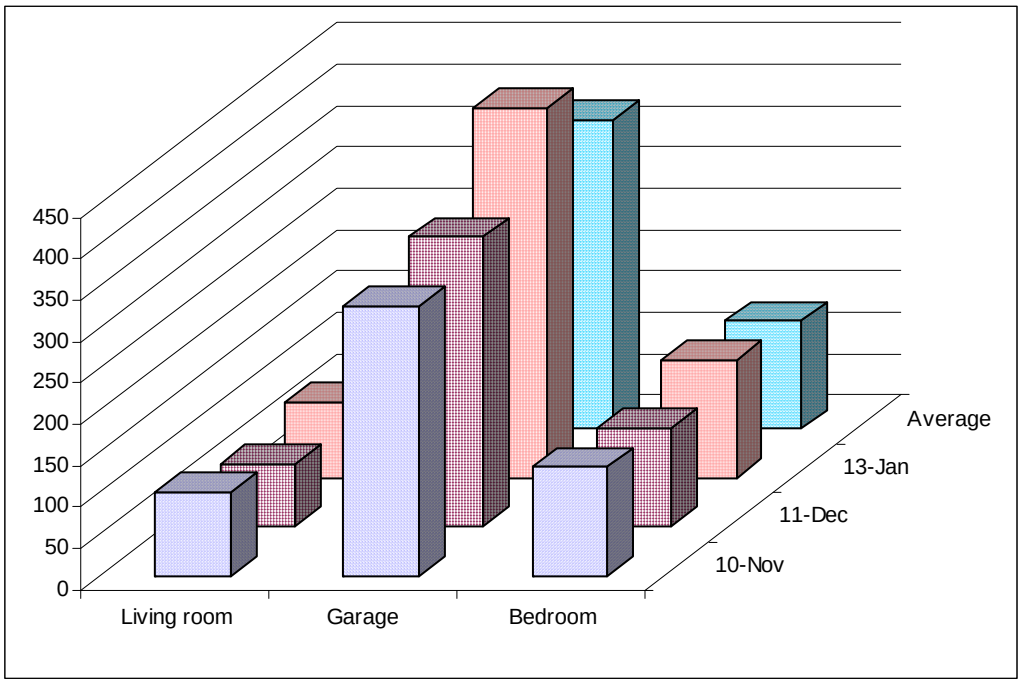

Figure 5. Radon concentration in a dwelling during the cold season.
Figura 5. Concentrația de radon într-o locuință în sezonul rece.

High levels of radon are observed in January in the home garage.

CONCLUSIONS

The radon concentration decreases with the increasing level of the dwelling (garage > second floor). The highest radon content is in brick, tile, concrete and insulation materials. Seeing the 2008 evolution, it was noted a close link between the radon content of ground and inside buildings. In locations where there are several sources of penetration of the radiation, the radon concentration is higher (living room) in comparison to the locations where there is only one source (bedroom). Brazdă Neighborhood from Craiova contains, due to the mineralogical composition of the soil, a higher amount of radon, in comparison to 1 Mai Neighborhood.

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