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DETERMINATION OF IONISING RADIATION LEVELS IN THE TEXTILE INDUSTRY PRODUCTION PLACES

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Abstract. *The results of natural nuclides concentration measurements in some textile industry places are given in this paper. The gas radon (Rn-222) concentrations were detected by passive method, using track detectors LR-115. The results at the experimental locations were compared with respective results at the common locations in the same industry. The gas radon levels were compared with values under international standards.*
After strictly provided procedure, it could be seen, that ionizing radiation levels in inquired locations are absolutely under permitted limits, according to the basic safety standards in radiation protection.

Key words: *natural radiation, gas radon, track detectors, textile industry*

INTRODUCTION: EXISTANCE OF IONISING RADIATION IN HUMAN ENVIRONMENT

Air-quality determination, in occupational as well as in living environment, is necessary by any technology application in front of the third millenium. There are many physical and chemical parameters they determinate the air-quality at particular location. In the last tenth years, one important view was added to these parameters-this is the radiation point of the view. Although the influence of radioactivity to the human health was discovered about hundred years ago, not earlier than last 20 years are provided more intensive measurements of radiation levels and recommendations for their limitation.

From all the natural ionizing radiation, the greatest influence on people health has radiation that arise from everywhere presented radioactive gas radon and its natural short-lived progenies.

All over the world, there is a lot of necessary attention that is dedicated to radon levels measurements, specially in the living and occupation indoor envirenment. The considerable interest for radon and its healthy effects comes from very big part that radon

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has in the total human dose, that men receive from all the natural radioactive sources. In fact, the average annual effective dose from all the ionizing sources was estimated to be 2.4 mSv [1]. Over 40 % of this dose originate from internal exposure to radon (by air inhalation). These facts have as consequence an adequate radiation risk at the common population health.

Everywhere presented radionuclide Rn-222 is made through natural decay chain of U-238 and its progeny Ra-226 in the background. By diffusion and convection radon infiltrates the air and water sources. Into the indoor atmosphere it cams by different ways, but usually from background under the buildings and from the building materials.

Gas radon Rn-222 itself has spontaneous radioactive decay with 3.82 days decay halftime during the airinhalation, its short-lived progenies penetrate into the lung, where they deposit with almost 100% efficiency. From all the natural radon daughters, the greatest role on the human health have two of them: Po-218 and Po-214. Both of them are strong alpha-emitters: the alpha particles, that are born trough their decay have initial energy of 6.0 MeV and 7.69 MeV, respectively. This high energy deposits continuously in the lung, what as consequence has permanent damages of airways innersureface and bronchial epithelium. At last, these damages and injuries could, directly or indirectly, arrive to the lung cancers appearance.

There are many approaches for quantitative determination of the relationship between radon exposure (inhalation) and the lung cancer originate risk. But in any approach, it can be established direct correlation between indoor radon concentration, at one side, and the lung cancer incidence, at other side. From this point of the view, the radon concentration (e.g. activity per unit of volume) could be an important parameter by the radiation risk estimation.

The radon concentration in the indoor environment are one order of magnitude up than the outdoor concentrations. By other side, in the few last decades, the people's lifestyle was changed in this way, that the people spend much more time in indoor ambient. The indoor atmosphere living factor was estimated to be 85 % to 90 % of all livingtime [2]. That brings inevitable higher risk from this kind of the ionizing exposure.

Ionizing radiation levels (especially gas radon level) have very important role for workers, they professionally work in closed fabric places. Ionizing radiation is on itself at high health risk and in combination with other harmful mechanical and chemical materials (what is the case in textile industry) influences badly not only in productivity and workeffects, but also in health of workers. Therefore, it could measure the radiation level in all of these industry places, especially in those, where the ventilation rate is limited under 0.5 air exchange per hour. If the radon level were exceeded, it would appreciate all kind of radiation protection, what has already introduced in our law regulative from the International Basic Safety Standards in the radiation protection area.

EXPERIMENTAL METHOD

The gas radon concentrations were determinate for indoor air in three different textile industry places. These places are:

(1) TIG Grdelica, where measurement was provided in the woolen yarn spinning room; this wool was originated from Russia;

(2) LETEKS Leskovac, where examination was provided under Australian wool, in the combing room;
(3) TI Vucje, where measurement was provided in the weaving room, under yarn made from Australian wool.

Both of building materials, that are built into fabric buildings, as well as used yarn, are very important parameters that could significly make influence in radiation level and exceed it. Because of that, these parameters were under special attention at preliminary data collecting.

Experimental method itself is devided in few, ussual, steps:

(a) putting on detectors at defined location;
(b) picking up exposed detectors, their film processing and observing;
(c) mathematic sampling and working out of observed data as well as the radon concentration determination.

Because of variability of indoor radon concentration during the seasons and even during the day, there isn't any reason for direct measurement providing. Due to these facts, it is necessary to take integral, passive method. By this method, detector is exposed to the radiation during longer time, in order of magnitude of about 100 days (at least 30 days).On this way determinated values represent the average value for observed time interval.

In these measurements the track detectors LR 115 on the nitrocellulose base were used. Sensitive layer of detector is an opened film. This film consists from red, 12 μm thick cellulose nitrate layer, that is adhered to some thicker bearer.

When alpha particles, which arise from radon decay, pass trough the cellulose nitrate, they make some mechanical damages on it, along their pathways. It is necessary to make these latent damages to be visible. That performs by the heat bath of 10 % watery solution of NaOH at 60°C during 2 hours. After washing out and drying the film, it is possible to visually observe made damages by the optical microscope with 500 magnifytion.

The counted track-number divides with film surface (in our case, the film surface is 2 cm^2), what represent the track density (ρ), e.g. track-number per 1 cm^2.This track density divides with number of days (t) during the exposition of detector, what gives track density per one day of exposure (ρ_t). The unit for ρ_t is [track/cm^2 day]. This calculated value multiply with the calibration coefficient (K), which is a constant for particular type of detectors. For these used detectors, K has the value:

$$K = 16\ [Bq/m^3][track\ /cm^2\ day]^{-1}.$$

The final result (ρ_t K) represents gas radon concentration (C) in the observed indoor environment, gave in unit [Bq/m^3].

RESULTS AND DISCUSION

During this experiment there were located six detectors of LR 115 type. Two of them were put in each of three noted textile industry: one of them (so called experimental) was placed into production room and the other one (referent detector) was put into office room.

Detectors were exposed during the spring in 1997. The radon concentration during the spring and autumn can be considerate as average annual values (the highest concentration are in winter, and the lowest are in summer). For this point of the view, these measured radon concentration values could be taken as representative for used locations.

The result of provided measurement are given in the Table 1.

Table 1. Gas radon concentrations in the estimated textile industry

Location		ρ $\left[\frac{track}{cm^2}\right]$	t $[day]$	$\rho_t = \rho \cdot t^{-1}$ $\left[\frac{track}{cm^2 \cdot day}\right]$	$C = k \cdot \rho_t$ $\left[\frac{Bq}{m^3}\right]$
T I G	*Spinning room*	650	58	11,21	179,36
Grdelica	*Office room*	400	58	6,90	110,40
Leteks	*Combing room*	310	61	5,08	81,28
Leskovac	*Office room*	290	61	4,75	76,00
T I	*Weaving room*	240	41	5,85	93,60
Vučje	*Office room*	190	41	4,63	74,08

From the Table 1. Can be seen that the measured radon concentration, at the all six experimental places, are under range that was recommended by international safety standards, which were accepted our law regulative. Namely, the average indoor radon concentration was estimated to be 37 Bq/m^3, for whole world [3]. According to International Commission on Radiological Protection [4] permitted indoor radon concentration are:

– 400 Bq/m^3 for old buildings;
– 200 Bq/m^3 for new buildings;
– 100 Bq/m^3 for future buildings.

It could be concluded, that all measured values satisfy recommended criterion. All experimental indoor places are in old buildings. For these buildings, the value of 200 Bq/m^3 could be limit.

However, the radon concentrations such like these can decrease by increasing of the ventilation rate. That should be one step more to the better quality of occupational environment and worker's health.

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NIVOI JONIZUJUĆIH ZRAČENJA U NEKIM POGONIMA TEKSTILNE INDUSTRIJE

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U radu su prikazani rezultati meranja koncentracije prirodnih radionuklida u nekim pogonoma tekstilne industrije. Određivana je koncentracija gasa radona (Rn-222) putem pasivne dugotrajne metode, korišćenjem trag-detektora LR-115 na bazi nitroceluloze. Rezultati na eksperimentalnim mernim mestima upoređeni su sa rezltatima dobijenim na referentnim punktovima u datim fabrikama tekstila. Izmereni nivoi radona upoređeni su sa vrednostima koje propisuju međunarodni standardi u zaštiti od zračenja.

Nakon striktno sprovedene eksperimentalne procedure i očitavanja i upoređivanja dobijenih vrednosti za koncentracije gasa radona u zatvorenim prostorima, može se ustanoviti da su nivoi jonizujućih zračenja na ispitivanim lokacijama potpuno u granicama međunarodnih standarda u radijaciopnoj zaštiti, a koji su prihvaćeni i u našoj zakonskoj regulativi.

Ključne reči: *prirodna zračenja, gas radon, trag-detektori, tekstilna industrija*