International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 3 Issue 5, May – 2019, Pages: 40-43

Radon Flux Density (222Rn) in Residential Premises of the Navoi and Samarkand Region.

Ulugbek Abdirakhmonov, Ulugbek Tuhktaev, Shakhboz Khasanov*, Shokhrukh Jurakulov, Umrzok Safaev

Samarkand State University, Samarkand, Uzbekistan.
*E-mail address: shakhboz.khasanov@list.ru

Abstract: *This article deals with the problem of radioactive exposure to radon on the population of the Navai and Samarkand region. Studies allow to calculate the average annual effective and equivalent doses to the public and the rate of radon exhalation on various types of finishing materials.*

Keywords— radon; decay of radon daughter products; volumetric activity; radon reduction; effective dose equivalent.

1. INTRODUCTION

Natural inert gas radon is found in two main forms: in the form of radon-222 (^{222}Rn-radon) a member of the radioactive chains formed by decay products of uranium-238 (^{238}U) and in the form of radon-220 (^{220}Rn-toron), a member of the radioactive chains of thorium 232 (^{232}Th). Radon contributes 20-25 times more ionization to the total radiation dose of the population than the product of the decay of uranium-thoron. Therefore, our work focused on ionizing radiation of radon and its daughter decay products. Heavy inert gas ^{222}Rn transfers from the soil into the atmosphere, the concentration of radon in the environment, due to dispersion in the air is quite low. However, when radon ^{222}Rn penetrates the premises, its concentration increases significantly, since it does not spread, as it occurs in atmospheric air. Immediately following the radon decay products are absorbed by dust and moisture, forming alpha-radioactive aerosol particles and, when inhaled, occurs the irradiation of lungs. Building materials, water and natural gas and atmospheric air as well as soil under the building are believed to be internal and external sources respectively [1-2].

Radon is a naturally occurring radioactive, colorless, odorless, tasteless noble gas and is also 7.5 times heavier than air [3]. It occurs naturally in minute quantities as an intermediate step in the normal radioactive decay chains through which thorium and uranium slowly decay into lead and various other short-lived radioactive elements [4]. The concentration of radon is decreased with the increase of atmospheric pressure, which helps air penetrate into the soil. This radioactive gas has the ability to accumulate in buildings, for example, living quarters, educational institutions, hospital complexes, etc. The danger of radon is that a person may face an invisible threat of gas exposure. Radon has a half-life of 3.8 days.

As a result of the decay of radon, the daughter decay products of radioactive particles (Bi, Po, Pb) are released, and then, as they are inhaled, damage the mucous membrane of the lungs. Being exposed to radon for a long period of time can lead to lung cancer. The problem of human exposure to radon today remains relevant. The 20th century proved that this radioactive gas that is found in the mines of uranium, caused fatal impact on human health. The climate of the Navai region for the winter season is characterized by complete sealing of the premises and insufficient airing. And for the summer season, on the contrary, the concentration of radon in the premises is rather low due to the constant air ventilation in them. Based on the foregoing, we conclude that the activity of radon from March to August decreases and is set at a certain level, and then increases again from October to January. It was found that, depending on the weather conditions, the frequency of ventilation, ventilation of the rooms, as well as the location of the room in the building, radon activity can vary significantly. For example, for the first and middle floors there is a slight increase in gas activity, since The exhalation of radon from the soil increases significantly (the summer period), and for floors above the third it does not change significantly. The first and ground floors are subjected to the most active influence of radon. An important source of radon in the house (in addition to the soil and air) are building materials. There are the following entry routes for radon; through the wiring connections, cavity walls and gaps around labor. The concentration of radon in the ground layer in this area is 3.52-7.64 Bq/m^3. However, a number of finishing materials have high rates of effective specific activity of natural radionuclides (for example, ceramic tiles), so the use of such products can significantly increase the gamma background of the premises.

2. EXPERIMENTAL METHOD

In order to determine the amount of radon in air or in water, the results of the gamma spectra of its derivatives are used. As it is known, the derivatives $^{214}_{82}$Pb and $^{214}_{83}$Bi obtained from $^{222}_{86}$Rn emits gamma rays with an energy of 295,21; 351,92 keV and 609,31; 1120,28 keV respectively. Radon flux density was calculated using coal sorbent method (∅ = 26.5 cm, h = 3 cm, m = 50 g) (Fig. 1). We know that the radon absorption coefficient of the coal sorbent is at ≤ 100%. When heated to 300 ℃, it will completely get rid of radon gas. The air sample is absorbed by forced or natural diffusion on the sorbent, and after 3 hours its activation is measured in single-crystal NaI(Tl) detector. Although detection efficiency of γ-rays of NaI(Tl) detector is a very high, the energy resolution ability of γ-quanta in the range from 100 keV to ~ 10 MeV is too low. By softening the area of 40 cm of the land surface, to 30 cm depth was scrapped and the coal sorbent is placed at a height of 5 cm from the ground. It is tightly closed with a plastic chamber with a precise volume and radon is absorbed into coal sorbents by natural diffusion for 3 hours. The calculation of the radon flux density F_{Rn} (mBq*m^{-2}*c^{-1}) is carried out with the help of ASW program using the following formula

$$F_{Rn} = \frac{A * e^{\lambda(t+t_{exp/2})}}{K_n * S * t_{exp/2} * 3.6}$$

where: A - is the activity (Bq) of short-lived decay products of radon-222 in the sorption column, calculated by the standard algorithm of the ASW program from the spectra of gamma radiation of the sample and background taking into account the sensitivity of the radiometer spectrometer;

Fig. 1. Radon absorber, covered with a plastic storage chamber to determine the RFD (radon flux density)

γ - the decay constant of radon-222, which is equal to 7.55 -10^{-3}, h^{-1};

t - the period from the end of the sampling to the beginning of radiometric measurements,

K_n - is an empirical correction factor taking into account the fraction of radon absorbed by the sorption column in passive sorption mode (K_n = 0.50) or when air is pumped in volume V = 20 dm^3 through the sampling chamber in active sorption mode (K_n = 0.72);

S - surface area under the sampling chamber, m^2;

t_{exp} - exposure time of the sampling chamber, h;

3. RESULTS AND DISCUSSION

The required parameters are set in the "About the measured spectrum" tab for the "RFD Radec" calculation type: the date and time of the start and finish, the correction factor K_n and the area under the camera S.

Table 1. Seasonal variability of the radon-222 flux density

Navoi region				**Samarkand region**			
Month	**RFD (mBq*m^{-2}*c^{-1})**	**Temperature ℃**	**Humidity**	**Month**	**RFD (mBq*m^{-2}*c^{-1})**	**Temperature ℃**	**Humidity**
November	70	11	60	November	55	10	85
December	53	-3	65	December	47	-4	87

January	53	11	31	January	84	10	33
February	26	2	42	February	45	2	45
March	33	14	74	March	40	15	72
April	30	12	42	April	39	20	40
May	57	28	20	May	27	25	35
June	71	30	26	June	30	29	35
July	37	38	17	July	20	37	19
August	59	39	14	August	35	38	18
September	61	26	17	September	38	29	15
October	65	16	43	October	50	14	84

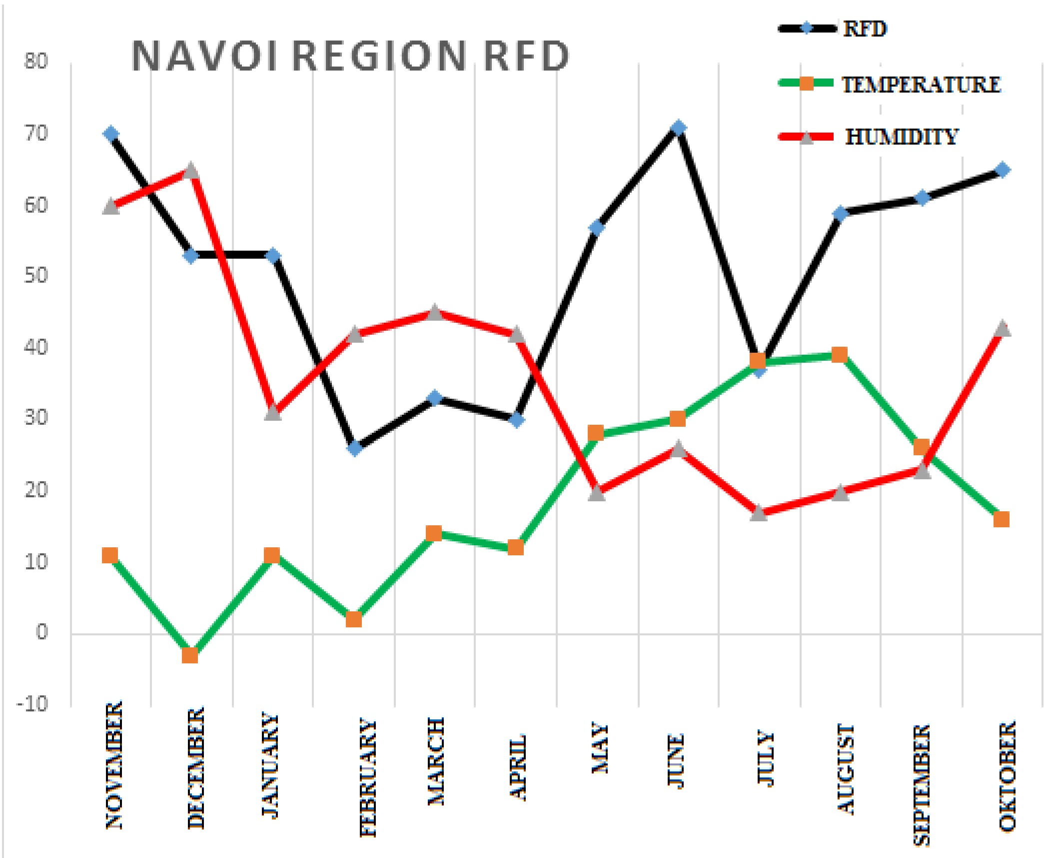

Fig.2. Seasonal variability of the radon-222 flux density

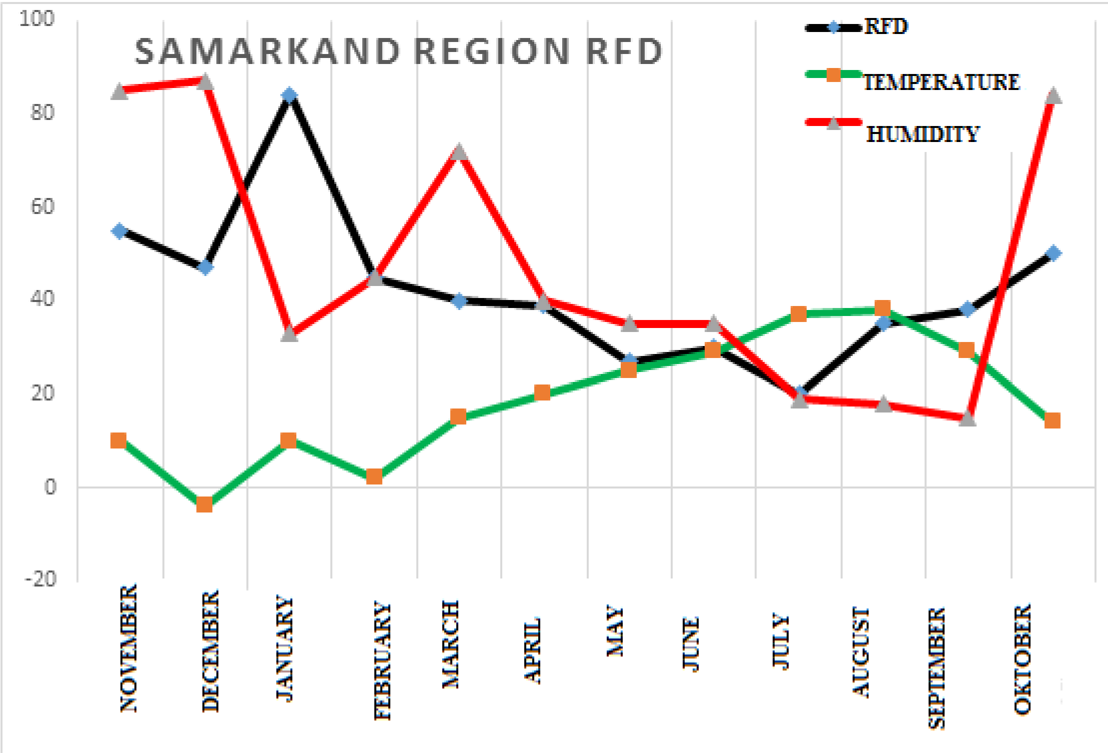

Fig.3. Seasonal variability of the radon-222 flux density

With this said, the following factors have a significant effect on the concentration of radon in rooms:
the building materials of which they are built, the purpose of the room, and the time of year. Indoors there are significant changes in the equivalent equilibrium volume activity of radon, which leads to different levels of exposure of the population.

4. Conclusion

In conclusion, we can say that it is possible to observe the increase of radon density or the rate of radon escalation in the autumn-winter period. A number of natural factors can affect when determining the density of the radon in field conditions, such as: geology of the earth - dimensions of soil particles, underground cracks and gaps; weather-related gradients -temperature, pressure, humidity, convection; Magnetic anomaly of the Earth and solar activity variation.

References

1. Mikhnev.I.P Concentration of radon in the premises and effective equivalent dose of exposure to the population -2018, -№2(24)-C.8-13.
2. Sidyakin P.A., Sidelnikova O.P., Kozlov Yu.D., Mikhnev I.P., Malyth V.T., "Materials for reducing the gamma-ray background and the concentration of radon indoors", Moscow, Construction Materials, No.8, pp. 26–27 (1998).
3. A Citizen's Guide to Radon - Revised December 2016. EPA 402/K-12/002/2016/ www.epa.gov/radon
4. https://en.wikipedia.org/wiki/Radon