Present Status of Radon and Radium Activity Measurements in Well and Bottled Water at the Federal University of Technology (UTFPR, Brazil)

Corrêa J.N.[1], Kappke J.[1], Paschuk S.A.[1], Schelin H.R.[1,2], Denyak V.V.[2], Perna A.F.[1], Reque M.[1]

[1] Federal University of Technology - Paraná, UTFPR, Av. Sete de Setembro, 3165, Curitiba, PR, Brazil
[2] Pelé Pequeno Príncipe Research Institute, IPPP, Av. Silva Jardim, 1632, Curitiba, PR, Brazil

1. Introduction

Among heavy radioactive elements, the most common are ^{238}U and ^{232}Th, which produce other radioactive isotopes and among them the radium and radon [1].

The ^{226}Ra concentration in water depends on its content in rocks and soil, soil permeability and solubility of uranium and radium compounds in water [2].

a. ^{226}Ra is considered the second largest source of radiation in water [1, 3]:
b. WHO in 2011 set a limit of 0.5 Bq/L for gross alpha radiation for safe consumption of water when no decision concerning mitigation or dose reduction should be taken [1].

2. Objectives

This work describes the present status and preliminary results concerning ^{226}Ra activity in bottled mineral water available in the market of Curitiba-PR, Brazil.

Another subject of this work was the ^{222}Rn activity measurements in drinking water collected from artesian bores within the city of Curitiba during the period of 2009 - 2010.

3. Methods

In order to measure the 222Rn activity in drinking water from artesian bores in regions within the city of Curitiba, the experimental setup was based on ALPHA GUARD detector connected to a specific kit of glass vessels Aqua KIT through the air pump. The measurements of ^{222}Rn were performed immediately after collecting the water sample and 45 - 50 days past when radon reaches secular equilibrium.

The ^{222}Rn concentration levels were analyzed by the computer software DataEXPERT by GENITRON Instruments. The average levels of ^{222}Rn concentration were processed taking into account the volume of water sample, its temperature, atmospheric pressure and the total volume of air in the vessels.

Figure 2. General view of ALPHA GUARD SETTED to measure ^{222}Rn in well water.

For ^{226}Ra activity measurements in bottled mineral water available in markets at Curitiba-PR - Brazil, the experimental setup was based on the Professional Radon Monitor RAD7. This detector is equipped with a special kit of glass flasks which allows to identify very low ^{222}Rn activity concentration in small water samples of 250mL (Fig. 2).

For ^{226}Ra measurements the collected water samples were stored in hermetic bottles of 250mL during 45 - 50 days when ^{222}Rn reaches secular equilibrium.

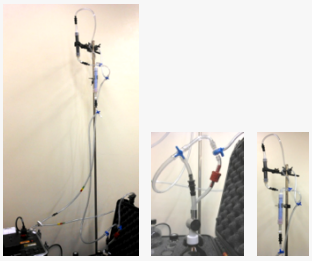

Figure 2. General view of RAD7 and RAD H_2O accessory kit mounted for the measurements of radium concentration in water samples.

The measurements of low activity levels of radon in water samples involves: (1) the construction of the system with an enclosed volume of air that includes the drying tube and the activated charcoal filter and exclude the sample; (2) the humidity control should be accomplished in the process of measurements and the system drying can be done between the measurements if necessary. The process of measurement is shown on Fig. 3.

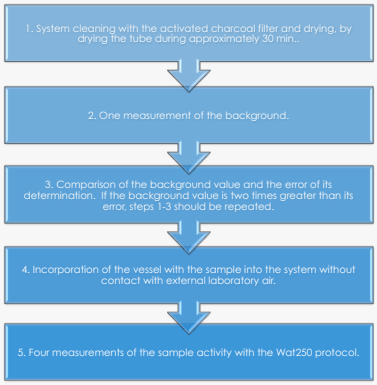

Figure 3. Developed process for bottled mineral water measurements with RAD7.

4. Results

The frequency of ^{222}Rn and ^{226}Ra activity concentration in drinking water collected from artesian bores is shown in Figure 4 and 5, respectively.

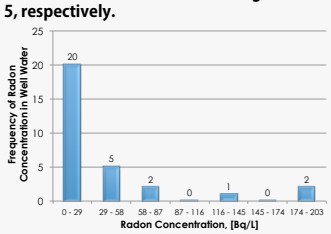

Figure 4. Frequency distribution of ^{222}Rn activity concentration in well water of Curitiba - Brazil.

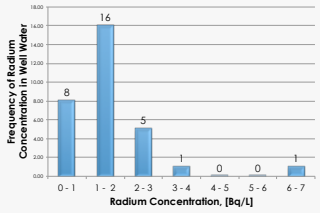

Figure 5. Frequency distribution of ^{226}Ra activity concentration in well water of Curitiba - Brazil.

Table 1 shows the ^{226}Ra concentration in samples of bottled mineral waters.

Table 1. Radio activity concentration (Bq/m^3) in bottled mineral water offered in the market near Curitiba-Brazil.

Water Sample	^{226}Ra Concentration (Bq/m^3)	Error (Bq/m^3)
A	-4.24*	±92.65
B	104.79	±42.00
C	166.35	±49.43
D	67.72	±28.07
E	192.45	±46.03
F	130.59	±96.69
G	22.69	±59.35
H	58.89	±38.34
I	116.26	±43.65
J	23.89	±47.87
K	66.22	±27.07
L	40.52	±53.07
M	164.73	±46.18
N	116.20	±51.22
O	75.93	±29.56
P	239.25	±69.55
Q	128.94	±54.90
R	64.21	±59.65
S	199.46	±40.27
T	56.66	±54.57
U	124.66	±44.63
V	73.41	±56.61
X	215.59	±56.77
Z	149.14	±41.74

* The negative mean value was obtained due to statistical subtraction of background.

5. Conclusions and Future Work

- The minimum and maximum ^{226}Ra concentration in bottled mineral water were of -4.24±92.65 and 239.25±69.55Bq/L, respectively.
- Further measurements are planned to be performed with other brands of bottled mineral water available in the market of Parana State, Brazil.
- Collected samples of artesian water presented an average ^{222}Rn activity of 60 Bq/L approximately which is almost 6 times bigger than the maximum level of 11.1 Bq/L recommended by the USEPA.
- It has to be noted that few artesian drillings presented the radon activity of almost 200 Bq/L.
- Further measurements are planned to be performed in other regions of Parana State and will involve the mineral water sources, explored artesian drillings as well as soil samples.

References

1. WHO - World Health Organization, *"Guidelines for drinking-water quality"*, 2011.
2. J. Somalai, G. Horvath, B. Kanyar, T. Kovacs, E. Bodrogi, N. Kavasi, "Concetration of ^{226}Ra in Hungarian Bottled mineral water", *Journal of Environmental Radioactivity*, **Vol. 62**, pp. 235-240 (2002).
3. USEPA - United States Environmental Protection Agency, *"National Primary Drinking Water Regulations; Radionuclides; Final Rule"*, 2000.

Acknowledgment

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