DETECTION SYSTEM FOR CONTINUOUS ^{222}RN MONITORING IN WATERS

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Introduction

The volume activity of ^{222}Rn in waters is the most frequently measured in order to control the population exposures from the radon. During the former two decades the investigation of the radon in waters has been extended also for the earthquake and vulcanic eruptions' prediction, for the fault location and for requirements in hydrogeology [1, 2]. The measurements of the radon can be continuous or discrete, or by carrying out the grab sampling, but many applications require monitoring as continuous as possible. It is necessary because of the correction of experimental data from fluctuations connected with natural causes.

This contribution presents one of the high-sensitive systems of continuous radon monitoring in waters. The device can be used for the continual control of ^{222}Rn activity concentration in water sources, for a study of the daily and seasonal variations of radon activity concentration in water systems, for the determination of the infiltration time of surface water into the ground water and for the next untraditional applications.

Radon Monitoring Device

The working principle of the constructed device for the continual radon monitoring is based on the removal of the radon from water and its subsequent measurement by the radon detector. The device layout is on the Fig.1. There are distinguished two circuits – water circuit and air circuit. The main part of the device is the outgassing vessel (OV) of 180 m□ volume. Water is supplied from the source (SW) to the outgassing vessel and then water outflows through the hole in the sidewall of the vessel into the waste piping (WP). The water volume of 120 m□ in the outgassing vessel is maintained by the movable arm with a water seal (WS). Radon contained by water is released by the flow of the inactive air, which is pressed by the compressor pump (CP) into the outgassing vessel through the frit (F). The air enriched by the released radon is dried and next is carried to the radon monitor (RM). The whole process runs continuously.

The volume activity of ^{222}Rn in input water is calculated according to the relation:

$$A_{v,w} = A_{v,a} \frac{p_a}{p_w} \frac{1}{k_d}$$

where:
$A_{v,a}$- the volume activity of ^{222}Rn in the output air from the outgassing vessel,
p_a - the overflow of the air through the outgassing vessel,
p_w - the water discharge through the outgassing vessel,
k_d - the outgassing coefficient defined as the ratio of the velocity of the radon removal from the water in the outgassing vessel by air to the velocity of the radon supply by the water inflow into the outgassing vessel.

The value of the outgassing coefficient depends on the air overflow p_a and the water discharge p_w ratio through the outgassing vessel. For the ratio $\frac{p_a}{p_w} \sim 10$ is $k_d \cong 0,9$.

Testing shows that at the present construction of the monitoring device and at the water volume of 120 m□ in the outgassing vessel, the optimum parameters of air and water overflows are: $p_a \sim (0,7 - 1,0)$ □.min^{-1} , $p_w \sim (0,12 - 0,20)$ □.min^{-1}. At these parameters the high value of the outgassing coefficient is obtained ($k_d \sim 0,75$) and more over the device is stable from the point of view of air and water overflows. The detecting limit of the device for the continuous monitoring of ^{222}Rn in water is 0,5 Bq.□$^{-1}$.

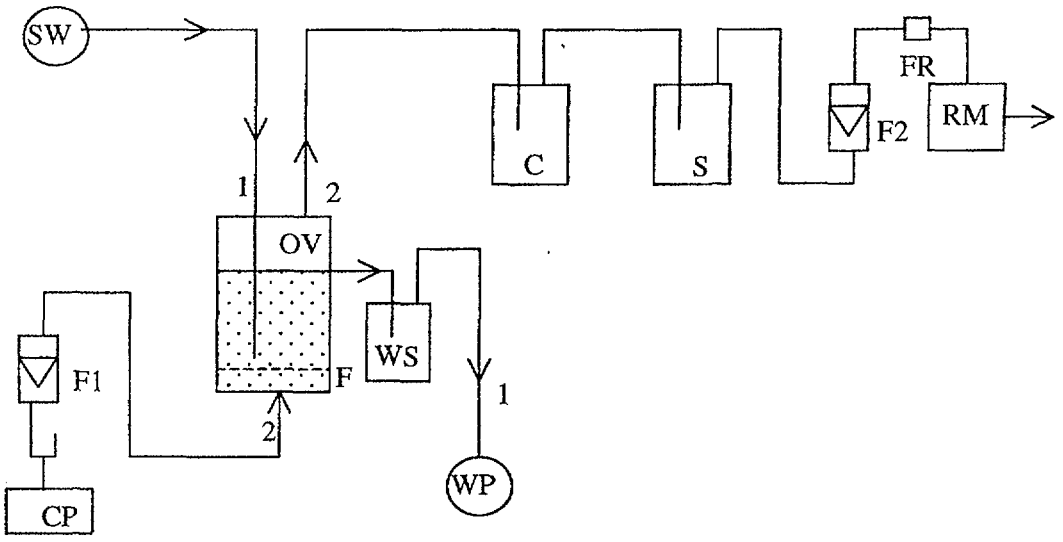

Fig.1. The scheme of the device for the continuous monitoring of ^{222}Rn in water.
(1 – water circuit, 2 – air circuit, SW – water source, OV – outgassing vessel, F – frit, CP – compressor pump, WS – water seal, WP – waste piping, C – cooler trap, S – silica gel, FR – filter, RM – radon monitor, F1, F2 – flowmeters)

Results and Discussion

The long-term stability of the measuring system was tested by water supplied from the water piping to the outgassing vessel. The overflow of the air and water through the outgassing vessel was kept on the level 0,8 □.min^{-1} and 0,13 □.min^{-1} respectively. The volume activity of ^{222}Rn in the air rising from the outgassing vessel was recorded in 10 minutes intervals.

Results of 9 days continuous monitoring of the volume activity of ^{222}Rn in water are presented in Fig.2. The whole system worked reliably during the testing. The volume activities of ^{222}Rn in water main are not stable but there exist the daily variations of them. The minimum values of the volume activity of ^{222}Rn were measured as a rule at the midday and maximum values at the late afternoon and night-time. During the day the volume activity of ^{222}Rn was changed sometimes up to 70 %. The smallest changes of the volume activity of ^{222}Rn were observed on Sunday.

Till now there was not reliably explained whether these changes are connected only with processes in water piping or also with processes in a water source. The testing device for the continuous measurements of the radon in waters could be useful also to the revelation of the origin of the radon variations in the transport water piping, respectively to its usage for the other novel applications.

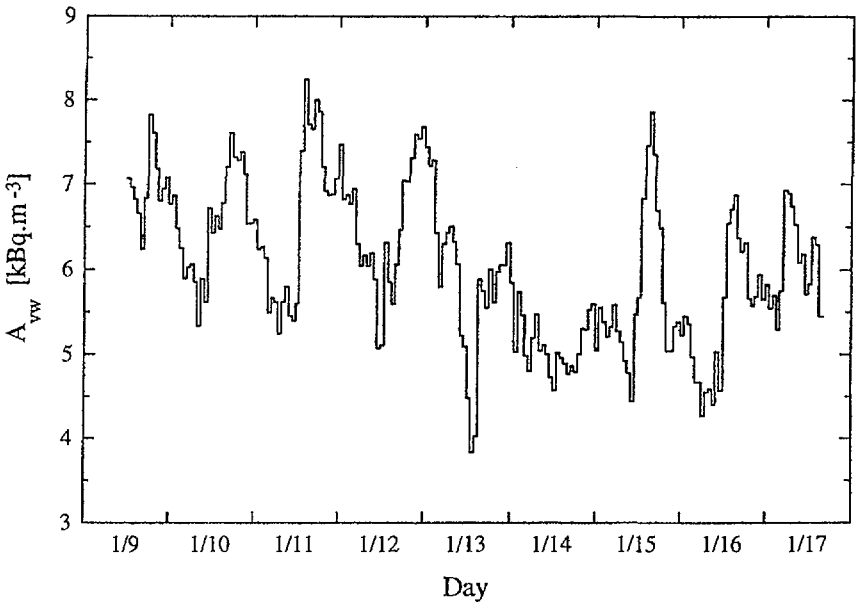

Fig.2. The time course of ^{222}Rn activity concentration in water of water piping.

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References

[1] Monnin M.M., Seidel J.L.: Radon in soil air and in groundwater related to major geophysical events (a survey). Proc. of the Sec. Workshop on Radon Monitoring in Radioprotection, Environmental and/or Earth Sciences (ed. by G. Furlan and L. Tommasino), World Scientific, Singapore, pp. 274-285 (1991)

[2] Friedmann H.: Selected problems in radon measurement for Earthquake prediction. Proc. of the Sec. Workshop on Radon Monitoring in Radioprotection, Environmental and/or Earth Sciences (ed. by G. Furlan and L. Tommasino), World Scientific, Singapore, pp. 307-316 (1991)