THE PLANT FOR OBTAINING AN AQUEOUS RADON SOLUTION

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УСТАНОВКА ДЛЯ ПОЛУЧЕНИЯ ВОДНОГО РАССТВОРА РАДОНА

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Аннотация. *Индикаторные методы исследования с помощью радиоактивных изотопов нашли широкое применение в различных областях науки, техники, медицины, геологии и т.д. [1-3]. Одним из наиболее эффективных индикаторов является радиоактивный газ радон – 222, образующийся в результате последовательных радиоактивных превращений урана – 238. В данной работе для получения индикаторной жидкости на основе радона – 222 была собрана установка, где в качестве источника радона использованы кремниевые и кварцевые породы, содержащие металлические вкрапления урана-238.*

Introduction. Indicator methods based on radioactive isotopes are widely used in various fields of science, technology, medicine, geology, etc. [1-2]. One of the most effective indicators is the radioactive gas Rn – 222 which is formed by consecutive radioactive transformations from U – 238. In this research was assembled the plant for obtaining an aqueous radon solution. Silicon and quartz rocks, which contain metallic inclusions of U – 238, are used as a source of radon.

Description of the plant. The solubility coefficient of radon in water is 0,25, in organic liquids, for example, in oil and kerosene – 0,8. It was necessary to make radon activity in the generator volume of several MBq/m^3 in order to obtain an aqueous solution with an activity of several kBq/L. The large pieces of uranium-containing rocks (silicon and quartz rocks) with dimensions of several tens of cm were crushed into smaller fractions with dimensions of 15...30 mm. Crushed rocks (with overall weight ~ 45 kg) were placed in plastic containers with a volume of 2.2 L (150 mm height and 165 mm diameter). The top sides of plastic containers were drilled by “web” scheme with a diameter of holes 2 mm to ensure the release of Ra - 222 gas. Plastic containers were placed layer by layer in a sealed steel barrel with a volume of 200 liters (860 mm height and 590 mm diameter) with a wall thickness of 1.4 mm and with a removable top bottom; overall 32 containers by 4 layers were placed in the generator.

The inner surface of the barrel was painted by two layers with a hydrophobic coating based on bitumen. Air circulation and gas intake from the bottom of the radon generator were made by two chokes (Fig. 1).

Results. The radiometer *RAD 7* was used to measure the radon volumetric activity in the air of the generator and aqueous radon solutions; H_2O method was used to measure radon concentration in water (Fig. 2).

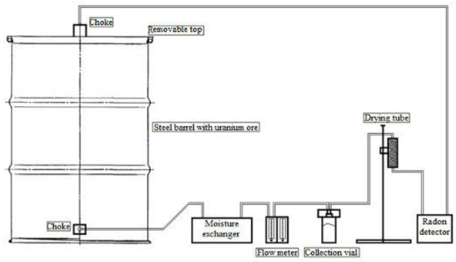

Fig. 1. The plant for making an aqueous radon solution

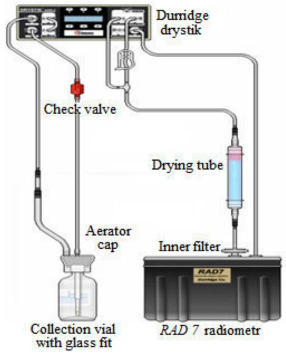

Fig. 2. H_2O *method*

The measurements of the volumetric activity of radon in water were carried out by different times and flow rates to determine the optimal conditions to make aqueous radon solutions with volumetric activity of several kBq/L (Fig. 3)

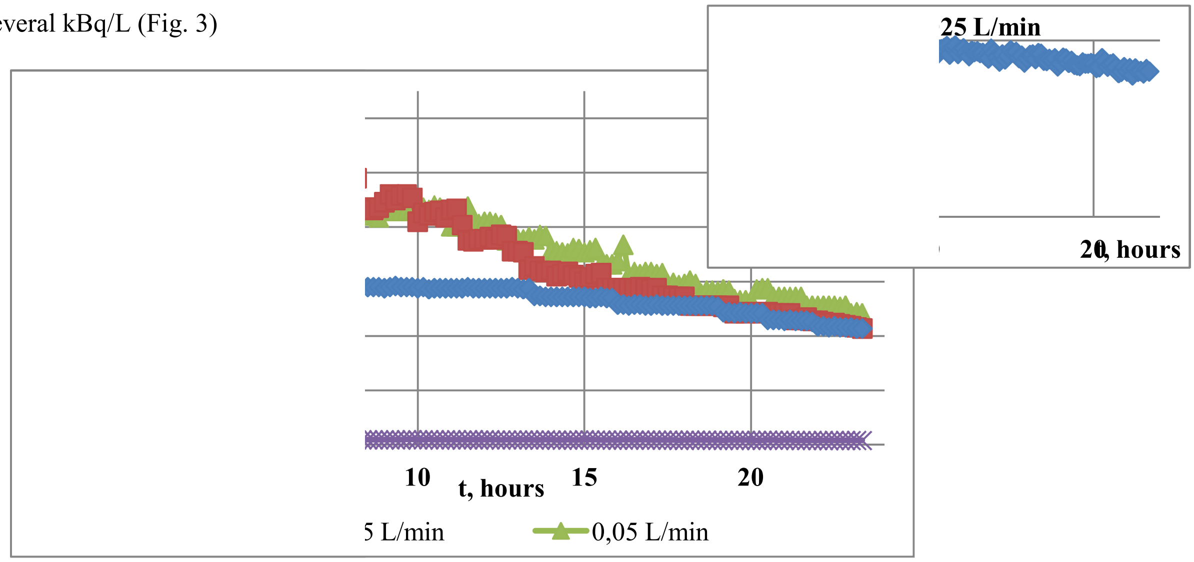

Fig. 3. The dependence of pumping time and flow rates on the volumetric activity of an aqueous radon solution

Fig. 3 shows low flow rates (~ 0,025 L/min) can`t make the volumetric activity of an aqueous radon solution more than 50 Bq/L. The volumetric activity of radon in water was rapidly increased to the maximum value and then slowly decreased with pumping time for flow rates 0,05...0,1 L/min by 1,5...3 hours. The slow decline of volumetric activity as a result of pumping gas with less volumetric activity and radioactive decays by the time. Flow rates 0,05 L/min and 0,075 L/min have got the same radon activity in water by over 2,5 hours of pumping time. After 8 hours of pumping the radon activity in water is almost independent of the flow rate.

It was revealed a qualitative dependence of the time interval t_{max} on maximum value of the volumetric activity of an aqueous radon solution VA_{max}. The maximum values of VA are reached at different flow rates (Fig. 4).

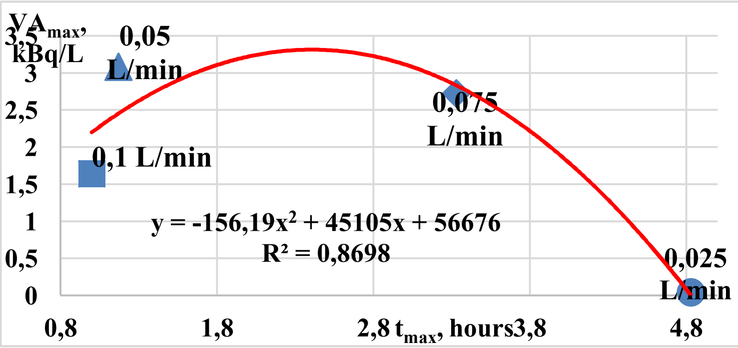

Fig. 4. The dependence of the flow rate Q on the time interval t_{max}

Fig.4 shows the designed generator has optimal pumping conditions to make the maximum radon concentration in water. The maximum volumetric activity of radon in water 3 kBq/L can be received by the flow rate 0,05 L/min and pumping time 70 minutes. The qualitative dependence of the flow rate Q on the time interval t_{max} which is needed to receive the maximum of the volume activity VA_{max} of an aqueous radon solution are presented in Fig.5.

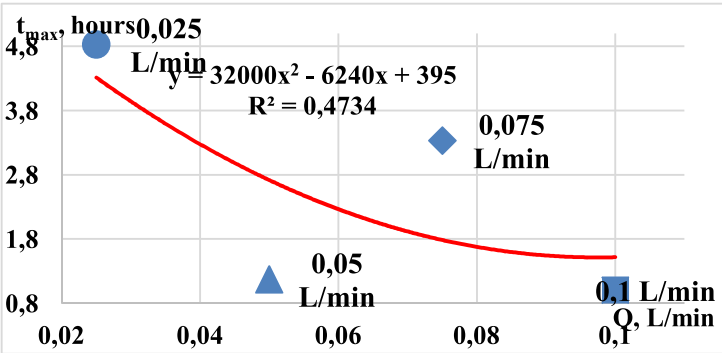

Fig. 5. The dependence of the time at different flow rates on the maximum radon activity in water

Fig.5 shows there is a tendency to decrease the time intervals t_{max} which is needed to receive the maximum radon activity in water by flow rates more than 0,025 L/min.

Conclusion. Crushed uranium-containing rocks (with overall weight ~ 45 kg) with dimensions of 15...30 mm in the generator with volume of 200 L can give a volumetric radon activity in the order of several MBq/m^3 by the 2 days. The dependence of the maximum volumetric activity of an aqueous radon solution by the time and flow rate is characterized by the presence of a maximum. The maximum volumetric activity of radon in water 3 kBq/L can be received by the flow rate 0,05 L/min and pumping time 70 minutes.

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