THE DIFFICULTIES OF DETECTOR CALIBRATION USED FOR MONITORING SOIL RADON-222

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Monitoring of soil radioactive gases is carried out both for the prediction of earthquakes and for the study of gas exchange processes between the lithosphere and the atmosphere. An optimal and widely used method for measuring 222 isotope of radon in soil air is to use an α- or β-radiation detector installed inside a well to a certain depth. The conversion of the pulse count rate measured by the detector into the amount of volumetric activity (VA) of soil radon is done by multiplying by a correction coefficient, which is determined from the calibration results. However, the procedure for calibrating detectors used to monitor soil radon-222 is not regulated. Analysis of publications on this topic showed the lack of uniformity in the approaches to calibration among various research teams, and also revealed the need for a comprehensive research of the issues of calibration.

Continuous monitoring of radon VA in the ground at different depths was carried out at the Tomsk Observatory of Radioactivity and Ionizing Radiation (TORIR) of TPU from 2010 to the present using α and β scintillation detectors (BDPA-01 and BDPB-01, ATOMTEX, Republic Belarus). The first series of calibration experiments was conducted in TORIR as early as 2011 using a Radon RTM2200 radiometer (Germany), which was cyclically connected to a calibrated well, in which an α or β radiation detector was installed, using silicone tubes. As a result, a strong influence of the cyclic air pumping process through the well and radiometer on the magnitude and dynamics of VA radon in the calibrated well was revealed. After connecting the air pumping system from the well to the radiometer, and vice versa, the average α-background decreased by 10–30%. This is due to the partial removal from the well of the 220th radon isotope, as well as the aerosol daughter decay products (DDP) of radon isotopes. It was noted that when the air pumping is turned off, the α-background in the well is quickly restored. The system of air pumping influences the β-background much more strongly, the amplitude of variations of the beta-radiation flux density inside the well recorded by the detector decreases by almost 2 times.

Pulse counting rate from α-radiation in the well after connecting the cyclic purge circuit decreased by almost 4 times. Wherein significantly increased the standard deviation. Although after the completion of the well pumping, the α-background (in VA units of radon) increased and became equal to the β-background.

The strong influence of the pumping system in the autumn calibration experiment, compared with the summer experiment, when after connecting the pumping system, the average α-background in the 0.5 m well decreased by only 20%, can be explained by a leakage at the junction of the radiometer tubes connecting with plastic-coated pipe in the well, due to large temperature drops.

Analysis of the results of the calibration experiments showed the following. Some correction coefficients determined for one detector in repeated experiments had a strong discrepancy. For the β-background, this can be explained by the fact that the detector was moved to a different distance from the ground when the air pumping system was connected, which changed the value of $N_{\beta s}$, from 1 to 3.1 imp./sec (from 47% to 65% of the total pulse count rate). Thus, the change in the height of the β-detector installation in the well strongly influenced both the correction coefficient for converting the counting rate to volumetric activity and the constant ($N_{\beta s}$) component of the counting rate due to β-emitting soil radionuclides not related to DDP of radon and thoron.

In a calibration experiment in 2018, a RAD7 radiometer (USA) was used. During calibration, previous errors were taken into account. Separate wells were created, intended only for calibration, without detectors, with insulated tubes and outward tubing for connecting a radon radiometer. Based on the results of calibration experiments, general recommendations were formulated for the conditions and procedure for calibrating ionizing radiation detectors installed in wells to monitor soil radon.

The main conclusions of the work: a) for calibration it is not recommended to use wells with already installed detectors, in opposite, better would be to drill an additional well with similar characteristics (depth, diameter); b) if, as a result of the maintenance of the wells with the detectors, the radiation detectors were moved, removed and replaced, it is necessary to recalibrate and determine the new correction coefficient; c) β-detectors are especially sensitive to displacement.