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METHOD FOR DETERMINATION OF RADIONUCLIDES CONCENTRATIONS IN GROUND LEVEL AIR USING THE ASS-500 VOLUME SAMPLER

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INTRODUCTION

A quantitative measurement method was elaborated for monitoring of the radioactive ground level air contamination [1]. The ASS-500 station is aimed on the monitoring of air contamination in both normal and emergency situations. Collection of aerosols from the air volume of the order of tens of thousends m^3 enables accurate spectrometric measurements of natural and artificial radionuclides in the wide range of their concentrations, starting from 0.5 $\mu Bq/m^3$ for ^{137}Cs. Collection is carried out in changing atmospheric conditions of temperature, pressure, humidity, dustiness, etc.

FILTER MATERIAL AND SAMPLING METHOD

The ASS-500 type sampler is a stand alone instrument for continuous air aerosol collection (Fig. 1). The Petrianov FPP-15-1.5 type filter with high collection efficiency is routinely used. Its aerosol collection efficiency is from 96 to 99 per cent for aerosols of diameter ranging from 0.3 to 1.25 μm at a linear flow rate varying from 0.25 to 4 m/s with pressure drop at the filter Δp from 500 to 9300 Pa. The infrared heaters are installed above the filter to keep it dry during sampling period. In the normal situation a weekly sampling is routinely accepted.

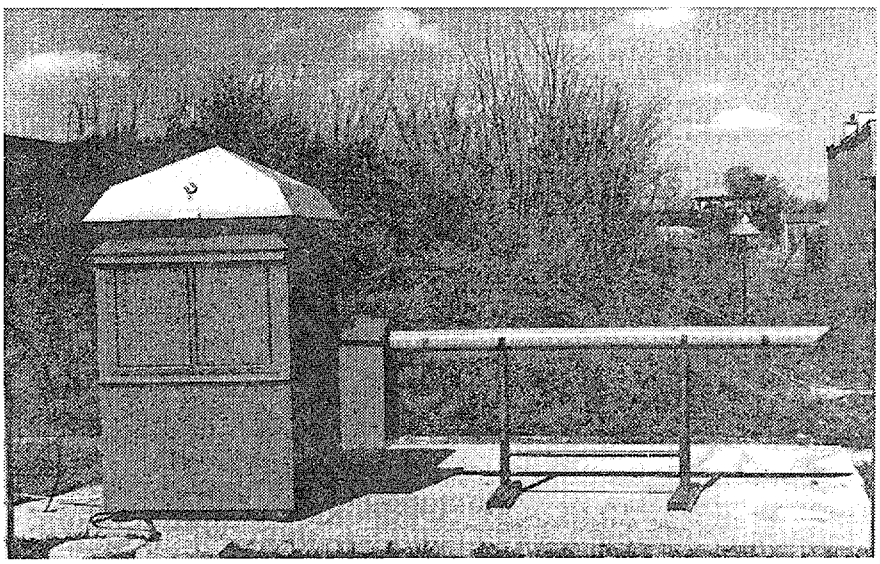

Fig. 1: Aerosol Sampling Station type ASS-500.

The air volume to be sampled ranges from 50 000 to 90 000 m^3. The flow and quantity of air flowing through the installation are measured by the vortex shedding flowmeter. The principle of operation of the vortex meter is the use of the formation of the vortices.

In the case of the increase of the air radioactivity or other reasons for intensification of measurements the sampling frequency should be increased with the decrease of the sampling period to as low as a dozen or so of minutes (like during Charnobyl accident).

The operation data concerning sampling procedure for ASS-500 station are the following:

- periodical sampling on the filter cartridge
- height of sampling: 1.5 m above the ground
- type of filter: FPP-15-1.5
- collection area: about 0.2 m^2
- filter dimensions: 440 mm x 440 mm
- nominal volume flow rate 500 m^3/h (adjusted with a valve)
- inlet to outlet distance: 3.5 m
- ambient temperature range: from -40 to +50°C

MEASUREMENT PROCEDURE

The high resolution gamma spectrometry using HPGe detector is applied for the quantitative measurements. A sample prepared to the main measurement has a shape of a cylinder of diameter of about 51 mm. To provide proper geometrical conditions of the measurement a semi-conductor HPGe detector of diameter close or bigger than the sample diameter and of the relative efficiency not less than 15 per cent is applied. The multiple character of the investigated gamma radiation spectra makes necessary the resolution of the spectrometer be not worse than 2.5 keV for ^{60}Co ($E\gamma = 1.33$ MeV). Photon energy of the investigated radionuclides ranges from 40 to 2620 keV. ^{210}Pb has a gamma energy line of 46.5 keV and ^{208}Tl - 2614.5 keV. It is desired that the spectrometer enable measurements in such a vide range. A coaxial N-type HPGe detector protected from the face side with a window of very low absorption for photons of 10 keV is very suitable. The detector is placed in a low background shielding house that decreases the gamma background at least two orders of magnitude. This requirement is met by a shielding house of three layer wall: outer one of 100 mm Pb, middle layer of 1 mm Cd and inner one of 2 mm Cu. Such shielding house also absorbs characteristic X rays induced in its material and the soft component of the cosmic radiation.

Each sample is measured twice. The preliminary measurement of the sample lasting 3000 s is performed directly upon termination of sampling. The aim of this measurement is detection of artificial radionuclides, if present in air, with LLD of about 20 - 50 $\mu Bq/m^3$. The results of the preliminary measurement are available within 1.5 h from the termination of sampling and removal of the filter.

If the preliminary measurement does not reveal enhanced activity of artificial radionuclides, the main measurement should be made 2 days after sampling has been completed to allow radon daughters to decay. Occurence of them on the filter is undesirable because they influence the low level detection limit for other radionuclides. Besides, during the 2 day period the humidity of the filter comes back to the value close to that of new filter. The aerosol sample mass is calculated as a difference between the mass of filter after sampling and before.

Preparation of the aerosol sample for the main measurement consists on the detachment of the fiber part of the Petrianov filter with the deposited aerosol sample from the gauze basis layer and on pressing it to a disk of 51 mm diameter and from 4 to 8 mm thick dependently on the amount of dust collected on the filter.

In order to estimate radionuclides concentrations in samples of different thickness three calibration measurements using standard source are performed to obtain three efficiency curves of the detector for thickness: 3.2 , 6.4 and 9.6 mm [2].

A pulse height analyser co-working with a computer is equipped with software allowing determination of concentration of radionuclides occuring in an investigated sample. The computer programs should define the low level detection (LLD) for contamination with possible artificial and natural radionuclides.

On the basis of the main measurement the concentration of each radionuclide in air is determined. The reports on the measurement results are prepared on weekly basis.

REFERENCES

1. D.Arnold, J.Jagielak, W.Kolb, A.Pietruszewski, H.Wershofen, R.Zarucki: Practical Experience in and Improvements to Aerosol Sampling for Trace Analysis of Airborne Radionuclides in Ground Level Air, PTB-Ra-34, 1994.
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