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Real-Time Radiological Monitoring of the Atmosphere Using an Autonomous Aerosol Sampler

Authors : Miroslav Hyza, Petr Rulik, Vojtech Bednar, Jan Sury

Abstract : An early and reliable detection of an increased radioactivity level in the atmosphere is one of the key aspects of atmospheric radiological monitoring. Although the standard laboratory procedures provide detection limits as low as few μBq/m³, their major drawback is the delayed result reporting: typically a few days. This issue is the main objective of the HAMRAD project, which gave rise to a prototype of an autonomous monitoring device. It is based on the idea of sequential aerosol sampling using a carrousel sample changer combined with a gamma-ray spectrometer. In our hardware configuration, the air is drawn through a filter positioned on the carrousel so that it could be rotated into the measuring position after a preset sampling interval. Filter analysis is performed via a 50% HPGe detector inside an 8.5cm lead shielding. The spectrometer output signal is then analyzed using DSP electronics and Gamwin software with preset nuclide libraries and other analysis parameters. After the counting, the filter is placed into a storage bin with a capacity of 250 filters so that the device can run autonomously for several months depending on the preset sampling frequency. The device is connected to a central server via GPRS/GSM where the user can view monitoring data including raw spectra and technological data describing the state of the device. All operating parameters can be remotely adjusted through a simple GUI. The flow rate is continuously adjustable up to 10 m³/h. The main challenge in spectrum analysis is the natural background subtraction. As detection limits are heavily influenced by the deposited activity of radon decay products and the measurement time is fixed, there must exist an optimal sample decay time (delayed spectrum acquisition). To solve this problem, we adopted a simple procedure based on sequential spectrum acquisition and optimal partial spectral sum with respect to the detection limits for a particular radionuclide. The prototyped device proved to be able to detect atmospheric contamination at the level of mBq/m³ per an 8h sampling.

Keywords : aerosols, atmosphere, atmospheric radioactivity monitoring, autonomous sampler
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