Abstract

This Ph.D. thesis deals with the problem of self-attenuation of low-energy gamma-ray from isotope of lead ^{210}Pb in industrial waste. Most of waste generated in industry (excluding nuclear industry) may be considered as NORM (Naturally Occurring Radioactive Material). Hence, the elevated concentrations of natural radionuclides are expected. Dealing with such waste carries some hazard for people and natural environment. The monitoring of exposure to radiation of either people or environment requires the reliable method of radionuclide concentration determination in all environmental compartments.

One of the most popular method applied for this purpose is gamma-ray spectrometry. It is a time- and cost-saving method where there is no need for a complex radiochemical separation of each radionuclide intended to be measured. All gamma-emitting radionuclides enclosed in a tested sample can be determined at the same time using this method. On the other hand, gamma-ray spectrometry is sensitive on matrix effects, such as self-attenuation of gamma-rays. Different phenomena are observed responsible for radiation self-attenuation that depends on sample density or its chemical composition. Industrial waste usually is mixture of many elements and often contains significant concentration of these ones with high atomic number. The higher effective atomic number of matter, the stronger gamma-rays absorption occurs, especially when low energy gamma-rays are considered.

The lead isotope ^{210}Pb is one of the most radiotoxic radionuclide among other natural ones usually present in NORM residues. Besides beta radiation, that is main source of radiation risk caused by its presence, only low energy gamma-rays (46,5 keV) are emitted during its decay. That is why an appropriate corrections for self-attenuation are required to improve accuracy of determination of ^{210}Pb by means of gamma-ray spectrometry. This correction factors can be calculated using Monte-Carlo method, based on exact knowledge about chemical composition of certain sample and spatial characterization of used detector. The accuracy of this approach strongly depends on accuracy of chemical composition determination. In case of industrial waste, especially those hazardous, chemical analyses are difficult to be performed for many reasons. Finally, such additional analyses increase total time needed and cost of ^{210}Pb determination in waste.

The other way to solve this problem, seems to be application of direct experimental method for mass attenuation coefficient determination. In that case, no additional analyses are necessary, however two additional measurement must be done. Using a point source of ^{210}Pb, one is able to obtain attenuation coefficient counting its gamma radiation with and without a sample between the source and gamma-rays detector used. Based on absorption equation, the appropriate correction factor can be calculated.

Author optimized and adjust the experimental method of correction factors determination for ^{210}Pb in industrial waste accounted to NORM category. Then, this method was applied to test nine type of industrial waste (almost 200 samples). Mass attenuation coefficients and corrected concentration of ^{210}Pb were determined. The wide variety of mass attenuation coefficients and necessary correction factors was noticed, however specific regularities were observed for particular waste categories.