Optimization of the method for determining the size distribution of radioactive aerosols based on the size distribution of ambient aerosols

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ABSTRACT

This work aimed to optimize the method of determining the size distribution of radioactive aerosols containing radon decay products based on the size distribution of ambient aerosols. The size distribution of radioactive aerosols allows more accurate determination of the dose conversion factors (DCF), which define the relationship between exposure to radon progenies and the corresponding effective dose. There are two approaches to determine DCF coefficients - the epidemiological method and the dosimetric method. The first one uses the results of epidemiological studies carried out on groups of miners working in underground mines, while the dosimetric approach recommended in ICRP Publication 66 of 1994, entitled The Human Respiratory Tract Model for Radiological Protection is based on the use of dosimetric models. These models take into account the dependence of the dose on the deposition in the respiratory system, which in turn is strongly related to the diameters of aerosols containing short-lived radon decay products. In practice, the epidemiological method of dose estimation is usually used, because measuring the activity size distribution of radon decay products requires specialized and expensive equipment and therefore is not widely used.

The aim of the research conducted in the study was to identify the size distribution of both ambient and radioactive aerosol size distribution related to the short-lived radon decay products, and to determine key parameters such as the diffusion coefficients, the attachment rate coefficient, the free path, and mean particle velocity. This enabled the association of both types of distributions and the determination of appropriate exposure-to-dose conversion factors. Consequently, it allows the use of more commercially available particle spectrometers to determine the particle size distribution of radioactive aerosols. The determination of such a correlation is of great importance because the size distribution of ambient aerosols can be determined with a much higher resolution in comparison to the instruments measuring directly distributions of radioactive aerosols.