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Advancements in NORM metrology - Results and impact of the European joint research project MetroNORM

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Content

Naturally occurring radionuclides are present in many natural resources. Industrial activities that exploit these resources may lead to enhanced potential for exposure to Naturally Occurring Radioactive Materials (NORM) in products, by-products, residues and wastes. Traceable, accurate, and standardised measurement methods and instruments, in particular for in-situ applications, are needed to decide on the re-use of waste materials without increasing costs whilst avoiding contamination of the environment and exposure of the public. Ionising radiation measurement in the recycling industry currently focuses on artificial radionuclides.

In this paper the main scientific results of the three years European Metrology Research Programme joint research project MetroNORM - Metrology for processing materials with high natural radioactivity – are presented. Significant improvements have been achieved by development, design and successful test of a novel hand-held prototype in-situ gamma-ray measurement system, an in-situ alpha-particle spectrometry prototype by integration with a remote expert support systems, a measurement system based on pixel detectors (MEDIPIX/TIMEPIX) and final sample preparation stage for the selected NORM measurement techniques. For 220Rn, the production chain in a vacuum chamber has been designed and the set-up and the generators and samples together with the chamber have been constructed and tested successfully. NORM standard reference materials and sources for calibration of laboratory instruments and in-situ measurement instruments - covering the NORM radionuclides 238U, 235U, 226Ra, 210Pb, 228Ra, 228Th, 208Tl, 228Ac, 214Bi, 214Pb, and 40K - have been prepared and applied successfully. In total 10 calibration and reference standards for gamma-ray spectrometry and alpha spectrometry measurement and reference materials for in-situ measurement systems have been developed. The laboratory and in-situ measurement systems and procedures for the measurement of NORM radionuclides and the reference materials have been developed with total relative measurement uncertainties lower than 10 % (k=1).

The revision of nuclear decay data of natural radionuclides has been carried out in order to improve NORM radionuclide metrology so that as many as possible descendants of uranium and thorium decay chains can be sufficiently accurately measured. To improve the required NORM related decay data, special radionuclide sources with the radionuclides 235U, 227Ac, 226Ra and 210Pb and had been carefully prepared and tested. A revised decay scheme for 138La including updated decay data has been established. In addition, the complex gamma-ray spectra of selected NORM key-materials have been measured and evaluated.

The potential impact of the results on NORM industrial practices by implementing the developed laboratory and in-situ measurement methods, procedures, instruments and reference materials is discussed. The scientific output of the joint research project have been so far – and potentially will be in future – considered in European and national standard bodies' working groups on dose assessment and classifications of emitted gamma radiation for building materials, technical preventive radon measures for buildings and the determination and evaluation of the total dose due to radionuclides at drinking water production plants.

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