Influence of neutron moderating materials in the characterization of 200 L radioactive waste drums by neutron activation analysis

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A prompt and delayed gamma neutron activation analysis facility using a 14 MeV neutron generator was developed at Forschungszentrum Jülich GmbH at a level of a prototype facility for the determination of nonradioactive toxic and reactive elements in 200 L standard waste drums [1]. Analytical performance and sensitivity of this facility called MEDINA (Multi-Element Detection based on Instrumental Neutron Activation) were investigated for a 200 L steel drum filled with a concrete matrix [1,2] as concrete often is used as embedding material in waste conditioning. However the waste may also contain additional inhomogeneously distributed neutron moderating and absorbing materials and/or gamma shielding materials which hamper the reliability and accuracy of the analytical results.

In this work, the influence of the presence of neutron moderating material in a concrete matrix on the determination of the waste matrix elemental composition is being investigated. Measurements were performed for various axial and radial distributions of polyethylene and concrete bodies placed in 200 L steel drums. The neutron generator was operated in a pulsed mode at a neutron emission of about $8 \cdot 10^7$ $n \cdot s^{-1}$. The neutron pulse was set to 50 µs and the repetition period of the neutron pulses to 1 ms. The 14 MeV neutrons are moderated and reflected by the graphite walls of the irradiation chamber and thermalized by the sample as well. The gamma-ray spectra were acquired between the neutron pulses over a counting time of 940 µs after a waiting time of 10 µs after end of the neutron pulses. The gamma-ray spectra were recorded for a total counting time of 3600 s. The net areas of the gamma-ray peaks for the isotopes of interest (^{1}H, ^{10}B, ^{12}C, ^{28}Si, ^{40}Ca and ^{56}Fe) are obtained by manual analysis of the spectra using the Gamma-W spectroscopic software. The mean thermal neutron flux was determined from the prompt gamma-rays of ^{56}Fe induced by the activation of the steel drum [3]. The elemental composition of the PE/concrete matrix is calculated assuming that the drum is filled only with concrete. This case would correspond to the real assay of inhomogeneous historical waste drums with no a priori knowledge of the content except the waste density. Discrepancies between measured and expected elemental concentration are evaluated and discussed involving MCNP5 simulations results.

References

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