THERMAL NEUTRON DIE-WAY-TIME STUDIES FOR P&DGNAA OF RADIOACTIVE WASTE DRUMS AT THE MEDINA FACILITY

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Introduction

In Germany, radioactive waste with negligible heat production has to pass through a process of quality checking in order to check its conformance with national regulations prior to its transport, intermediate storage and final disposal. Additionally to its radioactive components, the waste may contain non-radioactive chemically toxic substances that can adversely affect human health and pollute the environment, especially the ground water [1-2]. After an adequate decay time, the waste radioactivity will become harmless but the non-radioactive substances will persist over time. In principle, these hazardous substances may be quantified from traceability and quality controls performed during the production of the waste packages [3]. As a consequence, a research and development program was initiated in 2007 with the aim to develop a nondestructive analytical technique for radioactive waste packages based on prompt and delayed gamma neutron activation analysis (P&DGNAA) employing a DT-neutron generator in pulsed mode. In a preliminary study it was experimentally demonstrated that P&DGNAA is suitable to determine the chemical composition of large samples [4]. In 2010 a facility called MEDINA (Multi Element Detection based on Instrumental Neutron Activation) was developed for the qualitative and quantitative determination of non-radioactive, toxic elements and substances in 200-l steel drums [5].

The determination of hazardous substances and elements is generally achieved measuring the prompt gamma-rays induced by thermal neutrons. Additional information about the composition of the waste matrix could be derived measuring the delayed gamma-rays from short life activation products. However a sensitive detection of these delayed gamma-rays requires that thermal neutrons have almost vanished. Therefore, the thermal neutron die-away-time has to be known in order to achieve an optimal discrimination between prompt and delayed gamma-ray spectra acquisition.

Measurements

Thermal neutron die-away times have been determined for the following cases: a) the empty chamber, b) an empty 200-l steel drum, for a 200-l steel drum filled c) with concrete d) with polyethylene and e) with a mixture of polyethylene and concrete by measuring the prompt-gamma-ray count rate of relevant isotopes like of ^{1}H, ^{10}B, ^{12}C, ^{28}Si, ^{35}Cl, ^{40}Ca and ^{56}Fe which are emitted from different parts of the facility and the sample. Additionally, the average die-away-time was determined from the total detector count rate. The neutron generator was operated with a neutron emission of $8 \cdot 10^{7}$ n·s^{-1}, a neutron pulse with a length of 250 µs and a repetition time of 5 ms. The spectra were acquired between the neutron pulses over t_C=500 µs after a pre-defined waiting time t_D (multiple of 500 µs).

Results

The thermal neutron die-away time was ranging between 0.9 ms and 5 ms according to the sample composition. As an example the measured thermal neutron die-away-time Λ [µs] of a drum filled with concrete is presented in Fig. 1. Detailed results of this study will be presented and discussed.

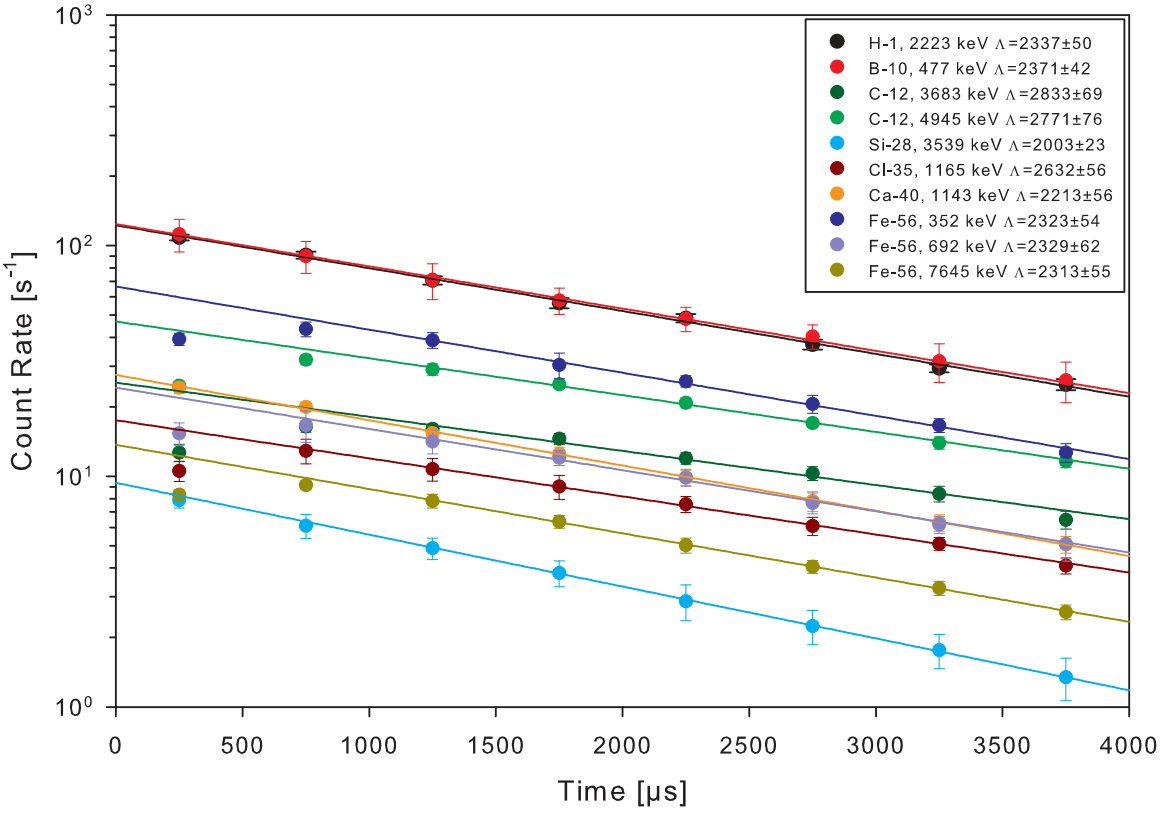

Fig. 1: *Measured thermal neutron die-away-time Λ [µs] for the drum filled with concrete.*

References

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