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Is it possible to measure Sr-90 in radioactive waste without harmful chemical reagents?

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Sr-90 is, with Cs-137, one of the main radioactive fission product occurring in nuclear power plants in terms of abundance proportion. This radionuclide can thus be present in significant amount in spent nuclear fuel or in radioactive waste from nuclear reactors. In the context of the increase of the number of decommissioning and dismantling operations in nuclear facilities, a reliable and rapid determination of Sr-90 is of prime interest for the characterization of all types of radioactive waste (effluents, ion exchange resins, concretes, sludges…).

Sr-90 has a half-life of 28.8 years and emits beta particles of relatively high energy (maximum energy of 546 keV). It disintegrates into Y-90 which is also a pure β-emitter (maximum energy of 2280 keV) with a half-life of 2.67 days. Sr-90 needs to be purified from interfering analytes through selective radiochemical separations before any reliable detection. It can be directly measured or indirectly evaluated from Y-90 growth. Both radionuclides are often measured by gas flow proportional counting and liquid scintillation counting (LSC). The separation yield is determined from stable strontium carrier by inductively coupled plasma (ICP) techniques or gravimetry.

Two main radiochemical methods for Sr-90 determination are generally implemented[1]: Sr precipitation in highly concentrated nitric acid or extraction chromatography on Sr-resin®. Both procedures are robust and selective to provide accurate measurement of Sr-90 in radioactive samples. However, they involve the use of harmful chemical substances, respectively fuming nitric acid and liquid scintillation cocktails for LSC detection. Both reagents are in the scope of European REACH regulation and have to be removed from use as much as possible.

The purpose of this presentation is to demonstrate the feasibility of accurate Sr-90 measurement in radioactive waste without the use of toxic chemical reagents. The presentation will first focus on the optimization of a precipitation method by applying a design of experiments methodology[2]. The implemented strategy induces the replacement of fuming nitric acid (above 82 % concentration) by concentrated nitric acid (69 % concentration) while maintaining high separation yield and improving the selectivity towards calcium which is the main interfering analyte of this method. Secondly, the presentation will deal with the implementation of plastic scintillation resin[3] (noted PS resin) to avoid the use of liquid scintillation cocktails. A method based on a PS resin selective towards Sr was optimized so as to achieve high decontamination factors towards interfering radionuclides, in particular Pu-241 β-emitter. For both developed purification methods, the validation step is performed by comparing the results obtained on different types of radioactive waste

(effluents, concretes and sludges) with the ones obtained with the reference method of the laboratory based on fuming nitric acid. The selectivity of both methods is also evaluated by checking Y-90 growth (see Figure 1).

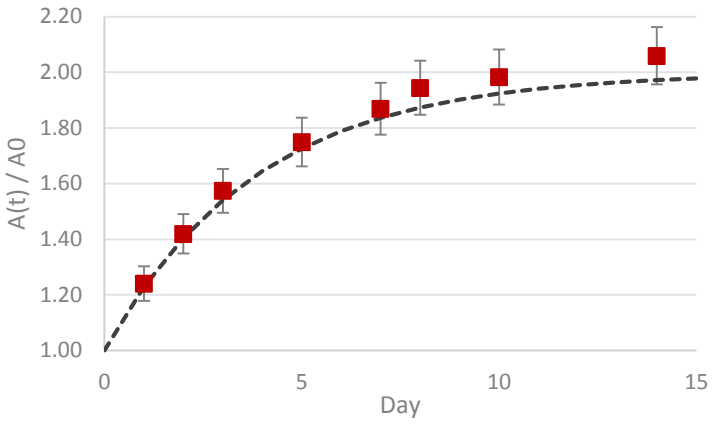

Figure 1: Y-90 growth curve from Sr-90 obtained with plastic scintillation resin selective towards Sr

References

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