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Radiochemical characterisation for a decommissioning purpose at NRG: The case of ion exchange resins

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The High Flux Reactor in Petten, Netherlands, is used for the production of medical isotopes as well as a material research reactor; during its exploitation several types of radioactive wastes are produced and accumulated.

That is the case in particular for the Ion Exchange Resins (IER) in use to treat the water of the primary water circuit of the reactor and the demineralizing basin. Several treatments are in favor to treat spent resins such as steamed reforming (THOR process), cementation, or incineration and cementation of the ashes.

The Nuclear Research and consultancy Group (NRG) is pursuing a politic of footprint reduction and waste volume minimization to achieve enhanced waste management and cost reduction. The treatment of the used resins has therefore been changed and the disposal route switched from cementation towards incineration.

The storage capacity on the Petten nuclear site being limited, the Consultancy & Services team developed in the timeframe of a year an extensive range of characterization techniques, both destructive and non-destructive to meet criteria for transportation and incineration of the resins and the final storage of the ashes.

Treatment and characterization of IER has already been practiced by several operating reactors, however the approach taken by NRG offers a combination of characterization techniques and the integration of some of the complex issues which have to be encountered in the waste management business:

- Representative sampling/Homogeneity
- Nuclides analysis selection
- Homogeneity guarantee
- Analysis method
- Reproducibility

Despite its apparent homogeneity, the presence of hot spots inside an IER container is always a risk; in order to control it recommendations mentioned in IAEA-tecdoc 1537 are applied: "*[···]a simple and stable waste stream could be declared homogeneous if NDA measurements of Cs-137 and/or Co-60 made at different locations are within a 30% relative interval.*"
3 Sampling campaigns have been carried on batches of used IER from various years. (N.B: IER are changed on average every two years and are stored by years and types, anionic or cationic). Based on the low dose rate of anion exchange resins the sampling could be achieved technically easily. Validation of the homogeneity is carried out by gamma spectrometry using the relative spread of the Co-60 and/or Cs 137 content measured.

The required characterization is foreseen to be provided by the following methodology:

1. Non-Destructive:
2. Gamma spectrometry (Specifically for Co-60 and Cs-137)
3. Alpha spectrometry (under advanced developement)
4. Total alpha/beta via Liquid Scintillation Counter

5. Destructive:
   -Specific beta-emitting nuclide analysis
6. H-3
7. C-14
8. Cl-36 (under advanced development)
9. Fe-55
10. Ni-63
11. Sr-90
12. Tc-99 (under advanced development)

Destructive analysis, elaborated by the Consultancy and Services group, consists as a first step on a complete digestion of the resin to maximize the recovery of radionuclides. The desired radionuclides are chemically isolated by selective separations and extractions and later measured using a Liquid Scintillation Counter.

The key step of the selective separation has been developed at NRG with good recovery rates (in the order of magnitude of 75% for most of the radionuclides) achieving limited losses of activity and better accuracy in the measurement. This selectivity has been checked and validation following ISO -17025 standards is on-going for many radionuclides presented.

Due to the controlled radiochemical process in combination with the very low counting activity of the LSC in use at NRG low sample activities are possible. These developed radiochemical methods are foreseen to be extensively applied to other decommissioned or to be decommissioned components of Nuclear Power Plants as well as for various complex waste streams.

Results (to be updated with latest results at the time of the presentation) show an excellent recovery level for the most important nuclides. More importantly, homogeneity can be assumed within a batch of ion exchange resins.

The results provided so far are fitting the profile of required characterization for both transport and incineration. It also constitutes a "radionuclide identification card", and, as such, can participate to the standardization of the treatment and characterization of such waste streams.

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