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Carbon-14 release from irradiated stainless steel

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Carbon-14 (half-life 5,730 years) is a key radionuclide in the assessment of the safety of a geological disposal facility (GDF) for radioactive waste. In particular, the radiological impact of gaseous carbon-14 bearing species has been recognised as a potential issue. Carbon 14 is expected to be released from a GDF over a timescale of several thousand years. A number of radioactive gases will be generated from waste materials within a GDF, with carbon 14 bearing methane (14CH4) likely to dominate any carbon 14 transported in a gas phase, potentially reaching the biosphere at low activity concentrations. Sources of carbon-14 include irradiated graphite, irradiated steels and Zircaloys, irradiated reactive metals, spent ion–exchange resins and spent fuel.
The objective of this work is to measure the rate and speciation of carbon-14 release from irradiated stainless steel on leaching under high-pH anaerobic conditions, representative of a cement based near field for intermediate- and some low-level wastes (ILW/LLW). In particular, this includes measurements of releases to the gas phase as well as to solution. The gas phase carbon-14 collection method allows for the discrimination of carbon-14 released as 14CO2, 14CO (and volatile oxidized species) or 14C-hydrocarbons. The carbon-14 solution analysis method used to date has measured the inorganic carbon-14 release only. Work is in progress to measure the total carbon-14 release to solution that includes any dissolved organic carbon-14 species. Three experiments have been in progress in NRG's Hot Cell Laboratory at Petten for a period of 20 months: two contain irradiated stainless steel with similar total inventories of carbon-14 (and also cobalt-60); the third is a control experiment with unirradiated stainless steel from the same batch. The steel samples are being leached in 0.1 mol dm 3 NaOH solution. The three experiments have been sampled six times to date and analytical data are now available for the carbon-14 releases to the gas phase, inorganic carbon-14 to solution and cobalt-60 releases to solution up to 13 months leaching. The experiments are still running and further sampling is planned after 2 years.
The presentation will cover: initial characterisation of irradiated steel samples to assess their suitability for use in the experiments; the approach selected and the conceptual design of the experiments for measuring carbon-14 releases from irradiated steel samples in a hot cell (i.e. a shielded cell); the preparation, installation and commissioning of the equipment in a hot cell. The main part will focus on the presentation and discussion of the results up to 13 months leaching.
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