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CArbon-14 Source Term

CAST

Summary of the progress achieved through CAST for the general public and decision makers (D7.25)

Author:

E.A.C. Neeft

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CAST – Project Overview

The CAST project (CArbon-14 Source Term) aims to develop understanding of the potential release mechanisms of carbon-14 from radioactive waste materials under conditions relevant to waste packaging and disposal to underground geological disposal facilities. The project focuses on the release of carbon-14 as dissolved and gaseous species from irradiated metals (steels, Zircaloys), irradiated graphite and from ion-exchange materials as dissolved and gaseous species.

The CAST consortium brings together 33 partners with a range of skills and competencies in the management of radioactive wastes containing carbon-14, geological disposal research, safety case development and experimental work on gas generation. The consortium consists of national waste management organisations, research institutes, universities and commercial organisations.

The objectives of the CAST project are to gain new scientific understanding of the rate of re-lease of carbon-14 from the corrosion of irradiated steels and Zircaloys and from the leaching of ion-exchange resins and irradiated graphites under geological disposal conditions, its speciation and how these relate to carbon-14 inventory and aqueous conditions. These results will be evaluated in the context of national safety assessments and disseminated to interested stakeholders. The new understanding should be of relevance to national safety assessment stakeholders and will also provide an opportunity for training for early career researchers.

For more information, please visit the CAST website at:
http://www.projectcast.eu

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Summary of the progress achieved through CAST for the general public and decision makers

Summary

This 2 page summary intends to describe the progress made through CAST for the general public and decision makers. Decision-makers are here defined as those actors with a responsibility in the management of waste: regulators, waste generators and waste management organisations. All references on which the described progress is based are included in the final overview of CAST project report Deliverable 7.23. The CAST project focused on the release of carbon-14 as dissolved and gaseous species from waste.

The measurement of released carbon-14 species for the neutron irradiated materials is challenging due to its low chemical amount in waste and low corrosion rates in cementitious materials. Dissolved organic carbon compounds has been measured to be the major carbon-14 species released from neutron irradiated steel, neutron irradiated Zircaloy and neutron irradiated graphite. Distinction between carboxylic acids, alcohols and aldehydes is to be made. The release of non-ionic carbon compounds such as alcohols and aldehydes is therefore conservatively assumed to be the main carbon-14 species. The extent to which these species can be assumed to be retarded in engineered and natural barriers is uncertain, and in the case of natural barriers depends on the host rock properties. These neutron irradiated materials are also known to have very small mass loss rates, so the potential carbon-14 fluxes to air from these three waste types as a consequence of their deep geological disposal is expected to be negligible compared to the flux of natural carbon-14 emanating from soil.

The main origin of carbon-14 in neutron irradiated steel and Zircaloy is nitrogen. Measured and calculated carbon-14 contents are of the same order in magnitude. For neutron irradiated graphite, it depends on the chemical and temperature conditions whether nitrogen is the main contributor to carbon-14 in waste. Nitrogen-activated carbon-14 forms a loosely bound carbon-14 gaseous species that can be released during crushing of neutron irradiated graphite.

Only measured carbon-14 contents in resins that have been prepared for conditioning are representative of behaviour likely in relation to a disposal scenario, due to the high impact of the storage and drying conditions on the contained carbon-14 content. Spent ion exchange resins can only contain anionic carbon-14 compounds. This containment limits the presence of organic carbon in ion exchange resins to dissociated anionic compounds of carboxylic acids such as oxalate and acetate; the only possible contained inorganic compounds are bicarbonate and carbonate. Attempts to measure release of carbon-14 in alkaline media have been made but carbon-14 has not been measured to be released in cementitious pore water. If released, inorganic carbon is retarded in cementitious materials due to the precipitation with calcite. This retention mechanism also takes place for oxalate. Sorption of positively-charged cementitious minerals is another retention mechanism and in CAST the literature for sorption of acetate has been found. The last evaluated retention mechanism is ion exchange; formate is exchanged with sulphate in ettringite. Consequently, there is no reason in cementitious materials only to assume retention for inorganic carbon and not for organic carbon during disposal of spent ion exchange resins when processed with cementitious materials. The amount of carbon-14 that is released and not decayed within the waste package may be negligible.