

Cement-Organics-Radionuclides-Interactions

FNSPE contribution

Barbora Drtinová, Jana Kittnerová, Jan Kozempel, Martin Vlk and Ekaterina Kukleva

Department of Nuclear Chemistry

Faculty of Nuclear Science and Physical Engineering, Czech Technical University in Prague

Břehová 7, 115 19 Prague – Czech Republic



„Czech Team“ – close cooperation with R. Vašíček (FCE CTU in Prague), P. Večerník (ÚJV Řež, a.s.), Z. Hlaváč (CVŘ s.r.o.)

DNC: 6 new students in 2020/21

Effect of organic concrete admixtures (plasticizers) and their degradation products as well as degradation products of organic radioactive wastes (including ion exchangers/PAN sorbents) fixed in the cement matrix on the migration of radionuclides in the cement/concrete environment

Task 2 – Organic degradation

Degradation products from radiolysis/hydrolysis of organic in strong alkaline environment

Task 3 – Organic-Cement-Interactions

Behavior of degradation products in presence of cementitious material

Task 4 – Radionuclide-Organic-Cement-Interactions

Task 3 + 

MATERIALS – SOLID (Tasks 2-4)

Hardened cement pastes CEM I (stage I and II; with/without plasticizer)

Concrete Richard (CEM III) – approx. 10 years old material from repository

All crushed and sieved (≤ 0.4 mm)

CSH phase – calcium-silicate-hydrate

Material selection for the Czech Republic:

Richard LLW/ILW repository life prolongation

Data for safety evaluation (drum in drum)

Concrete containers – future LLW/ILW + HLW repository (decommissioning)

HCP CEM I – reference material



MATERIALS – ORGANIC, LIQUID (Tasks 2-4)

Superplasticizer CX ISOPLAST 531 – polycarboxylic ether and lignosulfonate, for winter use

Polyacrylonitrile sorbents – PAN, AMP-PAN, KNIFC-PAN

Degradation products – EDTA, adipate, ftalate, formate/oxalate

– Degradation products identified in Task 2

Working concentration $5 \cdot 10^{-3}$ and $5 \cdot 10^{-5}$ mol L⁻¹

L/S 10; 100; 250; 500; 1000 L kg⁻¹

Liquid Phase – Portlandite water – saturated Ca(OH)₂ – $2 \cdot 10^{-2}$ mol L⁻¹

– NaOH of comparable pH (≥ 12.5)

MATERIALS – RADIONUCLIDES (Task 4)

U (under strong alkaline conditions solubility limit approx. 10^{-6} mol L⁻¹, ²³³U), **Pb** and **Eu** (10^{-12} – 10^{-4} mol L⁻¹, initial experiments with stable nuclides, ²¹⁰Pb, ¹⁵²Eu)

TASK 2 – ORGANIC DEGRADATION

Task leaders – Andra and CNRS-SUBATECH

Characterization and quantification of soluble organic species generated by radiolytic/hydrolytic degradation

- Radiolytic degradation of chosen plasticizer and sorbents in alkaline conditions
Gamma irradiation chamber in CVŘ (⁶⁰Co source), 1.5 kGy/hour
Dose up to 12 MGy (0.5; 1; 2; 4; 8; 12 MGy)
Sealed glass vials – 10 mL
- Degradation of chosen plasticizer and sorbents by hydrolysis in alkaline conditions
Time of hydrolysis up to 1 year
- Degradation of organic additives (plasticizers) in cement materials (HCP CEM I and Concrete Richard samples) by radiolysis
Cement materials prepared by FCE – cylinders, pucks
- Identification (and quantification) of the organic substances present after both degradation processes
HRMS analysis – raw material characterization
FT-IR and MS analyses (4000 – 400 cm⁻¹, Drift, ATR)
HPLC combinable with
UV/VIS – organic compounds
refractometry – organic compounds
radiometric determination
conductivity measurement – ions
- Preparation of ion exchangers based on PAN matrix (PAN, AMP-PAN, KNIFC-PAN)

