WG3 – Cement Organics Radionuclides Interactions (CORI)

WMOs priorities & expectations

November 03-04, 2015
- Since beginning of 2015, three meetings between WMOs representatives

- Comparison between WMOs inventories and specific issues arisen

- Improvement in exchanges between WMOs since 2014 (*e.g.* gas production rates, organic cement admixtures)

- Definition of common expectations ordering priorities

- Exchanges with topic leaders (to be developed especially for topics 1 and 4)

- Framing needs addressed to laboratories

- Identification of complementarity and relevance with other on going European projects
HLW and L/ILW-LL in separate sections of same repository. Cement backfill.

ILW-LL cell: ~ 400m long for disposal vault (backfilled with cement CEM V)

Repository for short-lived LILW (SFR) silo and caverns, cement backfill.

LILW-SL and LL in cement backfilled caverns (100 m long)
Crystalline and clayey host rock: organics sensitivity may be different

Low Level Short-Lived and Intermediate Level Long-Lived are managed differently

Cement-rich environment applies to all WMO’s

Reduce uncertainties and increase confidence regarding organics inventory

Define safety margins

Optimize disposal architecture, operating process, wastes density and distribution versus organic inventories
Inventories of organic wastes

PVC, neoprene®, hypalon®, polyethylene, polypropylene...
cellulose
polyacrylate
polyurethane
other (polycarbonate, fluoropolymers, nylon®,...)

Cigéo
Resins: Low-Level Long-lived disposal project (18% in total mass)

WG3 - WMOs
IGD-TP EF6, London
<table>
<thead>
<tr>
<th><strong>Identify the relevant organics from ‘overall’ inventories</strong></th>
</tr>
</thead>
</table>
| **NOM** | Site specific  
Non stoichiometric models  
Out of the scope of CORI |
| **Bitumen** | Largest to significant part of organic inventories  
Good state of knowledge  
Poorly relevant in the CORI framework |
| **Resins** | Significant part of organic inventories  
Low degradation rates |
| **Halogenated polymers**  
(PVC mostly) | Largest part of organic inventories (up to 50% excluding Bitumen & Resins)  
Low degradation rates |
| **Polyolefins polymers**  
(PE, PP...) | Significant part of organic inventories  
Low degradation rates |
| **Cellulose** | Large part of organic inventories (10% to 15% in mass)  
Hydrolytic degradation has been studied extensively |
| **Polyacrylates** | Large part of organic inventories  
High degradation rates |
| **EDTA** | Limited part of organic inventories  
Chelating properties (well studied in acidic/neutral conditions) |
| **Superplasticizers** | Indirect but significant organic inventory  
Ill-characterized |
<table>
<thead>
<tr>
<th>Material</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halogenated polymers (PVC mostly)</td>
<td>High phthalate source term + Low weight carboxylic acids?</td>
</tr>
<tr>
<td>Polyolefins polymers (PE, PP...)</td>
<td>Poorly characterized Low weight carboxylic acids?</td>
</tr>
<tr>
<td>Resins</td>
<td>Rather well characterized C1-C2 carboxylic acids + methylated amines + SO₄ + NH₄...</td>
</tr>
<tr>
<td>Cellulose</td>
<td>Isosacharinic acid + Low weight carboxylic acids</td>
</tr>
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<td>Superplasticizers</td>
<td></td>
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</tbody>
</table>

Need of characterization of relevant dissolved species for RN Include studies on kinetics whenever possible
From organic compounds to organic species

Radiolytic degradation → Gaseous species

Aqueous species

Gas production rates: considered as ~ known
No direct interactions with RN
Could be out of the scope of CORI considering data exchange between WMOs

Hydrolysis

Ill-defined speciation versus TOC
- Alcohols
- Esters
- Ketones, aldehydes
- Carboxylic acids

Expected scope of CORI
How are dissolved organics treated in PA?

- Kinetics of dissolved organics release: kinetic of cellulose degradation only

- Sorption on cement (Kd) and use of sorption reduction factor for RN that form complexes with organics (ISA and GLU) used by Andra, SKB, RWM and Nagra

- Solubility enhancement factor (ISA) used by RWM and Andra

- ONDRAF/NIRAS: Solubility of RN in high pH environment – up to now, no organics from waste are taken into account: Clay will be the main retention barrier (but including natural organic matter)
  - Assumption: natural organic matter >> organics in waste

- Degradation of organics can also contribute to gas production (H₂, CO₂, CO, CH₄)

Uncertainties arising

Threshold effects vs. Nature & content of organics
Consistency of correction factors
Sensitivity to uncharacterized organics
Important gaps in TDBs for organics and RN complexes under cementitious conditions. Acquisition of thermodynamic data is expected from TDB developments: exchanges in this field is encouraged, but should be out of the scope of CORI.
Relevant dissolved organics

Priorities towards complexing capacity

- Monocarboxylic acids (formic, acetic, propionic...)
- Dicarboxylic acids (oxalic, malonic, glutaric...)
- Aromatic carboxylic acids (phthalic...)
- Aminocarboxylic acids (EDTA)
- Hydroxicarboxylic acids (ISA, gluconic...)

Single organic species: well known (uncertainties under cement conditions)
Organics mixtures: less defined (especially for sorption/diffusion)

Relevant Radionuclides

- Transition elements
- Lanthanides
- Actinides

Relevant Toxic Element

- Pb

Relevant cementitious systems

- CEM I/II
- CEM V
- Armoured concrete systems

vs. Long term evolution

Relevant degradation conditions

- Oxic / dried conditions for radiolysis
- Anoxic / water saturated conditions
**Organic species: $^{14}$C carrier molecules**

- Gaseous species
- Inorganic dissolved species
- Organic dissolved species

$^{14}$C is released under

Need to improve current knowledge on organic $^{14}$C behaviour in cementitious barriers

**Consistency with 2$^{nd}$ topic in CORI: organic mobility**

$^{14}$C topic is recommended in CORI
**General view: CORI and on going projects**

**CAST**
- Topic1: degradation / characterization
- Topic2: mobility of organics and interactions with Fe
- Topic3: mobility of organics/RN complexes
- Topic4: modeling, up-scaling

**CORI**
- Topic1: degradation / characterization
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**MIND**
- MIND WP1 will focus on biodegradation from irradiated materials/effluents
  - Consistency of organic materials between MIND and CORI
  - Consistency with realistic degradation conditions

**CEBAMA**
- CEBAMA WP2 will focus on sorption/transfer mechanisms in cement materials
  - Consistency of cement materials between CEBAMA and CORI

**CEBAMA**
- CEBAMA will develop sorption and transfer models for mobile RN
  - Consistency in modelling approaches

CAST will provide source terms and speciation of $^{14}$C (resins, graphite...)
- $^{14}$C in CORI in consistency with CAST outcomes. Good time tables between both projects
Thank You!