



Use of Geopolymer for the Immobilization of Liquid and Solid Organic Waste

Results into practice – PREDIS partner's view

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sck cen



This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945098.

Current conditioning approach

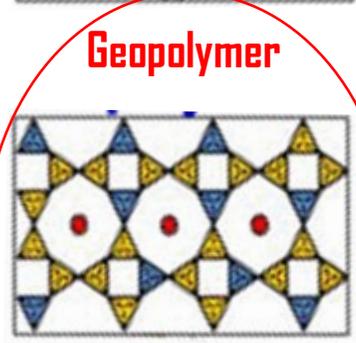
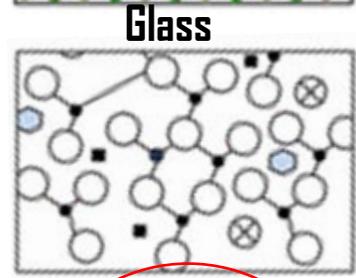
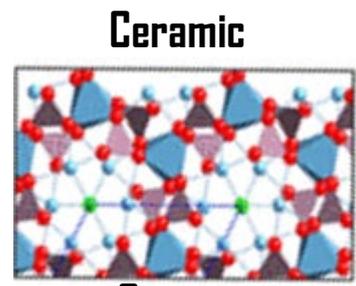
Various waste streams
(low/intermediate/high level
solid/liquid
organic/inorganic)



Shortcomings

- Difficult to meet ACRIA w.r.t:
 - ASR/DEF
 - Organic complexation of radionuclides
 - Thermal cracking

Alternative?

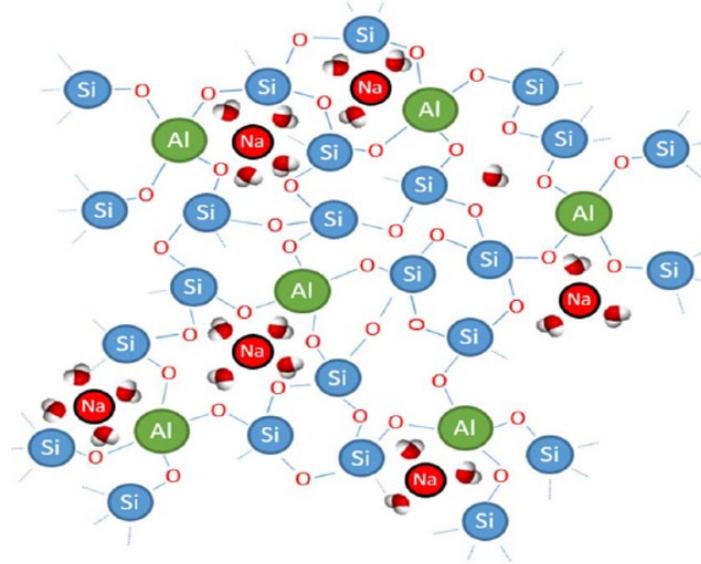


High T

Ambient to slightly increased T

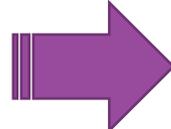


Geopolymer = promising matrix



3D network of Si-O-Al bonds

- High strength
- Less free water
- Low permeability
- No EDF, less ASR
- Compactible with organic wastes
- Thermal resistance



High potential to stabilize & solidify various waste streams



PREDIS project

Joint effort:

- 20 partners (liquid wastes)
- 14 partners (solid wastes)



Waste inventory

- Physicochemical characterization
- Radiology
- Moisture conditioning



Recipe design at lab scale

- Precursors
- Waste loading
- ACRIA
- Durability
- Active tests



Upscaling tests

- Drum scales
- Monitoring stability, T
- Modelling



Onsite implementation

- Polymerization technology
- Characterization
- Monitoring

Highlights – liquid wastes

Direct conditioning of liquid organic wastes in geopolymers:

- Waste types: oils, TBP, ionic liquid, LSC
- Waste loading: up to 40%



Scale up

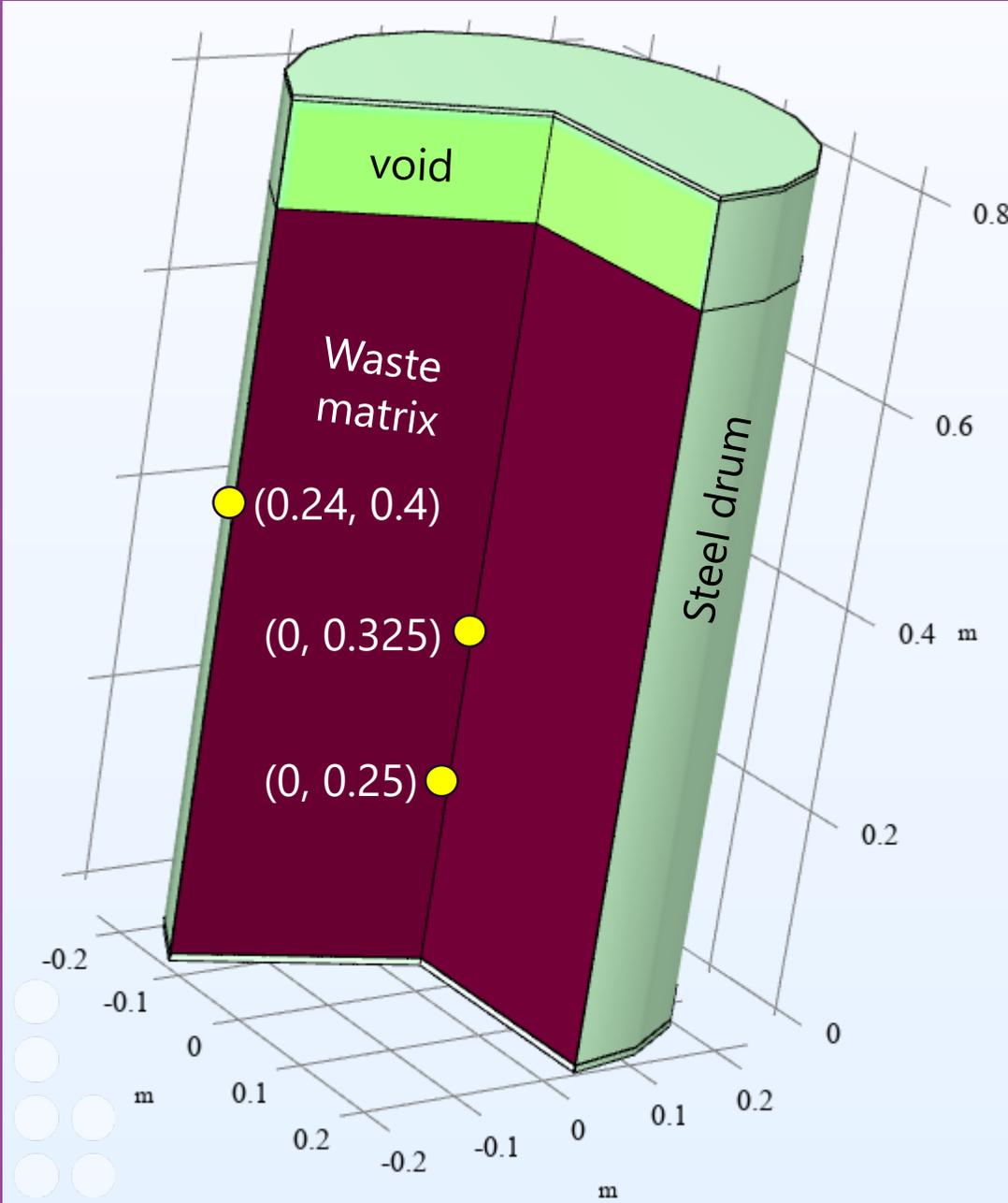


AAS + Lubricating oils

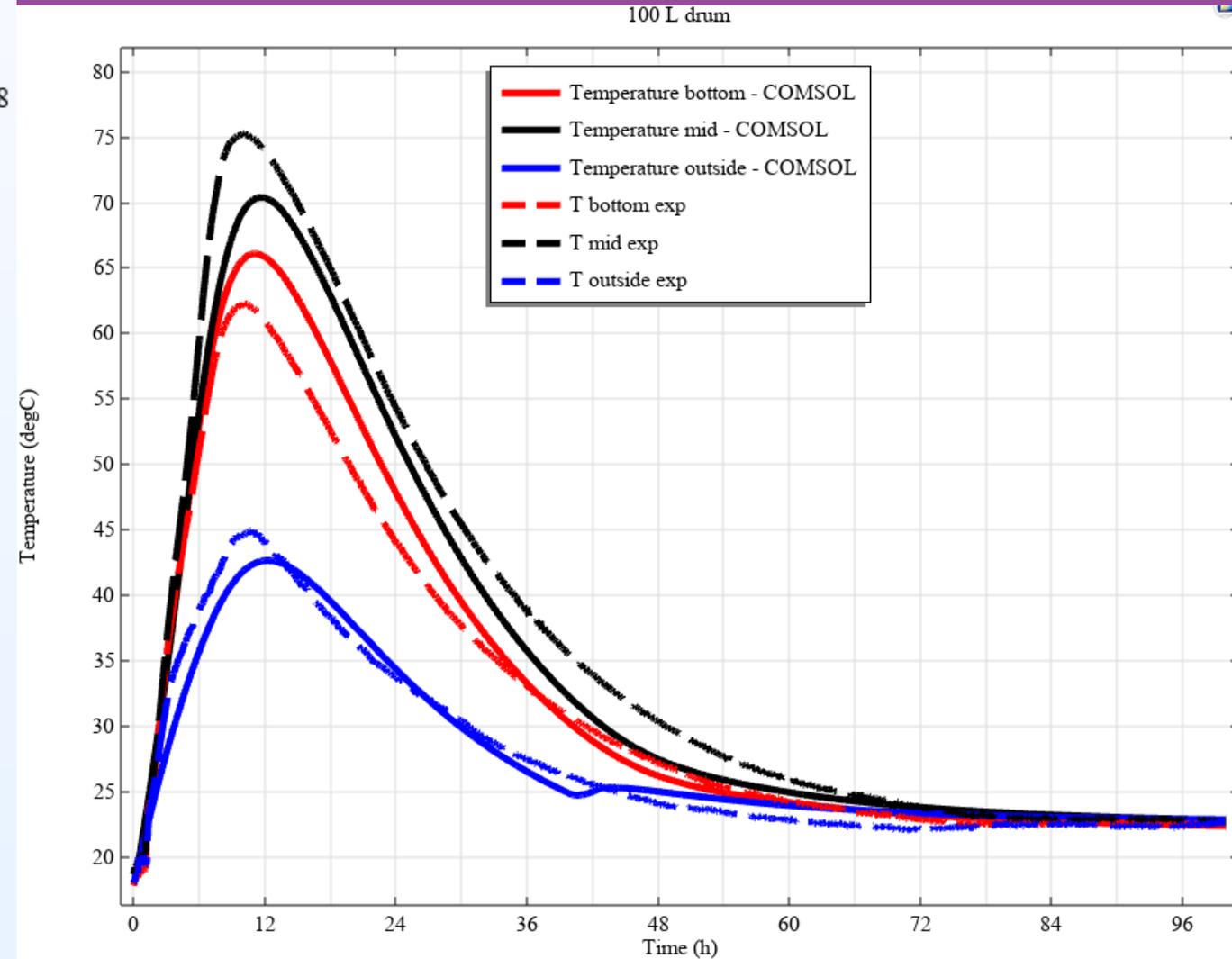


100 L drum @ CVRez

Modelled geometry (100 L)



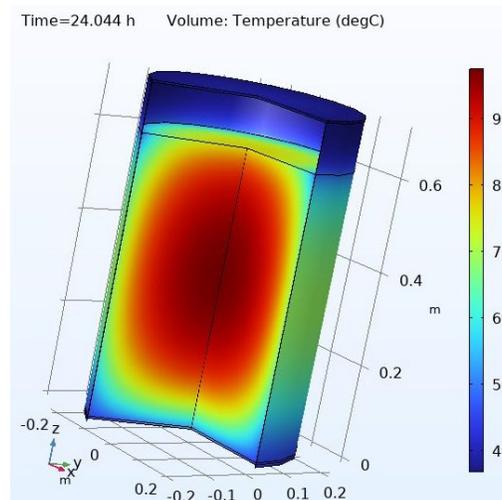
Preliminary temperature predictions at the sensor locations



Highlights – solid wastes

Conditioning of solid organic wastes in geopolymers:

- Waste types: molten salts, IER
- Waste loading: up to 20% (MSO), 30% (IER)

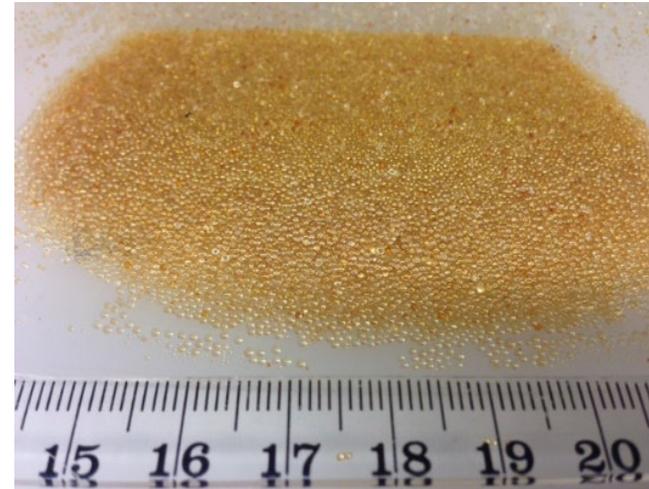


- CEM I / BFS / Silica fume / lime / limestone
- 10 – 14 wt.% waste loading

- Blast furnace slag precursor
- Activated by $\text{Na}_2\text{O} \cdot 2\text{SiO}_2$ and NaOH (from salt)
- 10 – 20 wt.% waste loading



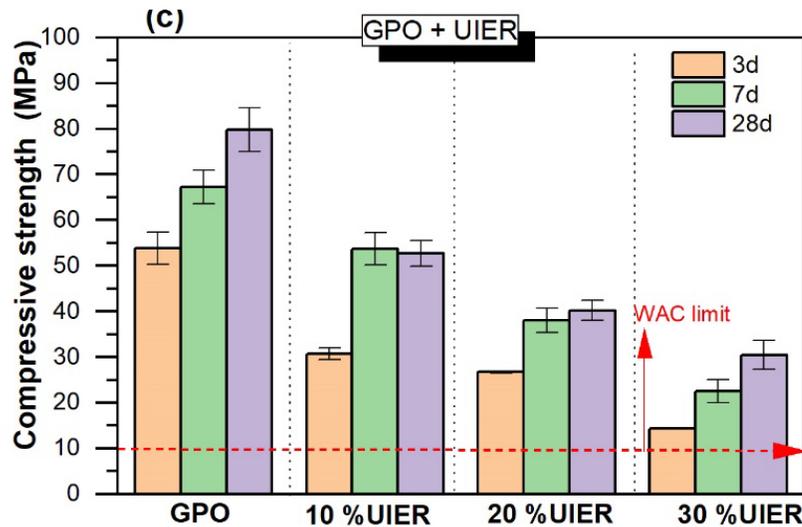
Highlights – solid wastes



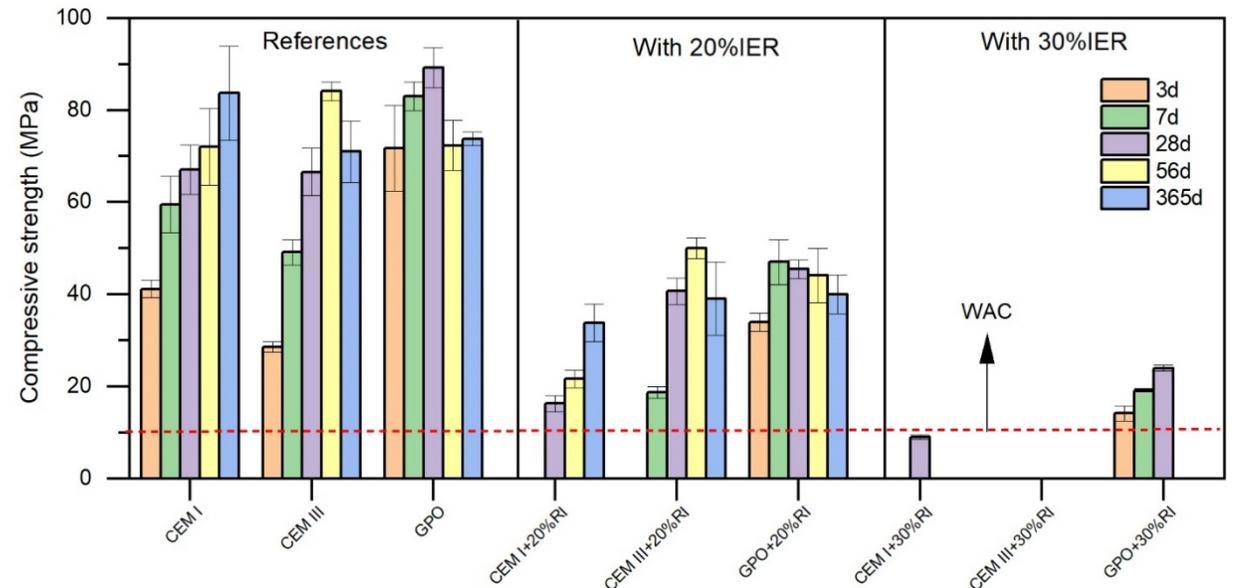
Conditioning of solid organic wastes in geopolymers:

- Waste types: molten salts, IER
- Waste loading: up to 20% (molten salts), 30% (IER)

Unreated IER



Treated IER



Highlights – solid wastes

Conditioning of solid organic wastes in geopolymers:

- Waste types: molten salts, IER
- Waste loading: up to 20% (molten salts), 30% (IER)



3 months at 21°C and 99% RH

Benefits & Challenges

- Solutions for legacy and problematic wastes
- Tailored recipes suitable for various waste types
- High waste loading, no secondary wastes
- High RN binding capacity
- Minimized effort to meet the ACRIA
- Robust, durable and sustainable



Benefits



Challenges

- No ACRIA available
- Low TRL
- Strict controlled conditioning processes
- Long-term performance

Showcase @ Czech republic

Fresh IER



After mixing
with geopolymer



Pilot installation @ UJV

Showcase - SIAL[®] matrix

- SIAL[®]
 - Commercial Geopolymer
 - Made from inorganic raw materials (MK → SiO₂ and Al₂O₃)
- Market
 - Licensed in Slovakia, Czech Republic
 - Applied in Japan, Taiwan, France, UK
 - Used for sludge, resins, crystalline borates, residues from thermal treatments and contaminated organic waste



Sludge/resins SIAL matrix [IAEA-TECDOC-CD—1701]

Impacts & Perspectives

1. Promising geopolymer matrices for radwaste immobilization:
 - High potential to comply with ACRIA
 - Suitable for various waste streams with high WL
 - Alternative to cementation
 - Sustainable & environmentally friendly materials
2. Yet challenging:
 - Long-term performance
 - Testing standards
 - Upscaling
3. But having some real scale applications:
 - SIAL matrix: Slovakia, Czech, Japan, Taiwan
 - Others?

Do the project provide helpful inputs to end-users to consider geopolymer as an alternative conditioning matrix?



Slag from steel production



Ash from coal power plant



Thank you for your attention!

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