New wasteforms for disposal of wastes from legacy and future fuel cycles

Neil Hyatt

Department of Materials Science & Engineering
The University of Sheffield.
n.c.hyatt@sheffield.ac.uk

IGDTP Forum, Kalmar, Sweden, October 2014

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

The views expressed in this talk are the personal opinion of the speaker and do not necessarily reflect those of sponsors or funding agencies.
1. New wasteforms arising from legacy decommissioning

- Key drivers are for safe, efficient and low cost hazard reduction
- Likely to produce new wasteforms of variable composition and microstructure
- Need to develop optimised processes and products compatible with disposal concepts

2. New wasteforms arising from future fuel cycles

- Key drivers are to minimise disposal footprint, by increasing FP loading
- Transmutation effects could be significant in governing long term behaviour in wasteforms
- MOX fuel disposal
New wasteforms – legacy waste

Activity: >50 TBq/m³ $\beta,\gamma$; >0.2 TBq/g $\alpha$

Hot isostatic pressing with 5wt% additive
Packaged product with no porosity or secondary waste
New wasteforms – legacy waste

Heterogeneous glass-ceramic waste form produced

All Cs incorporated into glass network

Some cracking associated with sectioning methodology

Primary phase - glass matrix
1. Boron enriched (light grey)
2. Silicon enriched glass (dark grey)

Various Secondary Crystal phases
1. Quartz (SiO$_2$)
2. Fe$_2$O$_3$
3. BaSO$_4$
New wasteforms – legacy waste

Rates obtained from SPFT testing pH 4, log Q/S = -7.0

Rate obtained for silicon dissolution predicts a maximum expected rate of glass surface retreat of 1 nm day⁻¹ at 90 °C.
New wasteforms – legacy waste

Cs Loss to Solution

HIPED

0.03% - 0.05%
14 Days
90 °C

CEMENTED

10% - 65%
1 Day
20 °C

Cs Loss %

100

10

1

0.1

0.01

Lowest measured

Highest Measured

Department of Materials Science and Engineering

Neil Hyatt
New wasteforms – legacy waste

- New thermal treatment wasteforms offer significant safety and cost benefits for legacy decommissioning programmes
- Potential to dispose of a much wider range of wasteform materials, typically heterogeneous in microstructure
- We need to develop:
  - Optimised treatment technologies for typical waste streams
  - An understanding of whole life cycle benefits, e.g. off gas considerations
  - Standard methodologies for estimating cost norms
  - An understanding of product evolution and interaction with near field
Glass ceramics for reprocessing wastes: increase FP and Ln loading by controlled crystallisation of selected host phases (>45wt% loading)

Key issue: we need predictable phase assemblage and microstructure
This depends on
• Composition
• Phase separation
• Thermal history

At present we have an incomplete understanding of the molecular scale mechanisms of glass-ceramic formation

Increasing the FP loading, means that heat loading and other effects may need to be considered.
Suggested way forward

- A scientific and technical working group to be established with a focus on new wasteforms for legacy and/or future fuel cycles – inc. high burn up and MOX fuels

- Review the direction of travel for member states in respect of new wasteforms and future impact on disposal programmes

- Review the state of the art and understand what has been achieved in national and international programmes

- Identify the key open questions to be addressed: scientific-technological and social aspects.

- This would address several of the High/Medium priority issues identified in the SRA – Main Achievements & Way Forward Report