Conditioning of LLW, ILW and HLW

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Basic Consideration of conditioning of radioactive waste

IAEA TECDOC Series

Technical Standards / Criteria of Waste Conditioning for Member States of the IAEA

IAEA SAFETY STANDARDS Series
(1) Objective
✓ To convert the waste to a solid form
✓ With a decreased solubility and improved mechanical stability

(2) Process
✓ Establishment Technologies
  • Cementation, bituminization, polymerization, calcination …L&ILW
  • Vitrification …HLW

(3) Essential to be taken account of
✓ The radiological characteristic of the waste
✓ Physical state of waste
✓ Chemical nature of the waste
✓ Compatibility of the waste
  • With matrix material
  • between matrix material and disposal environment
✓ Waste acceptance criteria of the repository
Stream of radioactive waste, generation, treatment/conditioning and disposal

Waste and Materials
- Metal
- Concrete
- Filter
- Wood (Woodchip)
- Rubber gloves

Low, Intermediate and High Level Liquid

Pre-Treatment
Treatment
Conditioning
Disposal

Cleared Material (Free)
Cleared Material (Conditional)
### Various Conditioning Methods for Radioactive Waste

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Conditioning Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Level Waste (LLW)</td>
<td>Cementation, Bituminization, Polymerization</td>
</tr>
<tr>
<td>Intermediate Level Waste (ILW)</td>
<td>Cementation, Bituminization, Polymerization, Calcination</td>
</tr>
<tr>
<td>High Level Waste (HLW)</td>
<td>Vitrification</td>
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</table>
Conditioning by Cementation (Example)

Cementation System

Cement supply hopper

Cement bag opening equipment

Compressive strength measurement

Mist separator

Measuring vessel

Cement induction conveyor

Packed column

Mixer

Condenser

Evaporator

Evaporation System

Concentrate storage tank

Condensate storage tank

Temporary Storage

Drain

Liquid waste

Compressing strength measurement

Evaporator

From leaflet of JAEA
Conditioned Waste for Disposal (Cement solidification)

Homogeneous Solidification
By Cement, Plastic and Bitumen
(Radioactive liquid waste)

Cement solidification of
Miscellaneous Solid Waste
(Metal & Concrete etc.)

Cement solidification of
Melted Solid Waste

Cement solidification of
Compressed Solid Waste

Cement solidification of
Miscellaneous Solid Waste
(Plastic & Rubber etc.)

From “Radioactive Waste Management Center Topics” (modified)
Conditioning by Bituminization (Example)

- Thin film evaporator
- Bitumen tank
- Condenser
- Bitumen storage tank
- Bituminized product
- Liquid rad-waste
- Liquid rad-waste tank

Radioactive Waste Characterization in JAVYS – Operational Experiences, Good Practices and Problems
Thin-film Evaporator for Solidification of Liquid LLW by Bitumen

Method | Cementation | Bituminization
--- | --- | ---
**Merit** | Cost effective and easy to get material | High reduction volume rate
Long-term stability | Excellent leaching resistance
Simple process |  |  
**Demerit** | Low reduction volume rate | Combustible solid
Long-term stability | (biodegradation, radiation impact)
Conditioning by Polymerization

<table>
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<th>Merit</th>
<th>Polymerization</th>
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<tr>
<td>High reduction volume rate</td>
<td></td>
</tr>
<tr>
<td>Excellent solidification property</td>
<td></td>
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</tbody>
</table>

| Demerit                                   | Combustiblesolid, Long-term stability (Organic matter) |

From Web site of Radioactive Waste Management Center (RWMC)
From generation to disposal of High Level Waste

High Level Waste (HLW)

From METI website
Conditioning of High Level Waste (Example)

From Leaflet of JNFL
✓ It is possible to make the package (conditioning) of the radioactive waste to dispose safely without depending on the category of high, intermediate and low level waste.
✓ A necessary technical standard is established, and conditioning is performed to meet this, and also a record is maintained.
✓ It is necessary to carry out the conditioning and the disposal of the radioactive waste reasonably while securing safety.