Solidification of Radioactive Waste with APS™ polymer

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Proven and NRC Approved Method of Solidification

- Produces **stable waste form** that meets 10 CFR 61.56 requirements
- **Specialized epoxy polymers** used to immobilize and encapsulate radioactive wastes
- **Mature technology** used to treat over 3,000 m³ of radioactive waste at nuclear power plants and government facilities
- **Simple and effective** technology
  - Room temperature application
  - High waste loading (≈100%)
  - Suitable for treating varying types of waste (resins, filters, etc.)
  - Successor of “DOW Process” US Patent: 4,405,512

Qualifications:

- 300 years
- $1 \times 10^6$ Gy (Absorbed Radiation)
Nuclear Sites:

- Bechtel Bettis Naval Reactor Facility – In Situ
- BNFL (UK) – Macro Encapsulation
- Connecticut Yankee – 14 drums sump sludge (Mixer)
- Diablo Canyon – In Situ Resin and Filter (In Situ)
- Dresden – Contain Solidification (Mixer) and In Situ Resin
- Idaho National laboratory – Circuit Board Macro Encapsulation
- Puget Sound Naval Shipyards – IX and GAC Vessel Solidification (In Situ)
- Magnox Trawsfynydd Power Station – Resin Solidification (Mixing)
- Paducah – Uranium Chip Solidification (Macro Encapsulation)
- Pilgrim Station – Resin Liner Solidification (In Situ)
- Savannah River – Silver Coated Pkg (In Situ) and Aqueous Hg (Mixing)
- V.C. Summer – Resin (In Situ)
- Westinghouse Naval Reactors Idaho – Stabilize Zircaloy Swarf (In Situ)
Application of APS™

- **Method #1 – In Situ Process**
  - Easily permeable material (IX resin, Carbon, etc.)
  - Polymer percolates from top to bottom filling interstitial spaces

- **Method #2 – Continuous Mixing**
  - Powdered resins
  - Fine materials such as soils, sludge, dried powder, fine sand, etc.
APS™ - In Situ Filter Encapsulation (ENCAP™)

- Compatible with Filters, Tools, Large Objects
- Process Steps
  - Load filters (objects) into perforated metal cage
  - Load permeable media (resin) into interstitial space
  - Solidification proceeds in normal manner (previous description)
Typical Applications Include:

- Spent resin contained in:
  - High Integrity Containers (HICs)
  - Steel Containers
  - Drums (200 L, etc.)
  - Disposable IX Vessel (US Navy)

- Packaged high-dose rate components:
  - Filter Elements
  - Metal Parts
  - Irradiated Metal
  - Radiation Sources
Continuous Mixing Method #2

- Factory Acceptance Testing of Mixer

200L Drum filled with waste
AVANTech APS™ – Advantages

- NRC-approved Topical for stabilization of waste containing radioactivity below the limits of 10 CFR 61.55
- Eliminates need for HIC or similar specialized high cost container
- Can be used with any type of dried powder, bead or granular media
- Superior performance compared to traditional methods such as Portland cement:
  - Very low leachability
  - High compressive strength
  - Waste loading is greater than 5 X higher than Portland cement
    - Advanced Polymer: $W_L \approx 100\%$
    - Portland Cement: $W_L \approx 18\%$
■ Highly predictable process – no chemical reaction between waste and polymer required

■ Solidification polymer is “stable” for 300 years; therefore, concerns of container or vessel deterioration are eliminated

■ All sizes of disposal containers are acceptable for use with APS™

■ ALARA – Remote application of polymer minimizes personnel exposure

■ Low equipment costs compared to traditional cementation processes

■ APS™ uses relatively simple equipment that is small in size
  ✓ Reduced facility space requirements
  ✓ May permit use of spare space in existing facility
Samples With Evaporator Concentrate

- Mix ratio (polymer:waste) = 1 : 1.015 (mass)
- 1 000 g polymer : 1015 g EC
- 932 ml polymer : 1 200 ml EC

- Compressive Strength – 12.69 MPa
- After 30 thermal cycles – 16.12 MPa
Samples With Spent IER

- **Mix ratio (polymer:waste) = 1 : 0.712 (mass)**
- **500 g polymer : 356 g SIER**
- **466 ml polymer : 600 ml SIER**

- **Compressive Strength** – 9.83 MPa
- **After 30 thermal cycles** – 17.30 MPa
Samples With Sludges

- Mix ratio (polymer:waste) = 1 : 1.015 (mass)
- 500 g polymer : 408 g Sludges
- 466 ml polymer : 600 ml Sludges

- Compressive Strength – 7.76 MPa
- After 30 thermal cycles – 13.82 MPa
Treatment of EC

ECT PROCESS

RETRIEVAL
UHP-VIPER

HBT

PROCESSING
TFE

APS SOLIDIFICATION
MIXER

DRUM/ CAPPING/
EXOTHERM/
Treatment of SIER & Sludges

SIER

RETRIEVAL PUMP AND MANIPULATING ARM

HBT

PROCESSING CENTRIFUGE

APS SOLIDIFICATION MIXER

DRUM/ CAPPING/ EXOTHERM/
Equipment Layout
THANK YOU