GEN IV International Forum℠
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Overview of Waste Treatment Plant, Hanford Site

Summary / Objectives:

Currently, the U.S. Department of Energy (DOE) stores ~90 million gallons of **radioactive and hazardous waste** in ~230 underground tanks at Hanford and Savannah River. At Hanford, approximately 20 million gallons of that waste is in a liquid form (supernatant), approximately 10 million gallons is in the form of insoluble sludge materials, and the remainder is in a partially soluble solid form referred to as saltcake. Treatment and immobilization of the tank waste into a glass waste form is planned with the Hanford Waste Treatment and Immobilization Plant (WTP) being the principal plant where this will be accomplished. This webinar focuses on **the integrated flowsheet that encompasses storage, retrieval, pretreatment, immobilization, and disposal**. The major emphasis or focal point will be the vitrification with respect to: 1) Troublesome waste components and their impact on glass formulation/operations; 2) Critical process and product performance properties (why and how they are measured); 3) Process control strategies and use/impact of glass models/algorithms; 4) Relationship between acceptable glass compositional regions and operational flexibility; 5) Significant advancements in glass formulation and the impact on the flowsheet/operations; 6) Operational lessons learned.

Meet the Presenter:

Dr. David Peeler received his Ph.D. in Ceramic Engineering from Clemson University. Over the past 25 years, Dr. Peeler has focused on **glass formulation development and developing alternative processing strategies to improve operational flexibility and waste** throughput for the Defense Waste Processing Facility in Aiken, South Carolina and for the Waste Treatment Plant in Hanford, Washington. He currently serves as the EM Deputy Sector Manager at Pacific Northwest National Laboratory (PNNL) in which over $45M of R&D is annually performed focused on waste processing and environmental remediation. Dr. Peeler serves on the External Advisory Board for Clemson University's Material Science and Engineering Department and is an Adjunct Professor at Clemson. He is a Fellow of the American Ceramic Society and has over 85 external peer reviewed publications, over 300 internal technical reports, and has issued three patent disclosures with one international patent awarded.

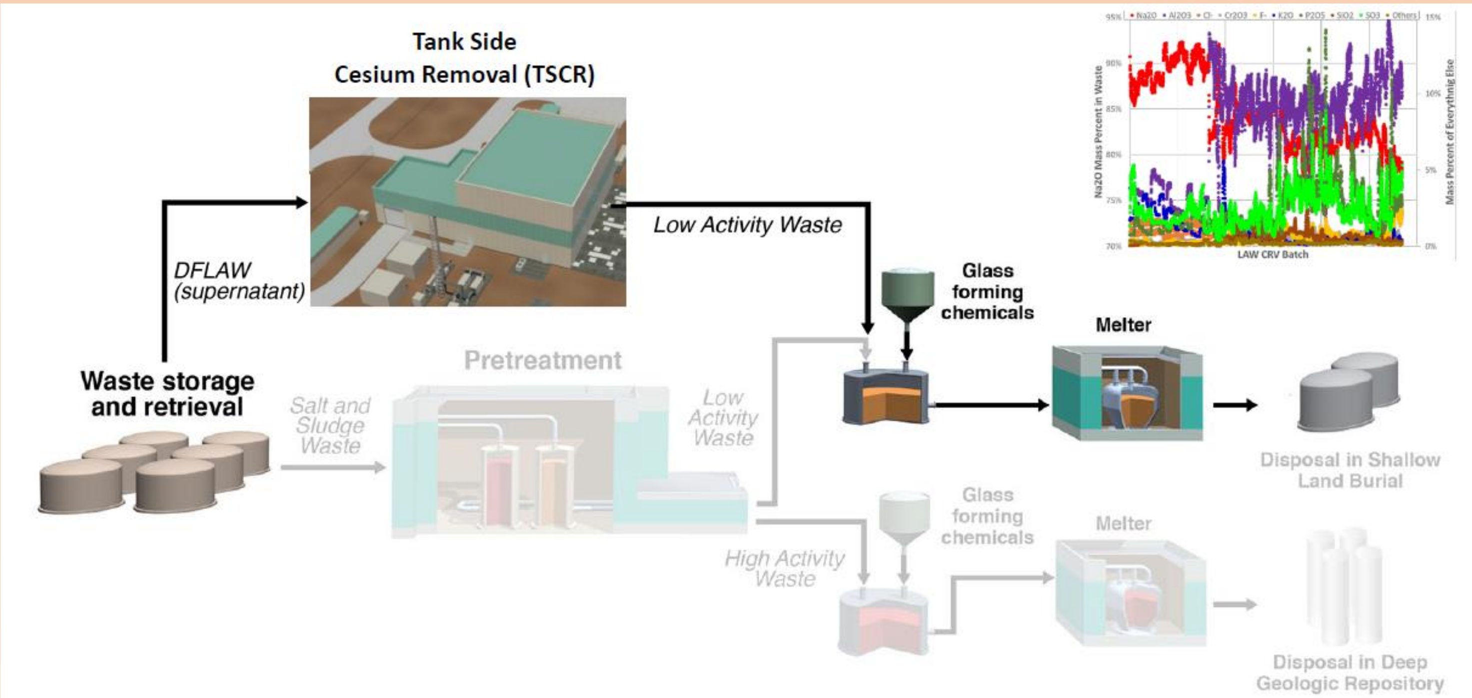
Overview of Waste Treatment Plant, Hanford Site

Background and purpose

- Approximately 90 million gallons of radioactive liquid waste currently being stored across DOE complex
- Legacy waste presents a significant environmental risk
- Fundamental and applied research are needed to develop, mature, and deploy innovative solutions
- Mission is retrieve, pretreat, immobilize and dispose

Hanford Flowsheet

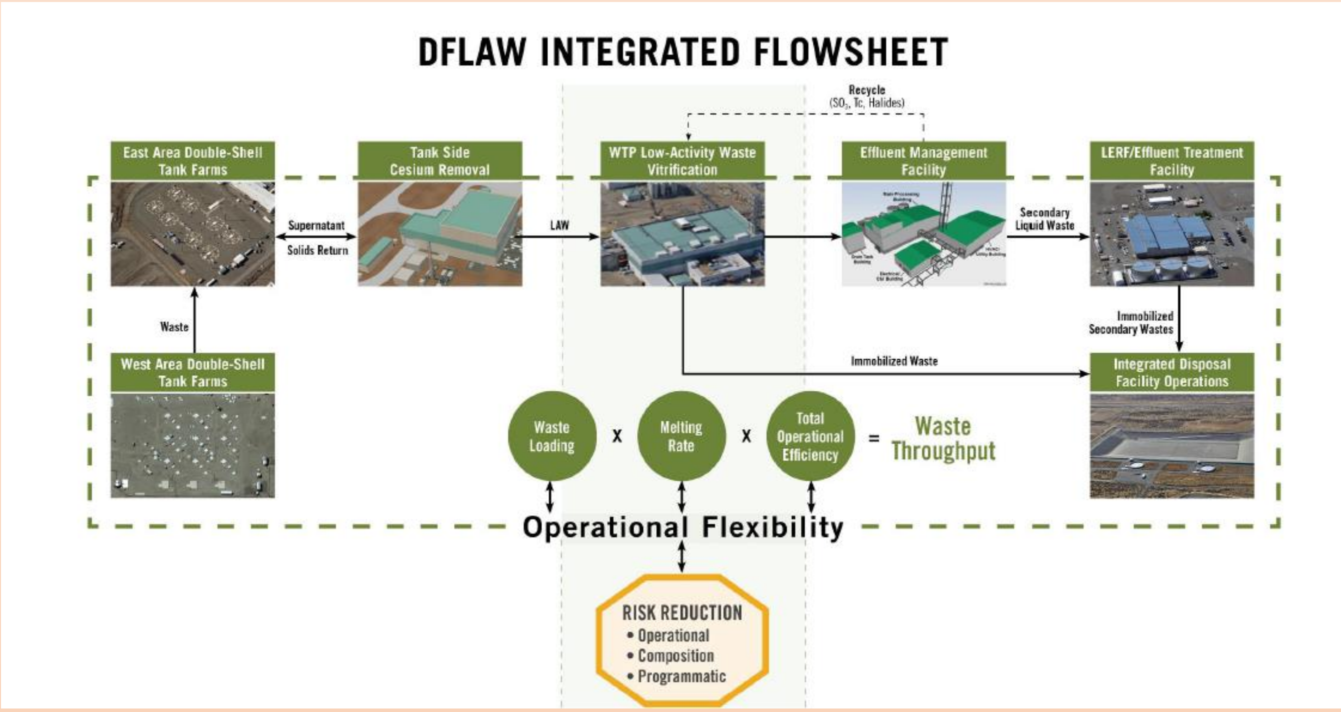
- One of the most (if not the most) technologically complicated efforts in the DOE complex (retrieval, pretreatment, immobilization)



Overview of Waste Treatment Plant, Hanford Site (continue)

Integration of Unit Operations

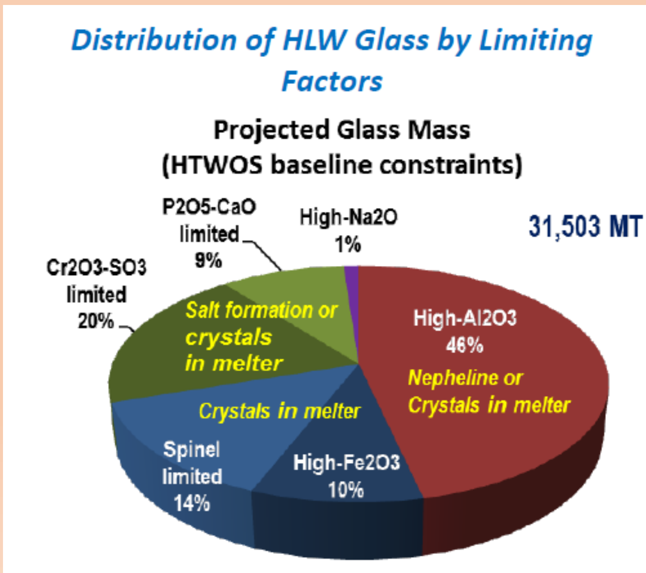
- Integration of unit operation is key factor to increase waste throughput and operational flexibility



Pretreatment

- Troublesome components have limited solubility in borosilicate glasses.

- "Solution" -> Balanced Approach
  - Pretreatment
    - Caustic dissolution (Al)
    - Oxidative leaching (Cr)
    - Sludge mass reduction for HLW
- Enhanced glasses
  - Increase solubility limits for troublesome components
    - Al_2O_3: 16 wt% -> 25 wt%
    - Cr_2O_3: 0.5 wt% -> 1.5 wt%



Kim DS, et al. 2011. *Formulation and Characterization of Waste Glasses with Varying Processing Temperature*. PNNL-20774, Pacific Northwest National Laboratory, Richland, WA.

Overview of Waste Treatment Plant, Hanford Site (continue)

Vitrification

- Glass formulation efforts must balance key processing and product performance-related constraints.
- Process control models that related composition to properties

Table 2. Summary of LAW Glass and Melt Constraints Used in ILAW Algorithm[a]

Constraint Description	Constraint	Source
Product consistency test (PCT) normalized releases of Na, B, and Si	< 2 (g/m^2) (for Na, B, and Si)	DOE 2000 (Spec. 2.2.2.17.2)
Vapor hydration test (VHT) 200°C alteration rate	< 50 ($g/m^2/d$)	DOE 2000 (Spec. 2.2.2.17.3)
Viscosity at 1100°C	≤ 150 (P)[b]	24590-LAW-3PS-AE00-T00001, Rev. 4
Viscosity at 1150°C	≥ 20 (P)	24590-HLW-RPT-RT-05-001, Rev. 0[c]
Viscosity at 1150°C	≤ 80 (P)	24590-HLW-RPT-RT-05-001, Rev. 0[c]
Electrical conductivity at 1100°C	≥ 0.1 (S/cm)	24590-LAW-3PS-AE00-T00001, Rev. 4
Electrical conductivity at 1200°C	≤ 0.7 (S/cm)	24590-LAW-3PS-AE00-T00001, Rev. 4
Waste loading (wt% waste Na_2O in glass)	> 14, 3, and 10 (wt%) for envelopes A, B, and C LAW, respectively	DOE 2000 (Spec. 2.2.2.2)
Waste classification	< Class C limits as defined in 10CFR61.55	DOE 2000 (Spec. 2.2.2.8)
^{90}Sr activity per unit volume of glass	< 20 (Ci/m^3)	DOE 2000 (Spec. 2.2.2.8)
^{137}Cs activity per unit volume of glass (waste form compliance)	< 3 (Ci/m^3)	DOE 2000 (Spec. 2.2.2.8)
^{137}Cs activity per unit volume of glass (system maintenance)	< 0.3 (Ci/m^3)	DOE 2000 [Section C.7 (d) (1) (iii)]
Canister surface dose rate	≤ 500 mrem/h	DOE 2000 (Spec. 2.2.2.9)

From 24590-LAW-RPT-RT-04-0003, Rev 1

Algorithm

- Need for "real-time" formulation
  - Waste feed compositions change from batch-to-batch
  - Frequency of different compositional feed vectors requires changes to GFC additions to provide operational flexibility
- Production schedule is very aggressive
- There is no lag storage –glass formulations need to be adjusted and determined **within *minutes***