Hanford Medium/Low Curie Waste Pretreatment Alternative Project (Fractional Crystallization) RL041101

DW Hamilton

CH2M HILL

Environmental Management

safety ❖ performance ❖ cleanup ❖ closure

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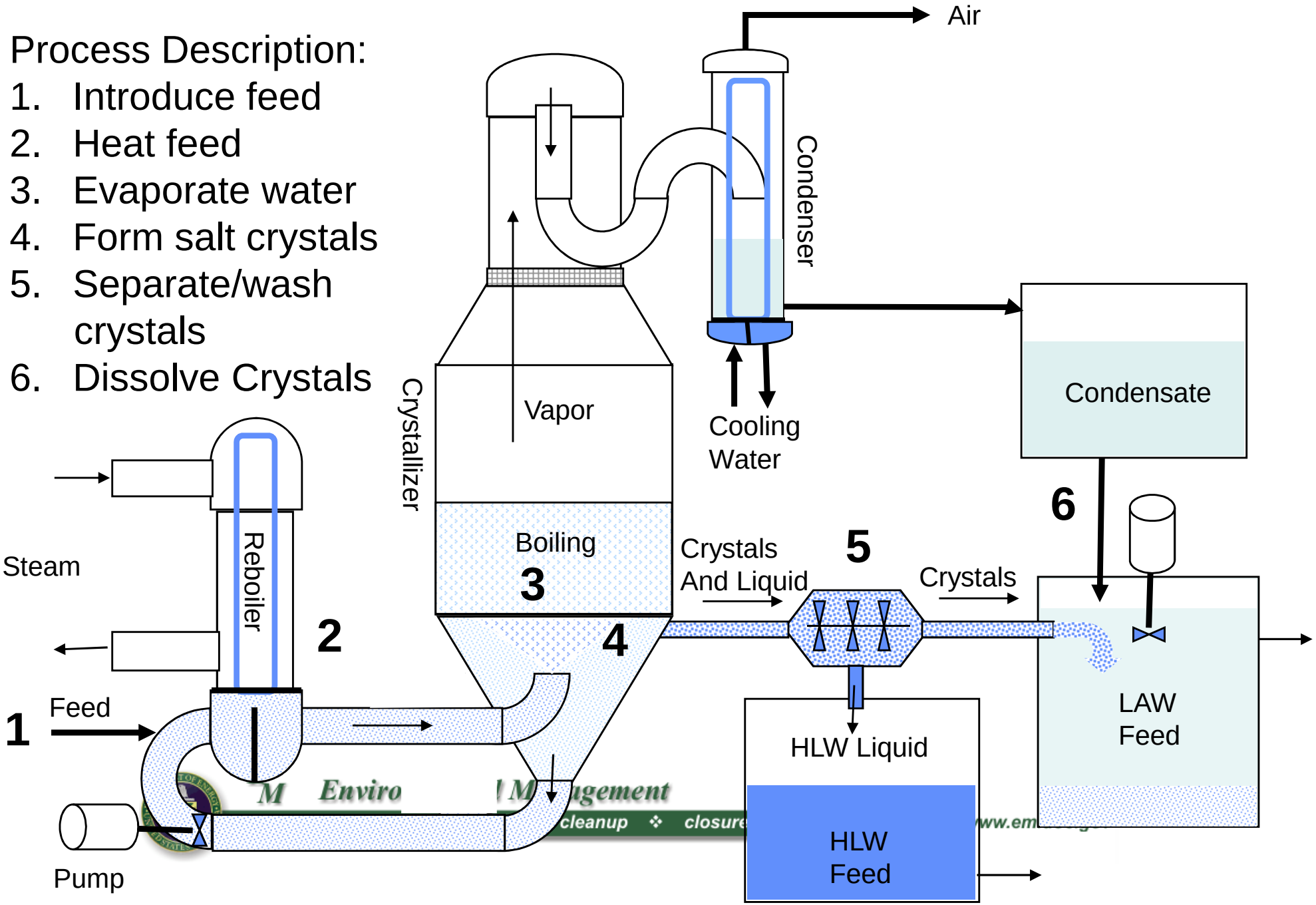
Fractional Crystallization Project Description

- **Technology need**
  - Medium/Low Curie Waste Pretreatment Alternative Project investigates the feasibility of using Fractional Crystallization (FC) to perform pretreatment of Hanford tank waste.
- **Requirements**
  - Achieve a single stage Cesium decontamination factor of > 50
  - Achieve a sodium yield (LAW Product/Feed) of > 50%
- **Relate to High-Impact Risk / Cost Issue**
  - Potential for early processing of Hanford tank waste at WTP or Supplemental Treatment

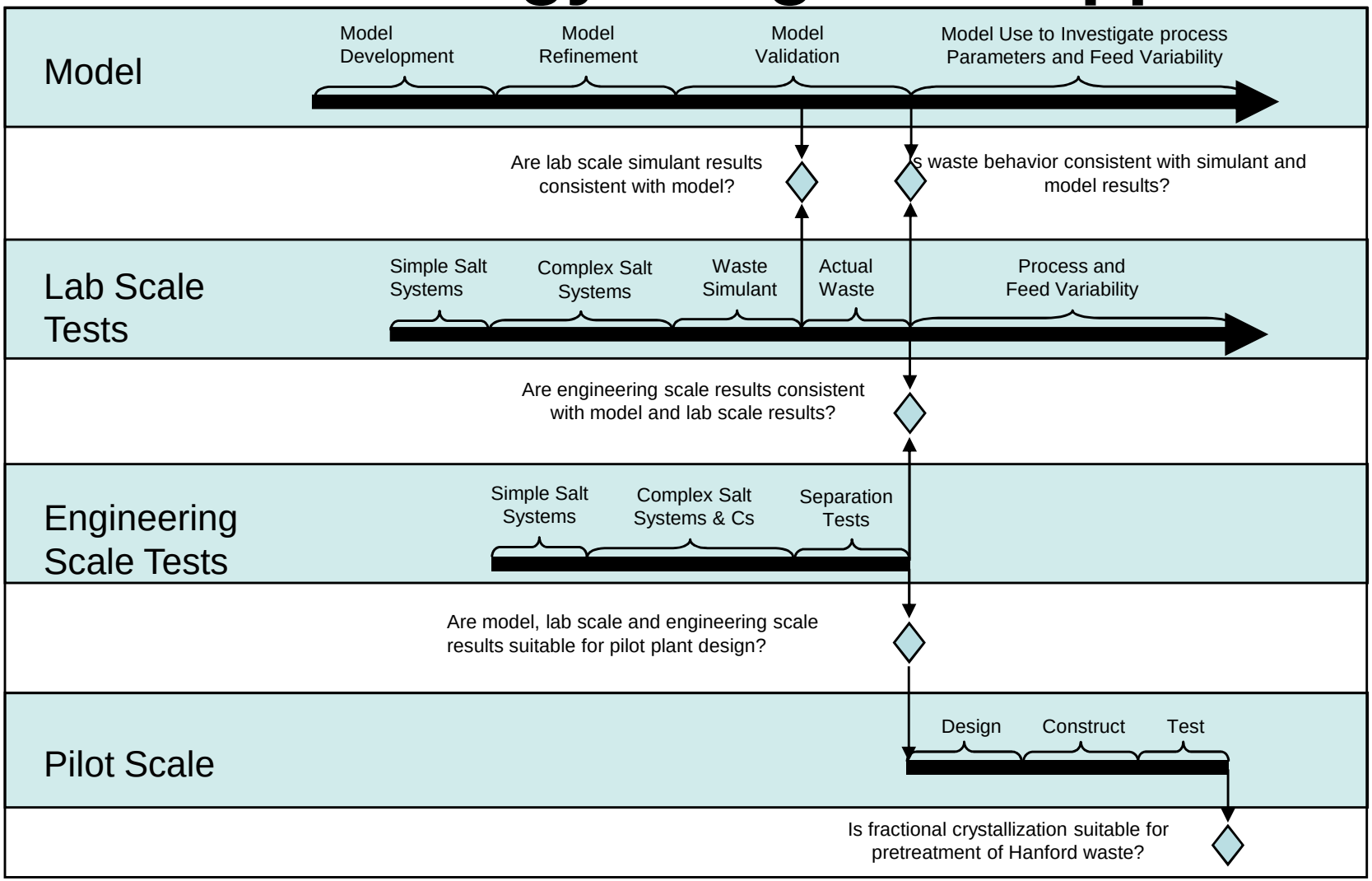
Fractional Crystallization Process

Process Description:

1. Introduce feed
2. Heat feed
3. Evaporate water
4. Form salt crystals
5. Separate/wash crystals
6. Dissolve Crystals



Fractional Crystallization
Technical Strategy/Integrated Approach



Fractional Crystallization Technical Strategy/Approach

- **Thermodynamic modeling using a commercial model, ESP by OLI.**
  - Understand the FC as it applies to Hanford waste
  - Predict the process performance using a variety of waste compositions
  - Plan experiments and develop process flowsheets,
  - Define lab, engineering, and pilot scale test parameters.

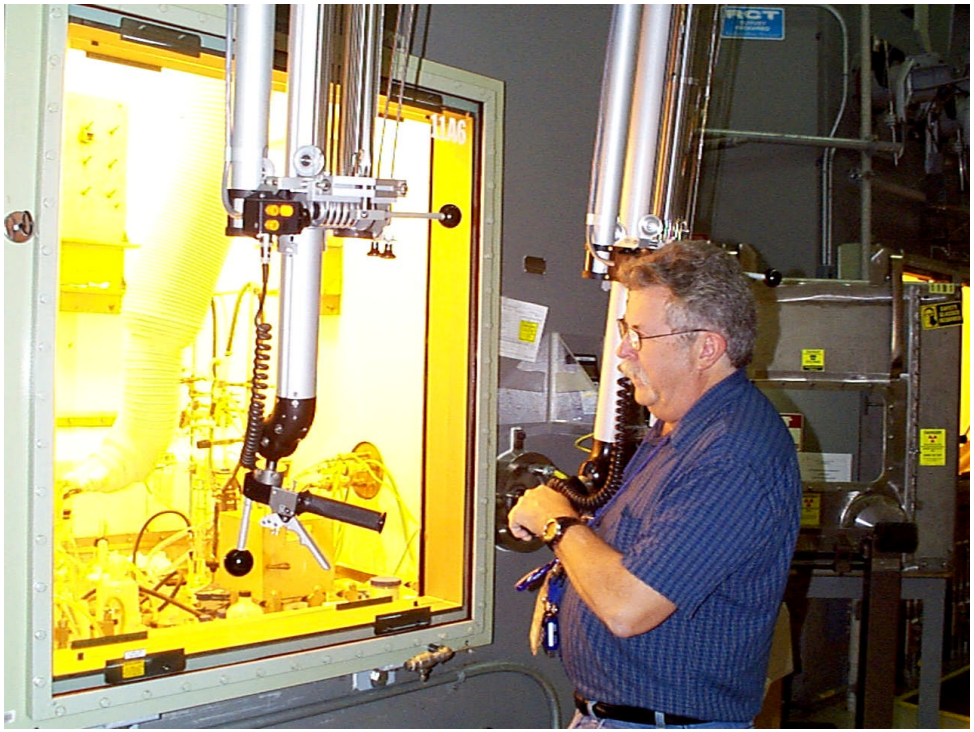
Fractional Crystallization: Lab-Scale with Simulant

- Two independent labs performed in excess of 100 tests with simulant to:
  - Validate the computer model performance predictions.
  - Investigate ease of control and robustness
  - Investigate the effects of feed variability

Georgia Tech and 222-S System

Fractional Crystallization: Lab-Scale with Tank Waste

- August 2006, laboratory-scale tests were conducted with actual tank waste samples in a hot cell at the 222-S Laboratory.
- The test were performed to:
  - Verify that actual waste behaves like simulant
  - Verify that the computer model predicts system performance with real waste at lab scale
  - Determine the effect of minor waste components such as, organics and solids on the fractional crystallization process
  - Determine the extent to which Cs and other radioactive waste components are incorporated into the product by co-precipitation and inclusions



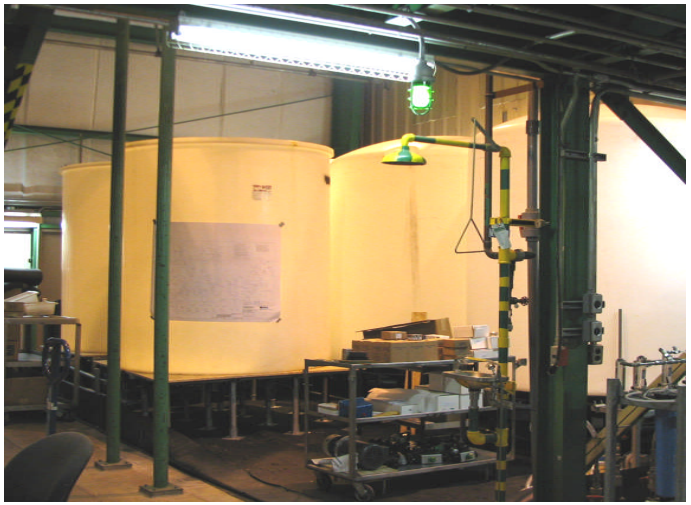
Fractional Crystallization Technical Strategy/Approach

- **Engineering Scale tests performed with simulants**.
  - Investigate continuous mode operation with Hanford simulant.
  - Define pilot scale design parameters.
  - Further investigate the effects of residence time and evaporation rate on product crystals.

Fractional Crystallization Technical Strategy/Approach

- **Pilot Scale tests performed with simulants.**
  - Use equipment that is prototypic of the equipment that would be used in a full scale production plant
  - Allow testing to be performed under continuous operation conditions, rather than batch or semi-batch operation
  - Testing to investigate potential impacts of process upsets and off-normal operation
  - Define parameters necessary for conceptual design of the Hanford SPF.

Fractional Crystallization Pilot Plant



Feed tanks inside the pilot plant: there are five tanks holding a total of 10,000 gal of feed.

The crystallizer holds 1,000 gal (including the recirculation loop and reboiler), and it circulates at a rate of 600 gal/min.

Fractional Crystallization Pilot Plant Centrifuge

Fractional Crystallization Technical Results

- The computer model predicted that the Fractional Crystallization process could meet project goals
- The process performed at all scales as predicted by the computer model.
- The actual tank waste samples behaved the same as the simulated waste samples tested previously
- Evaporation rate and residence time were consistent with construction of a reasonably sized pilot scale system
- The product salt yield and Cs decontamination exceeded all separation criteria
- Results were reproducible despite variations in process parameters and equipment configurations

Fractional Crystallization Technical Results

Results	Goal	Computer Model Prediction	Lab Scale Simulant Tests	Lab Scale Actual Waste	Engineering Scale Simulant Tests	Pilot Plant Tests
Cs DF	50 (2000)	110 - 270	> 150	>150 (13000)	167	100 - 200
Sodium in LAW	50%	70% - 80%	80%	80%	N/A	52% (70%)
Sulfur in LAW	None	N/A	N/A	N/A	N/A	80% reduction

Fractional Crystallization Status

- Benchmark Testing Complete
- Baseline Testing Complete
- Pilot Plant is idle in dry lay-up
- Simulant is in storage at SRNL
- Final Report to be issued in August 2008
- Additional testing dependant on Hanford Interim Pretreatment System Project Plans

Project Impact

- Fractional Crystallization has been determined to be a viable technology for pretreatment of Hanford tank waste.
- Technology selection is sensitive to specific mission application (salt cake SST's vs DST Liquids)
- Fractional Crystallization has been selected as a backup technology to Ion Exchange, the primary technology selected by the Hanford Interim Pretreatment System.