The DOE Office of Environmental Management International Cooperative Program:

Current Status and Plans for Expansion

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Office of Environmental Management

U.S. Department of Energy

and

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Office of Waste Processing Technical Exchange

Denver, CO

Introduction

- **History: >15 year program of International cooperation – Primarily in Russia/Ukraine**
- **Purpose**
  - Study waste management challenges of mutual concern
  - Continue international cooperation that has produced tangible results in the cleanup efforts
- **Current projects**
  - Focus on high-level waste and EM site cleanup needs
- **Strategy**
  - Focus cooperation on EM's accelerated closure mission
    - Align with EM Technology Roadmap and Multi-year Program Plan
  - Leverage International expertise and experience
  - Continue highly-beneficial relationships with leading international scientists

Current Projects

- Maximizing Waste Loading For Application to Savannah River High Level Waste (SIA Radon Institute and SRNL)
- Improved Aluminum Loading in HLW Glass (Khlopin Radium Institute, PNNL and SRNL)
- Environmental Remediation and Ecological Studies in the Chernobyl Exclusion Zone (International Radioecology Laboratory and SRNL)
- Cold Crucible Induction Melter Modeling and Control (St. Petersburg ETU and INL)
- Cold Crucible Induction Melter Demonstration for High Aluminum-content Waste (NETEC and SRNL)

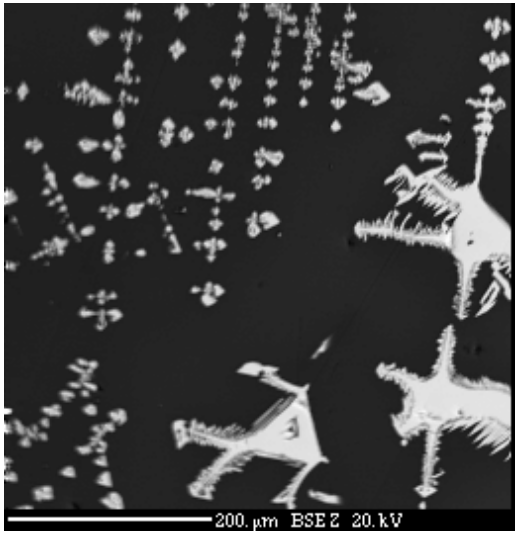
Maximizing Waste Loading For Application to Savannah River High Level Waste – Project Objectives/Past Accomplishments

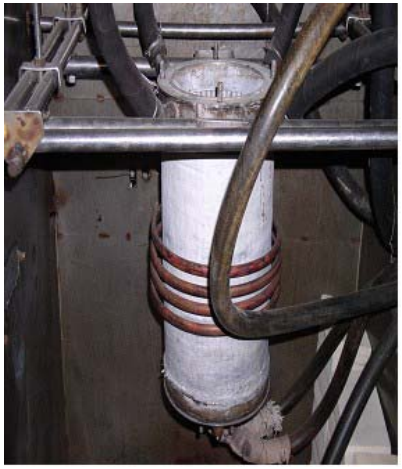
- Background: The Defense Waste Processing Facility (DWPF) at SRS has produced over 8 millions pounds of glass
- Waste loading has improved to the current level of ~38 wt%
- 38 wt % appears to be a limit for the DWPF Joule-heated melter
  - As waste loading is increased beyond 38 wt% the overall throughput is reduced
- SIA Radon and SRNL have worked collaboratively to determine waste loading advances that may be achieved using the Cold Crucible Induction Melter (CCIM) Technology (FY05-FY08)
  - Demonstrated dramatic increase in waste loading for range of DWPF feeds (high iron content and high aluminum content)

Maximizing Waste Loading For Application to Savannah River High Level Waste – Current Efforts

- FY09 testing is focusing on determining CCIM process limits
  - Maximum achievable waste loading
  - Crystallization within the melter and crystal settling
  - Melt homogeneity
- SIA Radon 216 mm CCIM test bed being utilized for studies

Crystals in a high waste loading glass





SIA Radon 216 mm CCIM

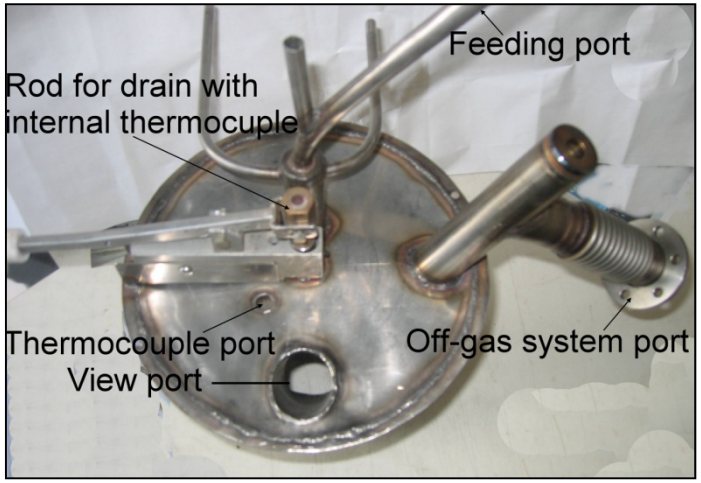
Melt pour from CCIM

Improved Aluminum Loading in HLW Glass – Project Objectives/Past Accomplishments

- SRNL and PNNL are partnering with the V.G. Khlopin Radium Institute (KRI) to study HLW glasses incorporating greater concentrations of aluminum
  - Several DOE wastes are high in aluminum, which can make glass processing difficult
  - Better understanding of how aluminum can be incorporated into waste glass will speed cleanup missions
- Efforts completed to date:
  - Matrix tests to develop a database and models to formulate glasses for high aluminum concentration waste streams (FY06 - FY08)
  - Melter tests for SRS glasses representing a projected Sludge Batch 5 composition with and without the implementation of Al-dissolution process (FY07 – FY08)
  - Scale-up melter tests for Hanford wastes with a selected glass containing 26 wt % Al_2O_3 (FY07 - FY08)

Improved Aluminum Loading in HLW Glass – Current Efforts

- At start of FY09, upgrades performed on KRI laboratory-scale melters
  - Added digital data acquisition systems
  - Design changes for improved heating, temperature measurement and visual observation of the melt
- Preliminary results of FY09 testing with SRS feeds show good ability to determine impact of frit composition on melt rate
  - Results match trends identified with SRNL lab-scale melters



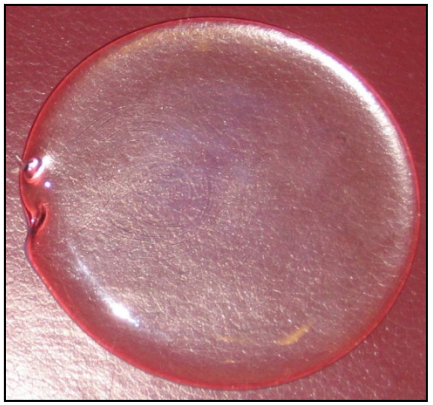
Upgraded top-head components for the SMK melter

Operation of the EP-5 joule heated melter

Improved Aluminum Loading in HLW Glass – Current Efforts

- Melt rate testing in support of SRS
  - Focus on developing an improved understanding of the impacts of B_2O_3 and alkali concentrations in the frit on melt rate for high aluminum wastes
  - Use simulated feeds representing high aluminum wastes

- For Hanford, a glass with 26 wt % Al_2O_3 processed at roughly 50% of the design specific rate of the WTP melter
  - PNNL is investigating the impacts of glass and melter feed chemistry to improve this production rate
  - KRI will test the resulting formulations to help further develop the method
  - Testing will be performed in KRI's EP-5 melter to allow for direct comparison with previous results



Glass frits developed for vitrification of SRS high aluminum wastes

International Radioecology Laboratory (Chernobyl) - Project Objectives

- Assess the long-term impacts to the environment from radiation exposure within the Chernobyl Exclusion Zone (ChEZ)
- Provide information on remediation guidelines and ecological risk assessment
- Evaluate the areas of potential application of monitoring methods, modeling techniques, and cleanup technologies used in the ChEZ that may apply to radioactively contaminated DOE sites

IRL staff member measuring Cs-137 and Sr-90 concentrations in birds

International Radioecology Laboratory (Chernobyl) - Past Accomplishments

- Nine subtask reports were completed and submitted to SRNL for review and approval
- SRNL and IRL are preparing a summary report of the first 9 subtasks that will be submitted as a scientific Note to the Health Physics Journal

IRL staff members performing a gamma-ray survey at the ChNPP Cooling Pond Dam

International Radioecology Laboratory (Chernobyl) - Current Efforts

- The nine remaining subtasks will be completed by 9/30/2009
- Monthly telephone conferences between SRNL and IRL
- A series of tech notes will be submitted to a radioecology journal to summarize the work.
- Journal Articles:
  - A summary report is planned for the 9 remaining subtasks that will be submitted as a scientific note
  - IRL is developing a journal article draft based on one of the subtask reports

International Radioecology Laboratory (Chernobyl) - Current Efforts

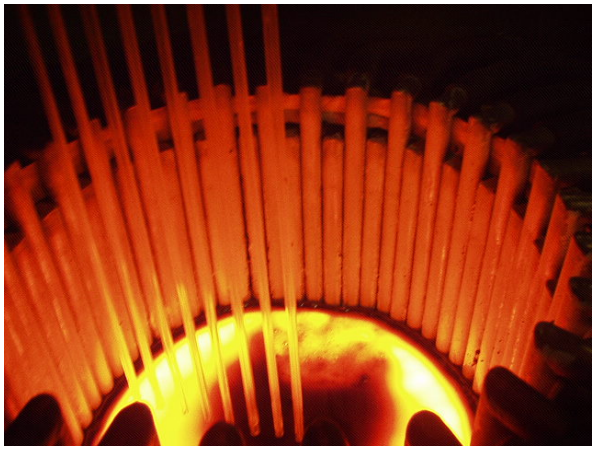
- A presentation summarizing this project is planned for the Annual Meeting of the Health Physics Society in Atlanta, Georgia, July 12-16, 2009
- SRNL and IRL are currently developing new research ideas for future collaboration:
  - Uranium migration
  - plutonium migration
  - Cooling pond
  - Remediation of abandoned areas

IRL staff member using a Germanium gamma-ray detector

IRL staff member and student analyzing soil samples

Cold Crucible Induction Melter Modeling and Control – Project Objectives/Past Accomplishments

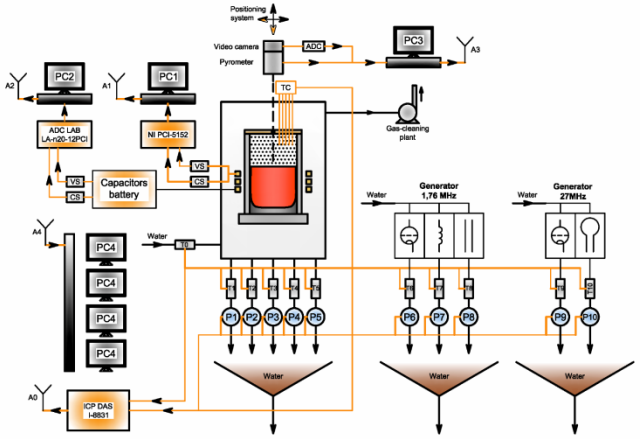
- INL is collaborating with the St. Petersburg Electrotechnical University (ETU) and the V.G. Khlopin Radium Institute (KRI) to investigate key operational parameters of the cold crucible induction melter (CCIM) technology
  - Automated control
  - Modeling for design and optimization
  - Innovative draining technology

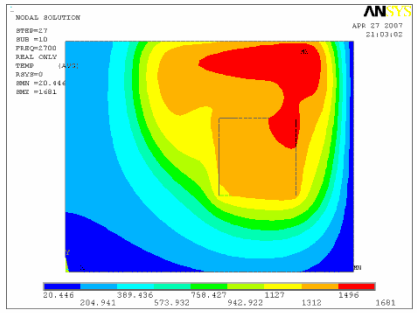


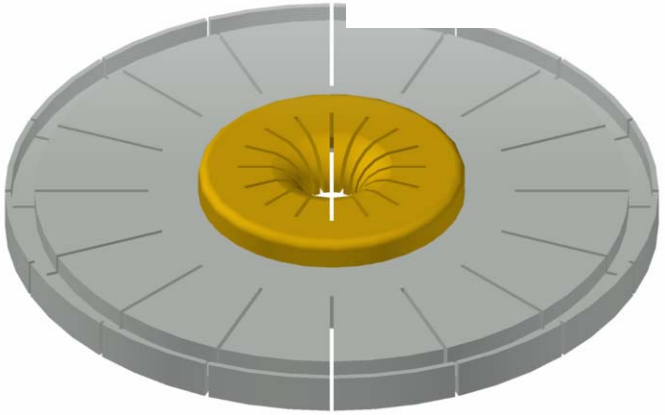
- Efforts completed to date:
  - Developed and validated a comprehensive model of a CCIM. Enhancing to include start-up process.
  - Designed, tested, and validated a drain device. Improving design to make more efficient.
  - Developed sensors and data acquisition algorithm to reliably measure and correlate power factor to operational temperature

Cold Crucible Induction Melter Modeling and Control – Past Accomplishments

- Automated Control
  - Improved data acquisition system
  - Data acquisition algorithm improved
- Modeling
  - Improved steady-state model performance
  - Enhancing model to include start-up process
- Drain Device
  - Drain design improved for better operation
  - Simpler and more flexible
  - Focus on pressure assisted stop

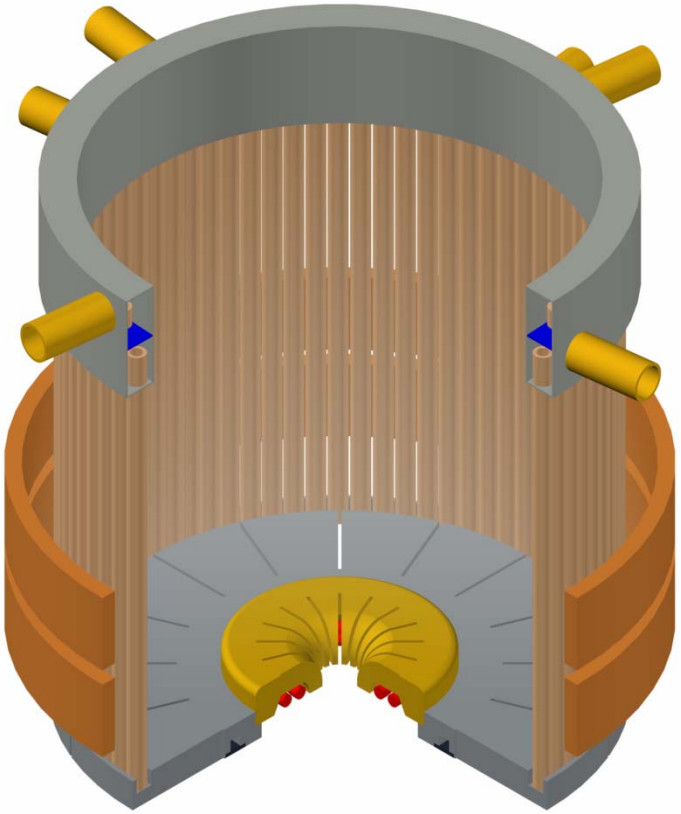






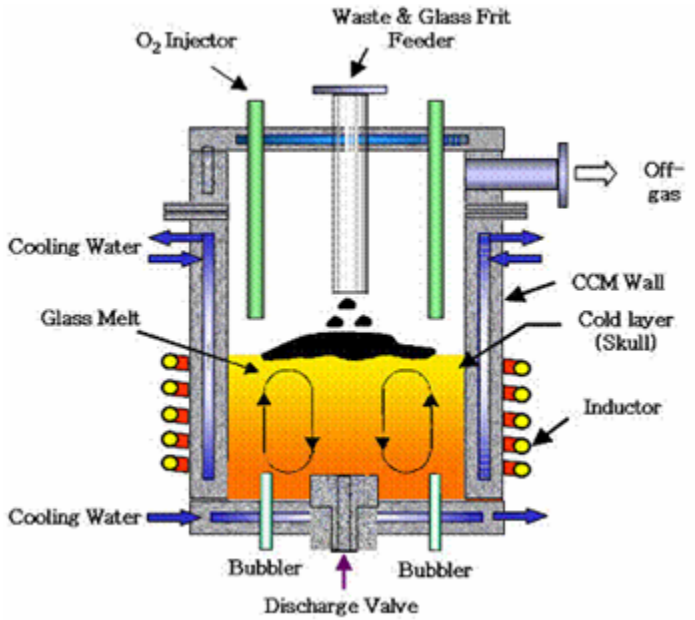
Cold Crucible Induction Melter Modeling and Control – Current Efforts

- Upgrade the calorimetry system for improved accuracy in power factor determination
  - Higher accuracy flowmeters
  - Temperature profile measurement with high temperature thermocouple
- Enhance the model to include the start-up process
  - Conduct sensitivity analysis of model parameters
  - Conduct experiments for comparison with model results
  - Use model to investigate scale-up
- Improve the drain design and test operation
  - Integrated design with crucible bottom
  - Evaluate effects of coil configuration (support with modeling)



Cold Crucible Induction Melter Demonstration for High Aluminum-content Waste - Project Objectives/Past Accomplishments

- Collaborative effort between NETEC and SRNL
- Objective: Demonstrate CCIM technology on DWPF slurry feed simulant to evaluate its ability to increase DWPF waste throughput
- Accomplishments:
  - Proved ability to process simulated DWPF slurry feed at increased waste loading
  - Demonstrated dramatic increases in melting rate (glass throughput)



Schematic of NETEC CCIM

Melt surface in CCIM at varying feeding rates

Near-term Plans for EM International Program

- Continued collaborative research with current partners
  - DOE-EM is pleased with the current progress and results
- Statement of Intent (SOI) signed between DOE-EM and the U.K. Nuclear Decommissioning Authority (NDA)
  - Information and technical exchanges are underway
    - Technology Readiness Assessments
    - Technology maturation plans
    - Glass formulation and vitrification technology
    - Nuclear materials and facility life management
  - Future collaborative technology development activities may be identified based on information exchanges

Longer-range Plans for EM International Program

- Interfacing with other DOE offices
  - e.g. DOE-NE on Advanced Fuel Cycle Initiative efforts
- Interfacing with other U.S. agencies
  - e.g. Department of State's Joint Standing Committee on Nuclear Energy Cooperation
- International agencies
  - e.g. IAEA
- International agreements
  - Similar to SOI with the U.K.