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Innovations

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Impact

- During its expanded 10-year period of operation, the interim salt waste processing system at SRS removed nearly all of the radioactive isotopes from ~6.8 Mgal of salt waste.
- The improved cesium removal system will increase the processing rate of SWPF from 7 million gallons per year to 8 million gallons per year (14% increase in throughput).
- The effort will result in early completion of the tank waste cleanup mission at SRS, with a cost savings of $600M-$1.8B.
- The successful collaborative effort demonstrated the synergy between scientific research and technology development.

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Optimizing Cesium Removal from Salt Waste at SRS

Summary

Delays to the expected start-up date of the Salt Waste Processing Facility (SWPF) at the Savannah River Site (SRS) threatened to extend the overall tank waste clean-up program at SRS several years, with a cost of more than $500 million per year. The Department of Energy (DOE) avoided the consequences of the SWPF delay through a concerted effort to improve the baseline cesium removal technology.

SRS Salt Waste

Of the approximately 36 million remaining gallons of radioactive waste from the Cold War production of nuclear weapons materials at SRS , over 90% by volume is "salt," consisting of liquid and soluble solids containing 49% of the radioactivity, mostly short-lived cesium (Cs-137) and low levels of actinides and strontium (Sr-90).

Background

Construction began in 2004 on SWPF, which is designed to remove most of the radioactivity from the salt waste, sending the highly radioactive elements to the Defense Waste Processing Facility (DWPF) to be stabilized in glass ("vitrified") and the remaining low-activity liquid waste to the Saltstone Facility for disposal in grout.

An interim, pilot-scale salt waste processing system was constructed at SRS and initially permitted in 2008 to operate for three years to treat a small inventory of low-activity waste at limited throughput. Using the same processes that the full-scale SWPF would use, the interim system had two goals: begin treatment of salt waste at SRS, and provide operational experience and lessons learned for SWPF.

Using an extractant called BOBCalixC6 formulated by scientists at Oak Ridge National Laboratory (ORNL), the interim salt waste processing system successfully removed cesium from approximately 2 million gallons of salt solution from its start in April 2008 until the end of August 2011.

Collaborative Approach

When construction and startup of SWPF were significantly delayed, the DOE Offices of Environmental Management and Science facilitated a collaborative effort among researchers in SRNL and other National Laboratories to make the cesium removal system more efficient to minimize consequences to the tank waste cleanup program at SRS.

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SRNL worked with the many partners in the effort–National Laboratories, contractors, suppliers, government agencies, and others–to establish process, regulatory, and schedule parameters and to facilitate concurrent research and testing to ensure that the new technology would be ready for use expeditiously.

Contributions from the Science program included work at ORNL on fundamental chemistry of calixarenes for cesium extraction; optimized chemistry and design of solvent system for cesium extraction in tank waste chemistry; and chemical and radiation stability of solvent system.

The collaborative effort identified several improvements to the cesium removal process, including a more vitrification-friendly alternate strip acid, and ORNL identified a more soluble extractant called MaxCalix. ORNL and SRNL performed numerous scale-up tests to evaluate and develop the performance of the new cesium removal system.

Deployment

Deployed in the interim system in 2013, the next-generation cesium removal system using MaxCalix raised the decontamination factor substantially (from about 200 to more than 40,000) and the processing rate from 1 Mgal per year to approximately 1.4 Mgal per year, allowing the continued use of the interim process to treat higher-activity waste solutions.

SWPF is scheduled to begin radiological operations in late 2018. SWPF is designed to use the baseline technology, including the BOBCalixC6 cesium extractant, for salt waste treatment. However, integrated testing of the new extractant and alternate strip acid in the SWPF full-scale testing program have demonstrated the efficacy of early deployment of the next-generation cesium removal system.

Return on Investment

For a total technology development investment of approximately $10M, the return is a lifecycle savings of $600M-$1.8B from early SWPF completion, tank farm closure, and shutdown of the Defense Waste Processing Facility.

Partners in Success

National Laboratories
Savannah River National Laboratory (EM)
Oak Ridge National Laboratory (SC)
Argonne National Laboratory (SC)
Pacific Northwest National Laboratory (SC)
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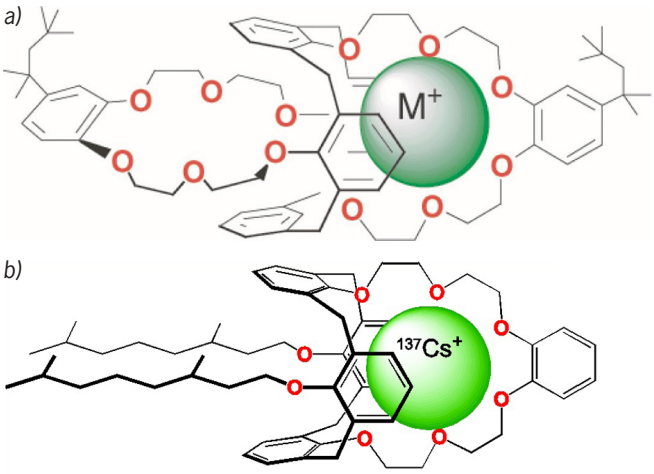

a) First Generation Cesium Extractant BobCalixC6 formulated by ORNL.
b) Leveraged additional basic research for a more soluble extractant called MaxCalix.
c) Full-scale centrifugal contactor testing

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