ANL/CFCT-C2017-17170

Argonne NATIONAL LABORATORY

Synthesis of Molten Chloride Salt Fast Reactor Fuel Salt from Spent Nuclear Fuel

Final CRADA Report

Chemical and Fuel Cycle Technologies Division

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prepared by
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Participants: Elysium Industries USA, Inc.

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Non Proprietary

Final CRADA Report

For the Office of Scientific and Technical Information (OSTI)

CRADA Number: 2017-17170
CRADA Title: Synthesis of Molten Chloride Salt Fast Reactor Fuel Salt from Spent Nuclear Fuel.
CRADA Start Date 2/22/2018 – **End Date** 2/22/2019

DOE Program or Other Government Support
Program office: Department of Energy, Office of Nuclear Energy, Gateway to Accelerated Innovation in Nuclear
Program manager name: Dr. John H. Jackson
Program manager phone or email: john.jackson@inl.gov

Participant(s)

Participant 1 name: Ed Pheil, Elysium Industries USA, Inc.
Complete address: 12 Droms Road, Rexford, NY, USA 12148-1401

Participant 2 name: Click or tap here to enter text.
Complete address: Click or tap here to enter text.

Participant 3 name: Click or tap here to enter text.
Complete address: Click or tap here to enter text.

Argonne National Laboratory

Argonne PI(s): Mark A. Williamson and James Willit

Funding Table

To add rows, right-click in bottom row and select “Insert” “rows above”.

	Planned Funding	Actual Funding	In-Kind
Government - Argonne	$23,000	$23,000	
Elysium Industries USA, Inc.	$4,600	$4,600	$
Enter Participant 2 here	$	$	$
Enter Participant 3 here	$	$	$
Total	**$27,600**	**$27,600**	**$**

Nature of Work

Describe the research (summary of Scope of Work and principal objectives of the CRADA):

Elysium Industries USA, Inc. aims to produce safe, cost effective, carbon conscious energy through the development of an advanced liquid-fueled reactor technology. The Elysium liquid-fueled reactor concept comprises a molten chloride salt fueled fast spectrum nuclear reactor, which can accept fissle material recovered from used nuclear fuel and excess fissile material from defense applications. A key technology development need for the system is demonstrating the feasibility of a low cost, efficent method to produce the chloride fuel salt from used nuclear fuel. This approach not only provides a pathway for the disposition of used nuclear but more efficient use of uranium resources for energy production.

Argonne National Laboratory provided technical consulation on the synthesis and characterization of molten chloride fuel salt for the Elysium Industries USA, Inc. molten salt fast reactor. Argonne’s consulation work spanned the fields of molten salt chemistry and process engineering.

DOE mission area(s):
Energy and Environmental Science and Technology
Choose an item.
Choose an item.

Conclusions drawn from this CRADA; include any major accomplishments:
Argonne's thermodynamic assessment of the chemistry used to synthesize chloride salt from oxide feed material confirmed the efficacy of the conversion method. Our analyses show UO_2 (a surrogate for used fuel in the analyses) can be efficiently chlorinated to form UCl_3 in molten $NaCl - KCl$ by using Na_2ZrCl_6 or K_2ZrCl_6 as the primary chlorinating agent for converting UO_2 to UCl_3 instead of $ZrCl_4$. The analysis identified several key factors that will probably enhance the conversion efficiency: (1) For maximum efficiency, both UO_2 and Zr must be present in the salt before K_2ZrCl_6 is added because K_2ZrCl_6 will otherwise partially decompose to generate KCl and $ZrCl_4(g)$. The K_2ZrCl_6 can be added as a separate reagent or formed in situ by adding chlorine gas to the molten salt with *Zr* present. (2) The chlorination agent should be added to the molten chloride incrementally at a rate commensurate with the UO_2 chlorination rate. Real-time measurement of the UCl_3 concentration could be used to control the timing and size of the incremental additions. (3) A slight stoichiometric excess of UO_2 and Zr should remain in the molten salt until the target equilibrium UCl_3 concentration is reached to minimize the amount of chlorinating species in the final molten salt solution.

Technology Transfer-Intellectual Property
Argonne National Laboratory background IP:
None.

Participant(s) background IP:
None.

Identify any new Subject Inventions as a result of this CRADA:
None.

Summary of technology transfer benefits to industry and, if applicable, path forward/anticipated next steps towards commercialization:
Argonne's technical consultation concerning molten chloride fuel salt synthesis yielded a fundamental understanding of the fuel salt synthesis process and supported ongoing molten salt reactor design activities.

Other information/results (papers, inventions, software, etc.):
None.

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