Process Intensification Scale-Up of Direct LiT Electrolysis

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Team members and roles

Savannah River National Laboratory™
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

CLEMSON UNIVERSITY
SOUTH CAROLINA
1889

- Brenda Garcia-Diaz
  - Project PI, Cell Design
- Prabhu Ganesan & Hector Colon-Mercado
  - Electrochemical Characterization
- Bruce Hardy & Anna d'Entremont
  - Modeling
- Dale Hitchcock
  - Cell Characterization
- Kyle Brinkman
  - Ceramic/Electrolyte Manufacturing
- Chris Dandeneau
  - Electrolyte Synthesis & Characterization
- Tech-to-Market Partners

High-level motivation, innovation, and goals of the project (how will your project better enable commercially viable fusion energy?)

Improving Tritium Extraction

- Tritium extraction technologies are important to maintain low tritium concentrations in the loop for the blanket material and recover as much tritium as possible
- Tritium extraction technologies are at a low TRL level (Kessel et al. 2019)
- Some extraction methods such as the Maroni process have the potential to introduce impurities into the loop

Innovation

- SRNL has developed a Direct LiT Electrolysis process that electrochemically oxidizes tritium from the blanket material within the blanket buffer tank
- Does not require additional vessels and reduces unit operations compared with other extraction methods
- Utilizes solid LLZO electrolytes that are stable during exposure to liquid metals

Goal

- Improve electrolyte and electrode manufacturing processes to scale-up electrode fabrication as well as demonstrate and model a scaled-up cell

Major tasks, milestones, risks, and desired project outcomes (include aspirational quantitative metrics to be achieved)

- M2.1 – Demonstrate electrolysis energy efficiency greater than 41 kJ/g of tritium for 1 tonne / hr processing rate
- M2.2 – TEA showing 50% reduction in capital cost compared with Maroni process
- M3.1 – Demonstrate scaled-up electrolyte synthesis in 10 g batches and stability of the electrolyte exposed to Pb-Li
- M3.2 – Synthesis of an electrode greater than 2” with 90% cubic LLZO phase
- M3.3 – Demonstrate 100 hr electrode durability with cubic phase > 75%
- M4.3 – Operate a cell that can electrolyze LiD at a rate to purify 1 kg/ hr of Pb-Li blanket material with less than 20% degradation at 200 hours
- M5.1 – Model and Validate results to demonstrate that predicted energy efficiency is being achieved within 20%.

T2M and aspirational follow-on plans

- Identify relevant techno-economic metrics
  - Develop durability greater than a standard maintenance cycle (e.g. half a year)
  - Success in process intensification of the Direct LiT Electrolysis process has the ability to lower capital cost (>50% reduction) for tritium extraction and eliminate additional unit operations
  - Develop electrode synthesis commercialization partners
- Test & deployment plans/aspirations
  - Enables all fusion concepts utilizing a Pb-Li or Li blanket material
  - Demonstration at the 1 kg/hr rate scale will enable scaling through the use of multiple electrodes
  - Talking with commercial partners on electrolyte synthesis in conjunction with Clemson University