Molten Salt Thermophysical Properties and Test Facility

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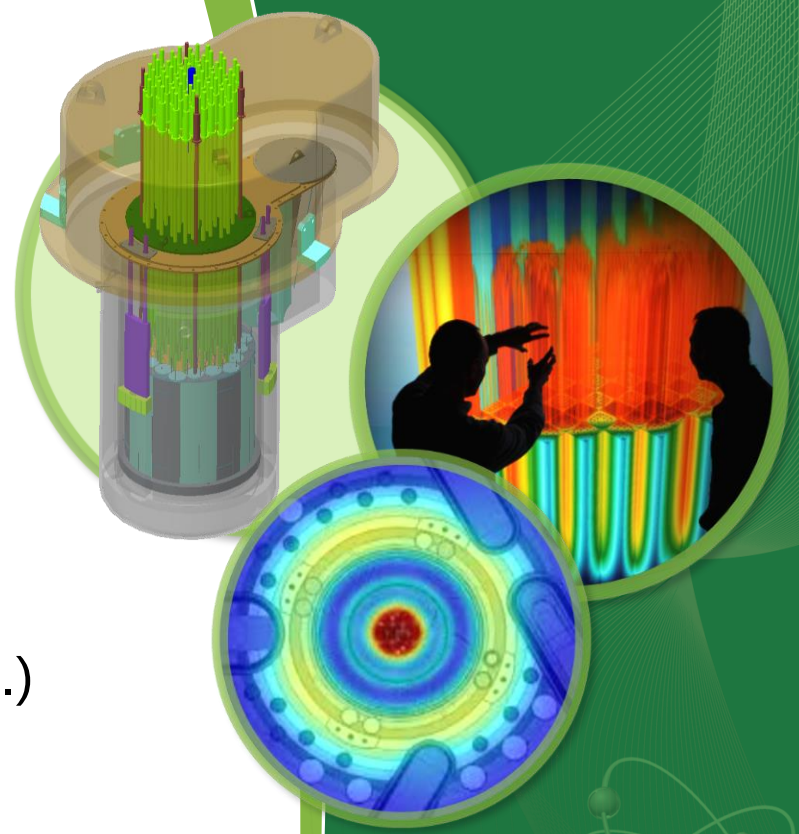


Collaborators:
Mark Williamson & Nathaniel Hoyt (Argonne National Lab.)
Jinsuo Zhang (Virginia Tech.)
Michael Simpson (University of Utah)

DOE Gen 3 CSP Kickoff Meeting
Orlando, FL
June 25, 2018

Facility to Alleviate Salt Technology Risks (FASTR)

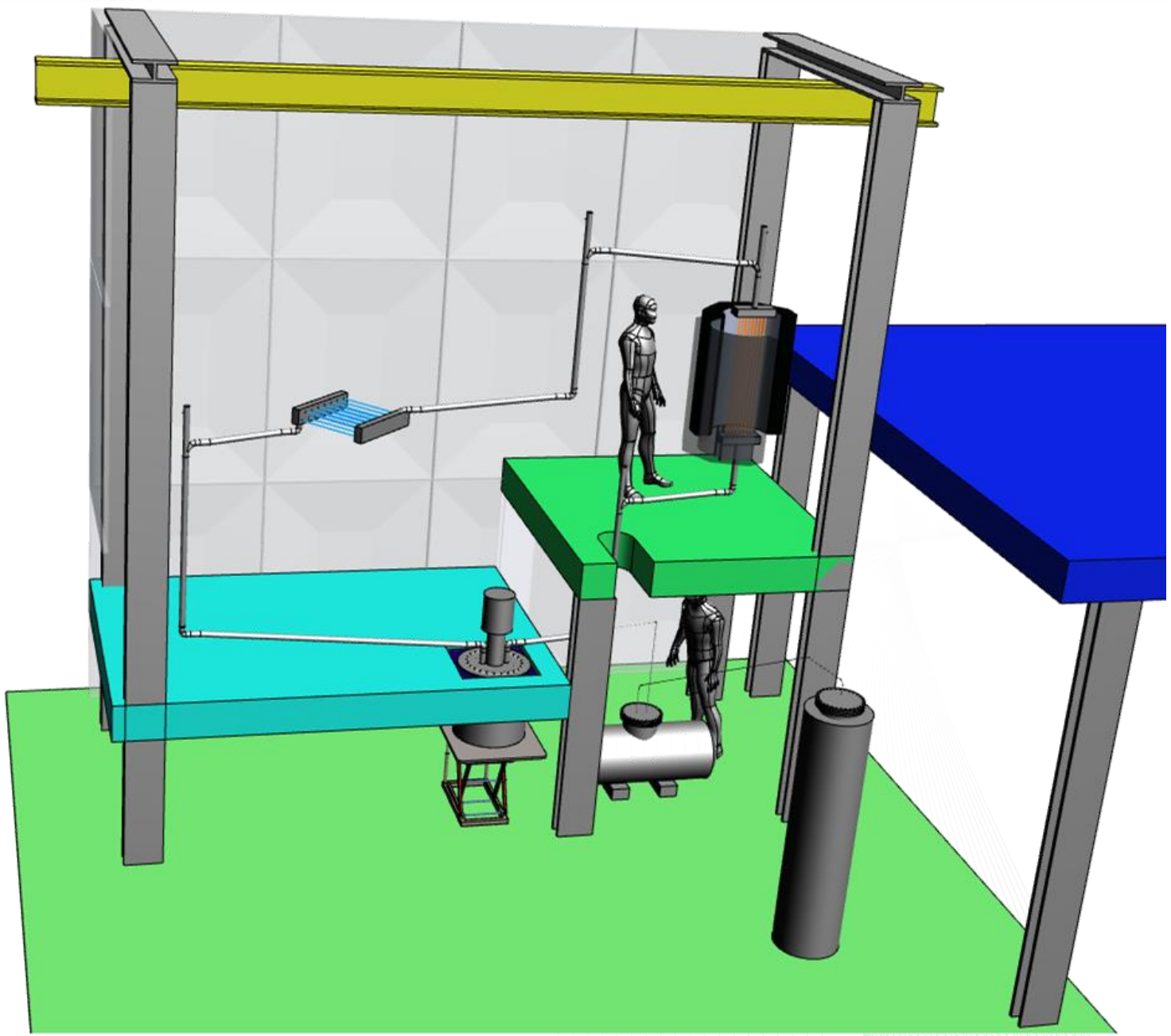
- Goal: Develop and deploy a relevant-scale >700°C salt loop to serve as a versatile testing platform for the Concentrated Solar Power (CSP) community to retire risks for the Gen 3 molten salt CSP pathway
- FASTR will be a facility for the research and industry community to test new components (e.g. heat exchangers, pumps and impellers, sensors, instrumentation, methods of corrosion control, and innovative materials)

- The project focus is to design, construct, and operate FASTR
  - A versatile forced convection high-temperature (>700°C) molten chloride salt loop
  - A salt preparation system to supply large batches (e.g. 200 kg) of clean salt
  - Supporting research to inform and support FASTR design and operation

Illustration of FASTR Concept

- Major components
  - Salt preparation vessel
  - Storage tank
  - Pump (sump and capable of in-line)
  - Receiver with heater
  - Air-cooled heat exchanger
  - Corrosion sample & instrument ports

Leveraged Insight



***Final design will deviate from illustrated layout**

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Key Capabilities, Timeline and Tests

- Capability Targets:
  - Temperature: 725°C operation
  - Salt capacity: 200 kg, 120 liters
  - Main heater: 300 kW_{th}, 1 MW/m^2 heat flux
  - Instrumentation suite:
    - Flow, pressure, temperature, level
    - Redox, impurity, H_2O/O_2
  - Flexibility to test new components
    - Pumps, tanks, receivers, heat exchangers, valves, etc.
    - Ports for corrosion and I&C tests

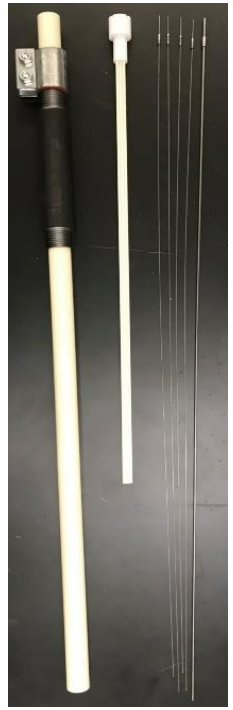
- Key dates (milestones)
  - Dec 2018 Design finalized
  - Jan 2020 Major components installed
  - April 2020 First salt cleaning
  - July 2020 Loop successful operation
  - Jan 2021 Initial tests completed

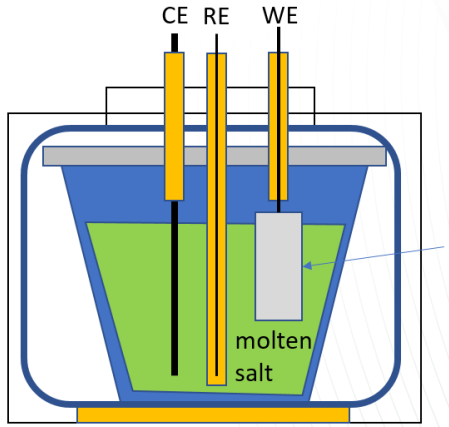
- Initial tests
  - Demonstrate corrosion control
  - Extended run time (≥200 h)
  - Heat transfer (turbulent)
  - General operation performance

Supporting Sensor Development

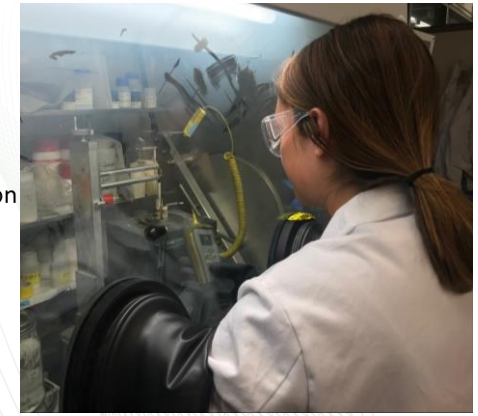
- Argonne National Lab. (ANL)
  - Long duration reference electrode
  - Multi-electrode array sensor for measuring oxide, hydroxide, and metal ion concentrations offering fast measurement rates, a wide potential range, and long service life
  - Oxygen sensor and in-situ O_2 removal cell
- University of Utah
  - Real-time in-situ corrosion sensor
  - $NiCl_2$ impurity sensor
- Sensors to be demonstrated on FASTR

Pilot-scale multi-electrode array sensor for molten salt monitoring





CE= counter electrode
RE= reference electrode
WE = working electrode



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Supporting Corrosion Testing

- Virginia Tech
  - Isothermal corrosion tests
    - Isothermal 700°C with 2 m/s flow
    - Loop made of SS 316
  - Up to 7000h of testing planned
  - Predictive corrosion modeling effort
- Separate award *PI: Bruce Pint (ORNL)*
  - Capsule screening tests &
  - Natural convection corrosion loops (with temperature gradient)
- Provide key input for FASTR material selection

Virginia Tech Salt Loop

Natural Convection Loop

Corrosion Capsules