NEXT Molten Salt Test Loop

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What is the NEXT Project?

- We want to solve the world’s problems!
  - Clean abundant energy
  - Clean water
  - Medical isotopes

- How do we want to do it?
  - By solving technical problems required to build working molten salt reactors.
Overview

- Thorium molten salt reactors: How do we get there?
- What are the goals for the NEXT Molten Salt Test Loop?
- What is the status of our system?
- What are the next steps for our Molten Salt Test Loop?
- Scaling up toward a reactor-sized system.
How do we get to a Thorium Reactor?

New Model

Old Model
How do we get to a Thorium Reactor?

- Making a safety case
  - We need data to compare with simulation
  - We need better instrumentation
    - Flow, pressure, and temperature monitoring
- Solving the world’s problems
  - We need to be able to monitor and filter fission fragments in molten salt
  - Know more about the chemistry of MSR’s
  - We need to test freeze plugs and flanges and....
Tools to solve problems

Goals for the MSTL

- Pump low temperature salt (<450 C)
  - Test everything and learn!
- Pump higher-temperature salt (~ 800 C)
  - Test everything and learn more!
- Use system as test bed for instrumentation
  - Flow meters, Pressure sensors, DAQ
  - Freeze valves, Flanges, Filters, automated valves
- Test corrosion and chemical monitoring technologies
MSTL Status: What are the Design parameters?

- Volume: approximately 19 liters with gas space for 7.5 more liters
- Currently running 36 kg of a eutectic mixture of Li NO$_3$, K NO$_3$, Na NO$_3$.
- Side and bottom heaters supply 10 kW to the sump.
- A 3 hp motor drives a centrifugal-type pump submerged in the salt bath from 1 to 60 Hz.
MSTL Status: What are the Design parameters?

- The pump is made of 316 SS, and has been modified from the original configuration.
- The original impeller was replaced with a better balanced one.
MSTL Status: What are the Design parameters?

- The pump is made of 316 SS, and has been modified from the original configuration.
- The original impeller was also replaced with a better balanced one.
- A change in the shaft diameter from 1” to 1.5” was made after we had some trouble with resonances.
MSTL Status: What are the Design parameters?

- The loop itself is made of 7.8 m of 25 mm diameter 316 SS pipe with mostly threaded fittings.
- We are testing unions, 3 valves, and a Krohne 4400 HT (450 C) flow meter.
- We are testing several different sealant aids in the threads including Teflon (370 C), Graphoil GTS Thread Sealant paste (635 C), and Deacon 8875 sealant (982 C).
MSTL Status: What are the Design parameters?

- The loop is wrapped with 12.5 mm wide heat tape that operates at 230 V.
- We currently have 23 type K thermocouples mounted to the loop and surrounding areas. We plan to add more as we add insulation.
MSTL Status: What are the Design parameters?

- A gas blanket system provides humidity for drying salt as well as cover gas.
MSTL Status: What are the Design parameters?

- The Data Acquisition system is based on the MIDAS software developed at PSI and TRIUMF for Medium energy Physics slow controls.
- It currently handles RS485, Ethernet, USB, and 4-20 mA current loop inputs.
We characterized the system with water.

We obtained the flow rate with a Sotera 825 flow meter, Krohne optisonic 4400 HT and by pumping water into barrels while monitoring mass.

We had some calibration issues with the Krohne...
Once that problem was resolved, we were able obtain a pump curve that has been passed on to the part of our collaboration that works on CFD.

We obtained pressure from transducers (now removed) on the inlet and outlet sides of the loop and monitoring flow.
MSTL STATUS: Pumping salt

- The NEXT Molten Salt Test Loop (MSTL)
- How do we know (The flow meter did not read)?
MSTL : Next steps

- Instrumentation to improve verification and validation
  - We are looking for different High Temperature Flow meters to test:
    - Krohne (600 C for >2 inch pipe)
    - Sporian Microsystems (800 C possible?)
    - Others?
  - We are working on designs for high temperature flow meters
    - To measure average flow rates of molten salt
    - To measure cross-sectional flow profiles of molten salt
- We are looking for pressure transducers to test or design
- DAQ development and testing (Versatile Test Reactor)
MSTL : Next steps

- Basic measurements with molten salt
  - Impurity analysis
  - Corrosion studies with flowing salt
  - Sound velocities of molten salt mixtures
  - Viscosity measurements
  - Development of online salt content analysis
  - Differential scanning calorimetry of salt mixtures

- Testing mechanical components
  - Valves
  - Filters
  - Freeze valves

- Move to higher temperature salt: likely FLiNaK
The second generation: Molten Salt Test System (MSTS)

- Goals of the MSTS
  - 200 liters of salt
  - Modular design for testing reactor components
  - Integrated salt cleaning system
  - Integrated Freeze plug
  - Sample and add salt while online
  - Optical access to the flowing molten salt
  - Test sections for instrumentation and hardware testing
  - Prepare for a full-scale non-nuclear prototype.
Do you want to test something?

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