U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

ASI Advanced Sensors and Instrumentation

Harsh Environment-Tolerant
Flow Sensors For Nuclear Reactor Applications

Dept of Energy #: DE-SC0013858

Advanced Sensors and Instrumentation (ASI)
Annual Program Webinar

October 27, 2022

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Sporian Microsystems, Inc.

SPORIAN® MICROSYSTEMS, INC

Project Overview

Objective: Develop a sensor for monitoring SMR coolant flow

Approach: Thermal anemometry (i.e., hot wire/film)

- Single penetration, compatible with non-circular x-section
- High-temperature + pressure operation (300°C+, 1500psi+)
- Compatible with conductive & corrosive fluids

General Functional Requirements:

	Long-term Target Application: SMRs	Near-term Target Application: Industrial Processes
Fluid	Borated water	Molten salts
Operating Temp	300°C	300-700°C
Operating Pressure	>1600 psi	<150 psi
Radiation	1E+18 n/cm^2	N/A, or uncertain
Operating Life	2 years	6 months - 5 years
Commercialization Path	Licensing, partnership, or acquisition	Direct sales

Project Overview

Participants

- Sporian Microsystems, Inc. – product design and development
- Texas A&M University Thermal Hydraulics Lab – superheated water flow testing
- United Controls International – QA consulting

Schedule:

Task #	Task Description	Year 1 (Months)												Year 2 (months)											
		Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21
Task 1	Work with OEMs & stakeholders to guide transition activities							M1																	
Task 2	Design and implement QA program							M2																	
Task 3	Construct prototypes and perform lab-scale V&V testing													M3											
Task 4	Revise design based on test results, and construct systems for final testing/demonstration															M4									
Task 5	Final V&V testing and demonstration in representative system tests																								M5

Technology Impact

Benefits

- Visibility over flow conditions
- Characterize fluid (coolant) mixing and cooling
- Indicate flow problems (e.g., clogs, frozen salt, empty pipe)
- Enable salt corrosion studies

Applicable Industries

- SMR
- MSR
- Concentrating solar power & thermal energy storage
- Glass processing (salt ion exchange)
- Metal making / refining

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Results and accomplishments

System Design

- Standard footprint with custom process interfaces
- Developing plug-and-play functionality

Challenges

- HT stability of internal components
- Calibration across wide operating range
- COVID and supply chain delays

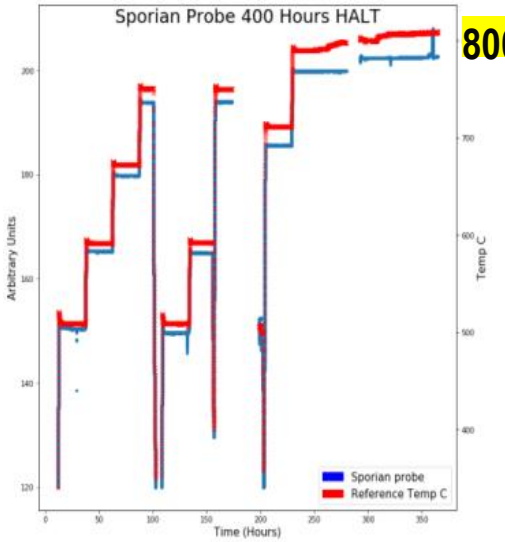
QA program updates

- Approaching NQA-1 / 10-CFR-50 Appendix B compliance
- Goal is to facilitate commercialization, not certification

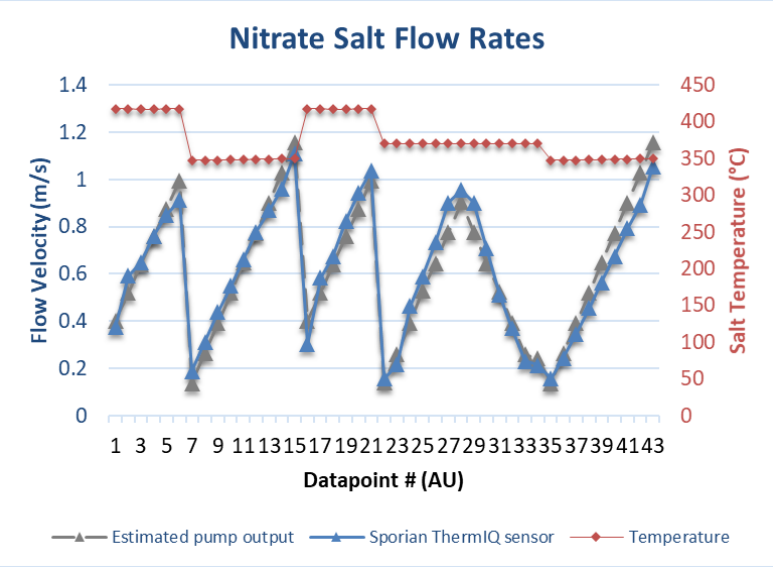
Results and accomplishments

Testing

- High pressure: 300-hour soak at 300C + 1700 psi in borated water
  - After “burn-in” period, no effect on flow sensing performance in water
- High temperature survival and aging
  - Stable over 100+ hours at 800°C, drift in flow response but appears repeatable



800°C



- Superheated water system testing
  - Testing at Texas A&M ended in August of 2022
    - 330 hours of testing displayed no measurable degradation and ±1%FS accuracy across the duration of the test for flow rates below 35 m/s and ±4%FS up to the maximum tested 50 m/s.
  - Evaluation at AMS showed good sensor performance down to flow rates of 0.05 m/s.
- Molten salt system testing
  - Nitrate salts – demonstrated roughly ±5% FS accuracy

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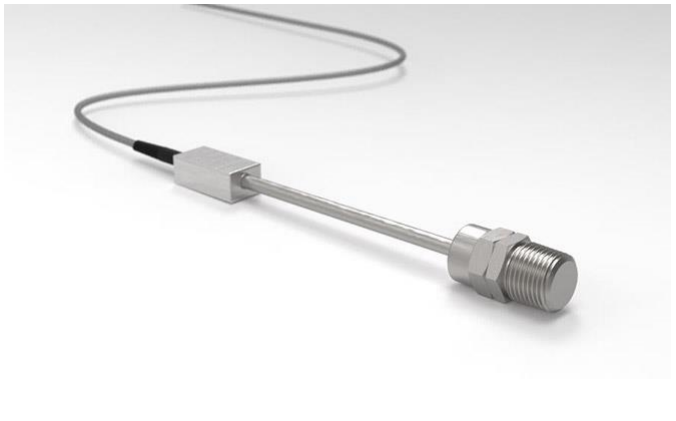
Coming Soon: ThermIQ® Product Release

SmartCap™ GT

- Pressure and temperature
- High Temperature
- High Bandwidth
- Gas Environments

SmartCap™ IM



- Pressure and temperature
- High Temperature
- Corrosive Fluid Environments

ThermaFlow™

- High Temperature
- Corrosive Environments
- In-situ

- Initial sales in Q1 2023 - Currently seeking early adopters
- More information at thermiq.biz

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Questions?

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Unprecedented capabilities in the world's harshest environments

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