Profile SFR-79

UW Sodium Loops 1 and 2

USA

GENERAL INFORMATION

NAME OF THE FACILITY	University of Wisconsin Sodium Loops 1 and 2
ACRONYM	UW Sodium Loops 1 and 2
COOLANT(S) OF THE FACILITY	Sodium
LOCATION (address):	3735 County Highway B / McFarland, WI 53558 / USA
OPERATOR	University of Wisconsin-Madison
CONTACT PERSON (name, address, institute, function, telephone, email):	Professor Mark Anderson Engineering Research Building Office: 1500 Engineering Drive Madison, WI 53706 USA University of Wisconsin-Madison Professor Nuclear Engineering Department 608-263-2802 manderson@engr.wisc.edu

STATUS OF THE FACILITY	Operational
Start of operation (date):	2009

MAIN RESEARCH FIELD(S)

- ☐ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☒ Thermal-hydraulics
- ☒ Coolant chemistry
- ☒ Materials
- ☒ Systems and components
- ☒ Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

There are two sodium loops located at the University of Wisconsin-Madison (UW). The loops were built to study chemistry, materials science, and instrumentation development under sodium fast reactor operating conditions. UW Sodium Loop 1 was competed in 2009 and UW Sodium Loop 2 in 2015. Both loops are relatively similar in terms of system parameters and can both be easily modified for specific experiments, however, Sodium Loop 1 is primarily used for instrumentation development while Sodium Loop 2 is a purpose built materials testing facility.

Both of the sodium loops at the University of Wisconsin contain approximately 2 [gal] of sodium, with the capability to flow at up to 35 GPM (>10m/s through the test section geometry). The sodium is pumped with a custom in house designed and built moving magnet pump [1]. The sodium flow rate is measured with a custom designed electromagnetic flowmeter which was calibrated with a NIST certified vortex shedding flowmeter. The temperature can be controlled precisely with PID controlled zone heating over a range of 100-650 ^{o}C.

Oxygen control of the sodium is accomplished with a cold trap and impurity level is secondarly measured with a plugging meter. Sodium impurities of <2wppm can be achieved in both sodium loops. Under development at the UW are electrochemical O_2 sensors for continuous and selective (O_2 only) impurity measurement which will be employed in parallel with plugging meter.

Optical fiber temperature sensor currently installed in Sodium Loop 1 gives quasi-continuous 1D temperature profile (with less than 0.5 mm resolution) over a length of 10 meters. This can be utilized to study such phenomenon as thermal striping and other unique low Prandtl number fluid behaviour. CFD validation can also be achieved with this capability.

3D drawing/photo

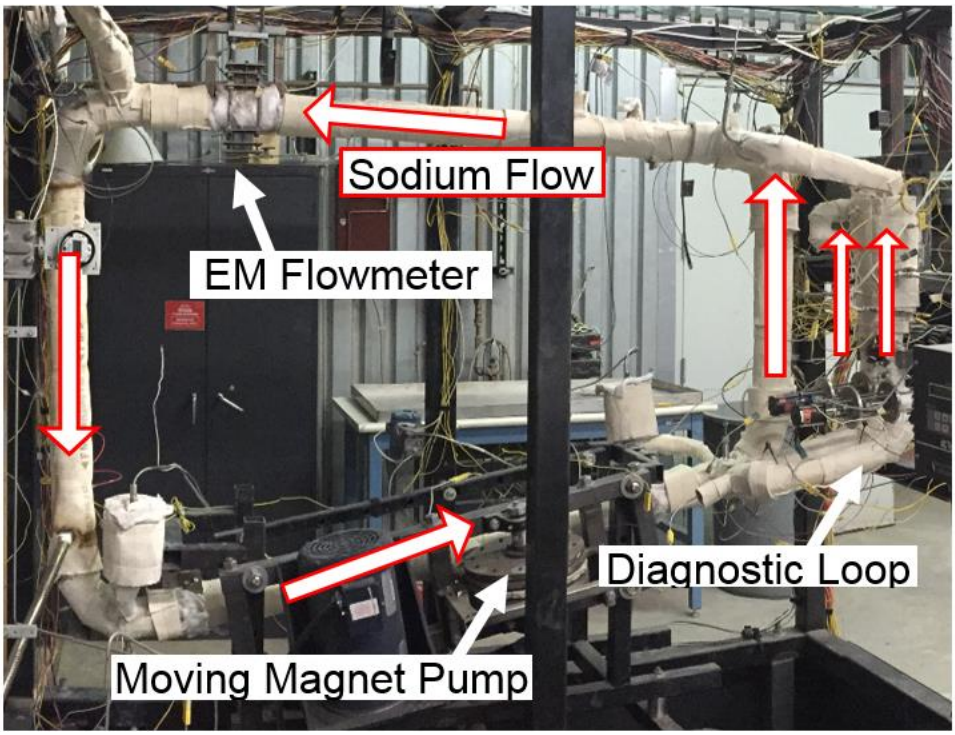

FIG 1. View of the UW-Sodium Loop 1, System Overview

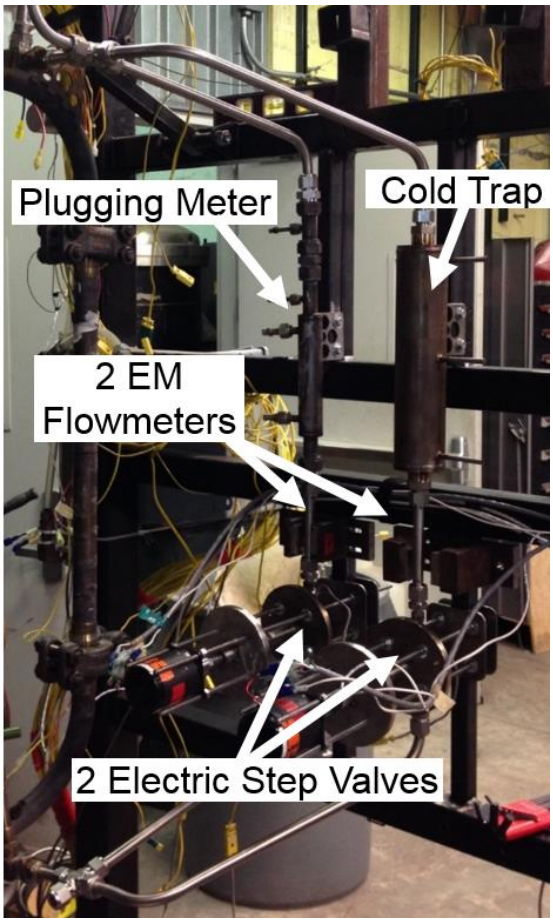

FIG. 2. View of the UW Sodium Loop 1, Diagnostic Loop

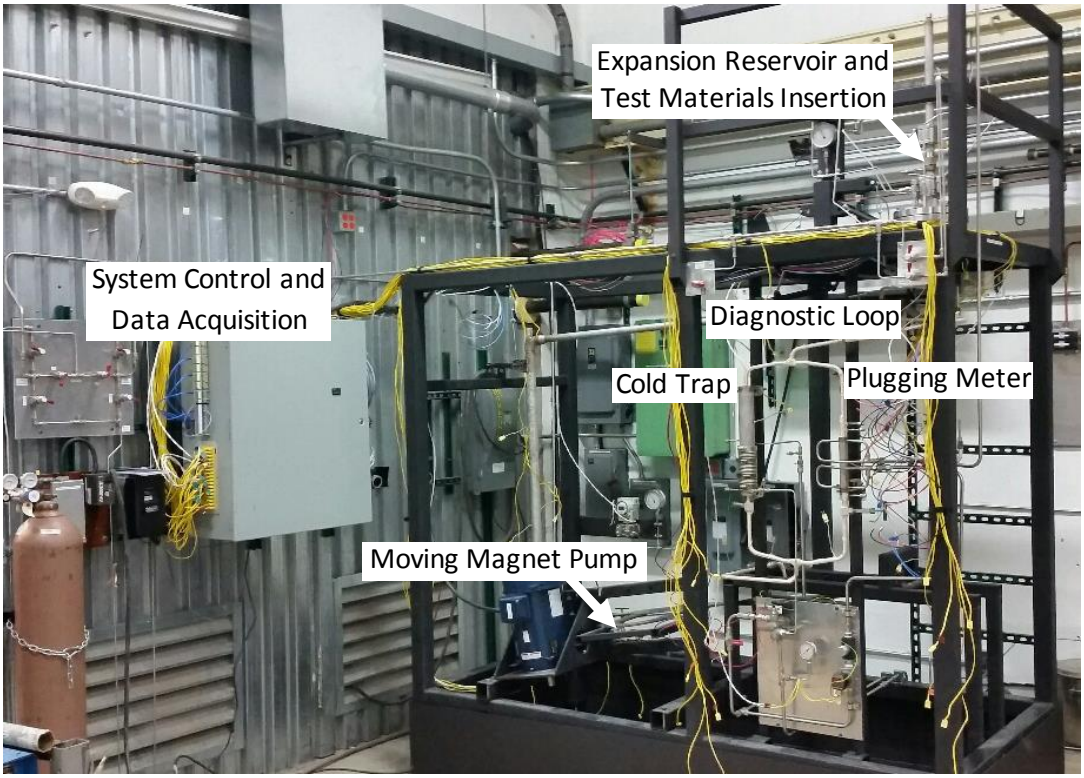

FIG. 3. View of the UW-Sodium Loop 2, System Overview Picture

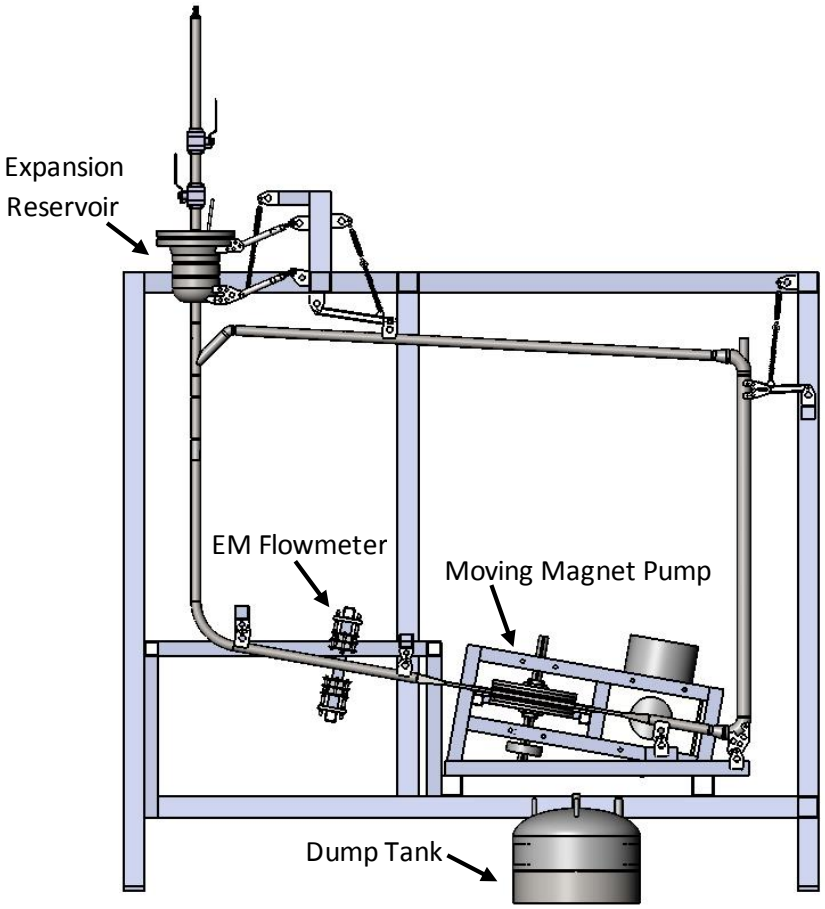

FIG. 4 UW-Sodium Loop 2, System Overview Drawing

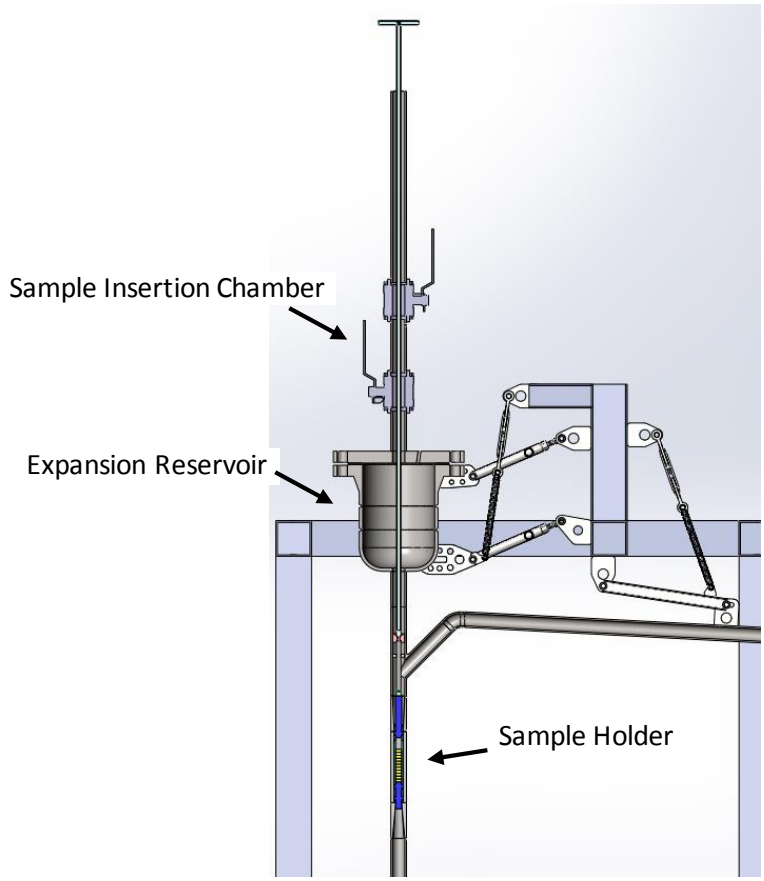

FIG. 5. Scheme of the UW Sodium Loop 2, Sample Insertion Drawing with Expansion Reservoir Shown

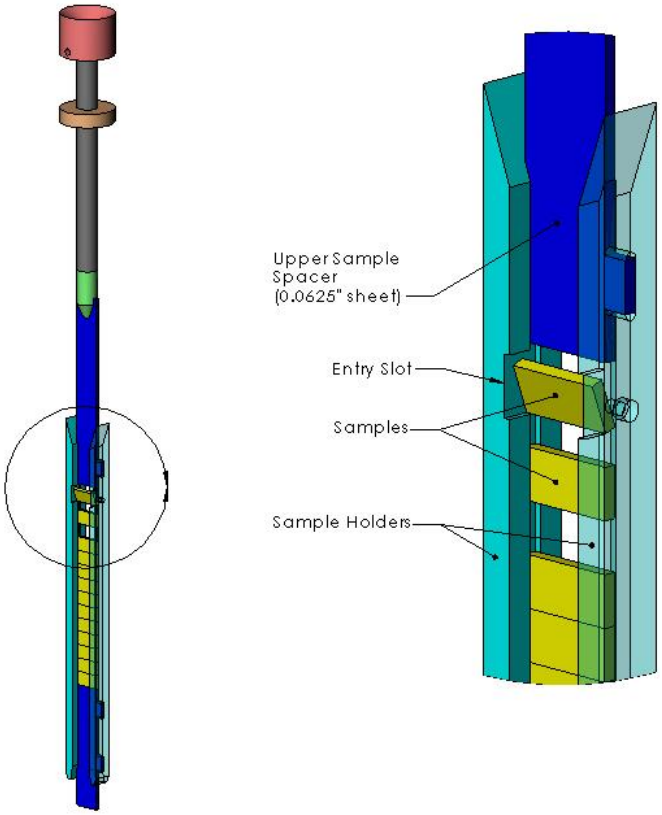

FIG. 6. Scheme of the UW Sodium Loop 2, Sample Holder

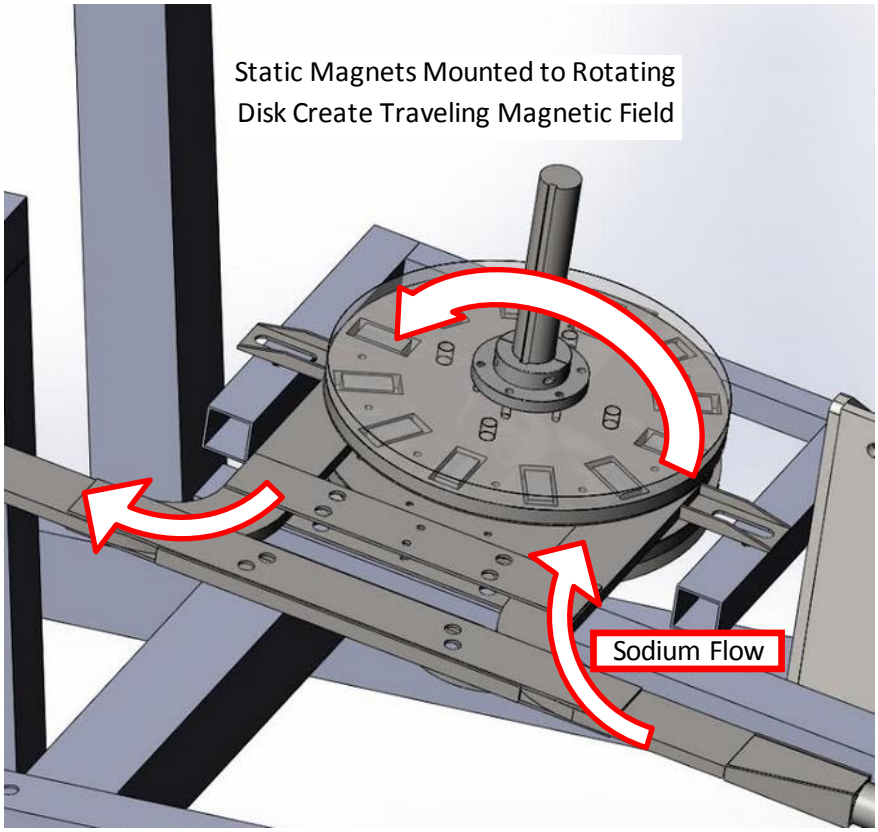

FIG. 7. View of the UW Moving Magnetic Pump

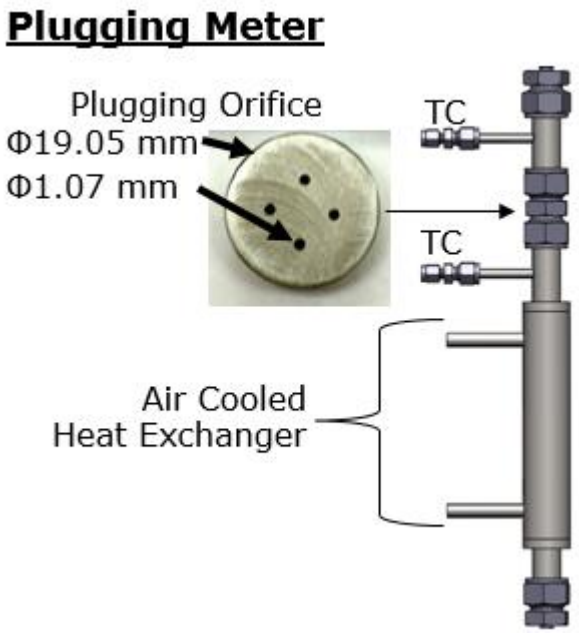

FIG. 8. Plugging Meter Drawing with Plugging Orifice Shown

Parameters table

Coolant inventory	5+ [gal] of reactor grade sodium in each loop
Coolant chemistry measurement and control	~0.15 [gal] cold trap with electronically controlled stepper valves provide precise metering of flow to achieve particular cold trap residence times. Plugging meter used to assess impurity concentration, plugging meter drawing with orifice dimensions can be seen above in figure 8.
Instrumentation	Moving Magnetic Pump (MMP) (0-35 GPM, 0-40 PSIG) <u>Electromagnetic Flowmeters in Each Sodium Loop</u> 1 main flowmeter calibrated with vortex shedder 2 flowmeters in diagnostic section (1 for cold trap, 1 for plugging meter) <u>Heaters:</u> Heavy Insulated, High Watt Density Heating Tape (~2,400 W Total) High Watt Density Immersion Heater <u>Temperature Sensors:</u> Calibrated and Standard K-Type Thermocouples Optical Fiber Distributed Temperature Sensor Pressure Transducers Across Pump Duct in Sodium Loop 1 Pressure Transducers Across Sample Test Section in Sodium Loop 2 Electrical resistance level sensor and electrical point level sensors installed in both sodium loops Argon cover gas & vacuum system High-temperature, sodium-compatible valves Plugging meter Cold trap

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

The UW Sodium Loop 1 was used to design, build and evaluate the UW moving magnetic pump. Loop 1 has been used in the past, and is currently being utilized, to test electrochemical O2 sensors for use in sodium. Optical fiber temperature sensors for deployment in sodium (fiber in stainless steel capillary with inert cover gas) have been

successfully utilized. Material science has been performed on metals and ceramics in flowing sodium using both loops 1 and 2.

PLANNED EXPERIMENTS

Materials testing is underway in Sodium Loop 2

Instrumentation development including electrochemical O2 sensors, vanadium wire equilibration technique for measuring oxygen impurity, optical fibers etc. is currently underway in Sodium Loop 1.

We plan to conduct sodium to SCO2 heat exchange with PCHE and further test new pump, flow meter and instrumentation. Also of interest is sodium fire experiments and study of potential release of radioactive nuclides. Another facility is being constructed to investigate sodium film boiling phenomena.

REFERENCES (*specification of availability and language*)

1. M. HVASTA, Designing and Optimizing a Moving Magnet Pump for Liquid Sodium Systems