Profile SFR-4

HTMTSL

CHINA

GENERAL INFORMATION

NAME OF THE FACILITY	High Temperature Mass Transfer Sodium Loop
ACRONYM	HTMTSL
COOLANT(S) OF THE FACILITY	SODIUM
LOCATION (address):	China Institute of Atomic Energy(CIAE), P.O.Box 275 (34), 102413, Beijing, China
OPERATOR	CIAE
CONTACT PERSON (name, address, institute, function, telephone, email):	LONG Bin, P.O.Box 275 (34), 102413, Beijing, China, Department of Fast Reactor Research and Design, Tel:+86-10-69357613 , Email:bin.long@hotmail.com; binlong@ciae.ac.cn

STATUS OF THE FACILITY Standby

Start of operation (date): 2000

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

High temperature mass transfer sodium loop (HTMTSL) is a pump-drive un-isothermal test facility to study the carbon transfer effect of steels which were used for primary and(or) secondary loops in sodium-cooled fast reactor (SFR). Simulation corrosion tests of SFR structural materials at different test conditions can be performed in this loop.

HTMTSL basically consists of a main circuit with double test sections (i.e. a hot leg and a cold) which could hold around 50 pieces coupon, sodium purification system, cover gas system and instrumentation and control system. The main components and its technical parameter are listed as following:

Test section: it consists of two test sections, one is located at high temperature area, and the other is at low temperature part. FIG. 1 shows the structure diagram of test section. It was made of austenitic steel 316 S.S. tubes with ϕ50mm x 3mm, the length of test section is about 600mm. The free surface of hot sodium was covered by argon gas.

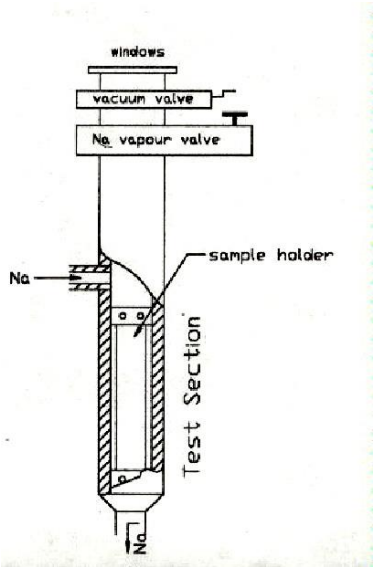

FIG. 1. Schematic of test section

Surge tank: surge tank locates at the highest position of the loop which could provide expansion space for sodium during the melting. FIG. .2 shows the structure of surge tank. The tank volume is about 0.03m^3, and the structure material is 316 S.S. The coupons could be placed here to perform corrosion test at lower sodium velocity.

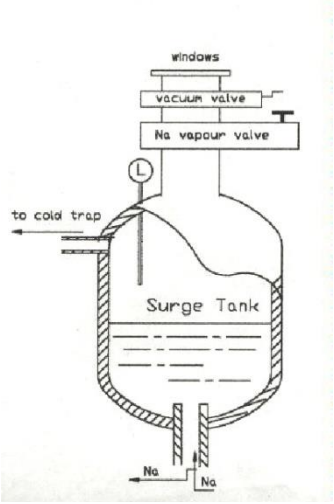

FIG. 2. Schematic of surge tank

Heating system: it consists of a heater and auxiliary heater. The total power for this system is about 12 KW

Intermediate heat exchanger (IHX):U-shape IHX was used as the heat exchange in the loop. FIG. .3 shows the structure of this IHX. The hot sodium goes through the outer casing while cold sodium flowing in the inner tube. The diameters of outer casing and inner tube are ϕ25 and ϕ14mm, respectively. The heat transfer area is about 96 cm^2. The temperature different between inlet and outlet is about 30-50^oC.

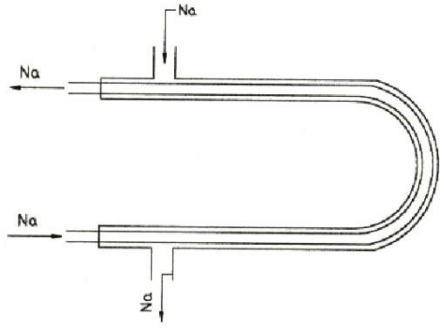

FIG. 3. Schematic of IHX

Electromagnetic pump for main circuit: EM pump is "the heart" of circuit system, which drives the sodium flowing in the loop. FIG. 4 is the picture of the EM pump. The main parameters of the pump are listed as following:
Type: air cooling type single-phase electromagnetic pump
Pump head: >0.2 MPa
Nominal flow: 5 m^3/h
Maximum temperature: 550^oC

FIG. 4. EM pump for main circuit

Flow meter: permanent magnetic flow meter was used in the loop, flow range is 5 m^3/h, the maximum working temperature is 600^oC, and the error is 0.018 m^3/h.

Purification system: The sodium need to be purified after it was loaded into the loop because the corrosion products, leakage in the system and cover gas could contaminate the sodium. An in-site purification system is necessary during the operation of the loop. The flow of purification by-pass is about 0.02 m^3/h to 0.1 m^3/h. The volume of cold trap is 0.01 m^3. FIG. .5 shows the structure of the cold trap.

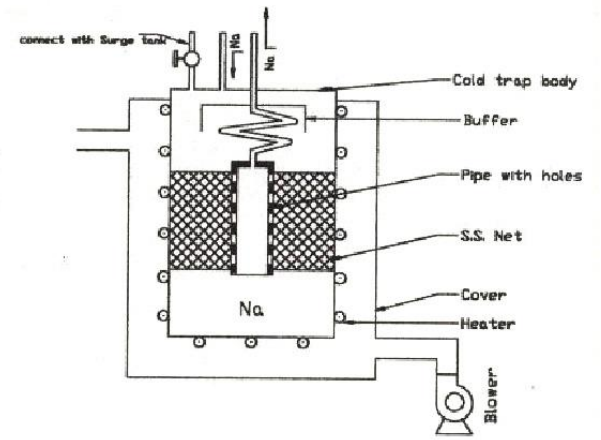

FIG. 5. Structure diagram of cold trap

Sodium loading and drain system: it consists storage tank and pipes and some valves. Storage tank is a "stomach" of the loop, which was located at the bottom of the whole systems. FIG. .6 shows the structure of the loading and drain system. The volume of storage is 0.06 m^3.

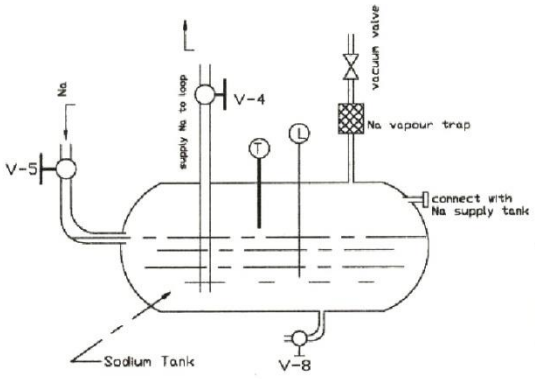

FIG. 6. Diagram of sodium drain and loading system

Cover gas and vacuum system: The free surface of liquid sodium was covered by high purity argon during the operation of the loop. The argon need to be purified by gas purification system, which consists of Ar bottle, buffle tank, purifier, vacuum pump and sodium vapor trap, see FIG. .7.

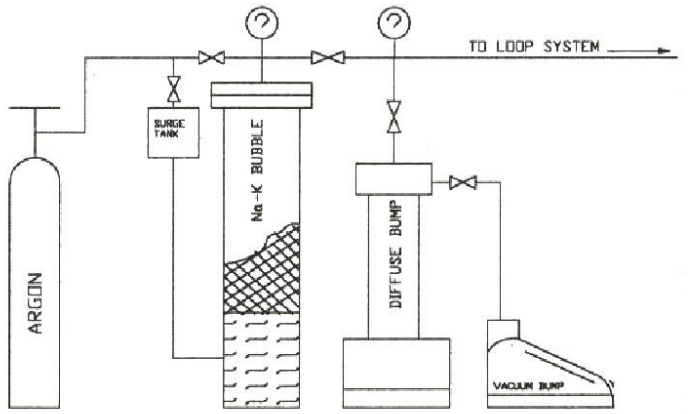

FIG. .7 Diagram of cover gas and vacuum system

Instrumentation and control system: The function of instrumentation and control system are: 1) the temperature control and display; 2) the sodium flow control and display; 3) pressure display; 3) alarm on sodium level and over pressure

Acceptance of radioactive material

No

Scheme/diagram

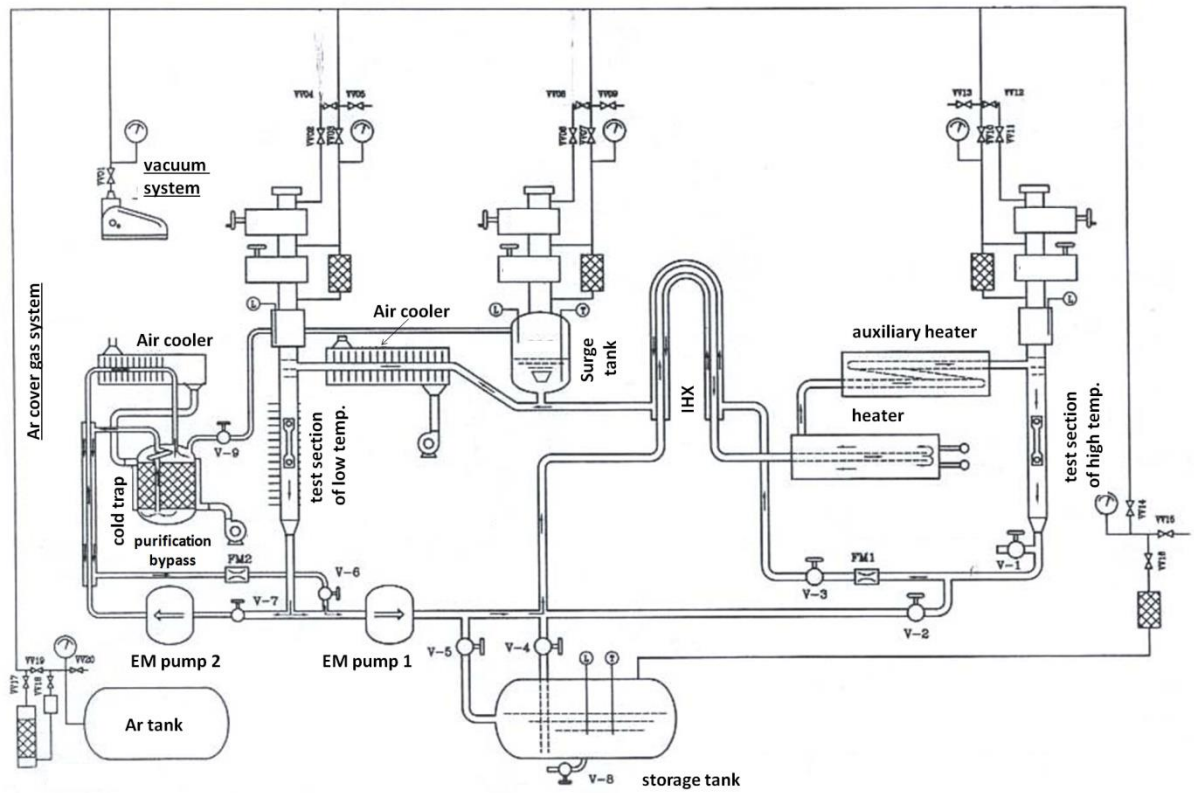

FIG. 8. *The diagram of HTMTSL*

3D drawing/photo

FIG. 9. HTMTSL site

Parameters table

Coolant inventory	125 kg
Power	Max 85 kW
Test sections	
TS #1	*Characteristic dimensions* inside diameter 44 mm Overall height →1000 mm
	Static/dynamic experiment Dynamic
	Temperature range in the test section (Delta T) 500°C-650°C
	Operating pressure and design pressure Operating Pressure →0.01MPa (gauge) Design pressure →0.2MPa
	Flow range (mass, velocity, etc.) The maximum sodium flow rate is 5 m^3/h
TS #2	*Characteristic dimensions* inside diameter 44 mm Overall height →1000 mm
	Static/dynamic experiment Dynamic
	Temperature range in the test section (Delta T) 350°C-450°C
	Operating pressure and design pressure Operating Pressure →0.01MPa (gauge) Design pressure →0.2MPa
	Flow range (mass, velocity, etc.) The maximum sodium flow rate is 5 m^3/h
Coolant chemistry measurement and control (active or not, measured parameters)	There is one cold traps in the circuit to guarantee the sodium purification process on line. The plugging temperature in the meter is lower than 120 °C when the circuit is on operation. The off-line measurement is available and the oxygen content dissolved in the sodium can be used and the limit for this loop is lower than 12ppm.
Instrumentation	Thermocouples, pressure transducer, Gas purification and injection system, flow meters

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

A first experimental campaign was conducted to verify the structural materials used for China Experimental Fast Reactor (CEFR) in 2000. The operation duration is 40 hours. No test was performed after that.

PLANNED EXPERIMENTS (including time schedule)

No experiment is on the planning in near time..

TRAINING ACTIVITIES

Training activities can be agreed with CIAE for the operation of the experimental campaign under the supervision of CIAE qualified staff.

REFERENCES (*specification of availability and language*)

[1] ZHANG D.D., High temperature sodium mass transfer test loop, *Chinese Journal of Nuclear Science and Engineering*, Vol.11, No.3, pp. 87-91, Sept. 1991. (In Chinese)

[2] ZHANG D.D., YAO Z.Y., LUO X.J.and et.al, The debugging and operation experience of high temperature sodium mass transfer loop, *Chinese Journal of Nuclear Science and Engineering*, Vol.15, No.4, pp. 47-53, Dec. 1995. (In Chinese)