Profile LFR-56

HELIOS

KOREA Republic of

GENERAL INFORMATION

NAME OF THE FACILITY	Heavy Eutectic Liquid metal Loop for the Investigation of Operability and Safety of PEACER
ACRONYM	HELIOS
COOLANT(S) OF THE FACILITY	Molten lead-bismuth eutectic
LOCATION (address):	Building 31-1, School of Energy Systems Engineering, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea
OPERATOR	Nuclear Transmutation Energy Research Center of Korea (NUTRECK)
CONTACT PERSON (name, address, institute, function, telephone, email):	Prof. Il Soon Hwang, Room 32-211, School of Energy Systems Engineering, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea, Tel. +82-2-880-7215, hisline@snu.ac.kr

STATUS OF THE FACILITY	In operation
Start of operation (date):	2005

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

HELIOS is a thermal-hydraulic scale-down facility for PEACER-300, with the thermal power ratio of 5000:1 and height ratio of 1:1. The objectives of the loop is to verify the operability and safety characteristics of PEACER-300 design with the applicability for thermal-hydraulic experiments under either forced or natural circulation mode and materials corrosion test.

HELIOS was designed to have the same height and total pressure loss coefficient with the prototype.
HELIOS consists of two closed loops which simulate the primary side and secondary side of the PEACER-300 reactor, respectively. Working fluids are lead-bismuth eutectic (LBE) for the primary side and a single-phase heat transfer oil for the secondary side (Dowtherm RP). The primary loop is comprised of a mock-up core, an expansion tank, a mechanical pump, a heat exchanger (shell side), an orifice, gate valves, tee-junctions, elbows, and straight piping among components with 49.5 mm (2’’ SCH 80) inner diameter, and is about 12 m high.
Four electric heating rods in the mock-up core work as a heat source, yielding 60.0 kW maximum power. The heat exchanger on the upper part of the primary side acts as a heat sink. LBE flows downward in the shell side of the heat exchanger while the secondary fluid flows upward in the tube side. Hot leg and cold leg are divided by heat exchanger and mock-up core. The expansion tank is installed to accommodate the volume change of LBE by temperature change, before the heat exchanger and the highest location of hot leg. The centrifugal sump type mechanical pump with about 14 m of LBE head and 14 kg/s flow rate was adopted.
There are three types of main measuring systems for forced and natural convection tests: an orifice flow meter, differential pressure transducers (Rosemount 3051 CD3A), and k-type thermocouples. Differential pressure transducers were installed over the core region, the orifice region, and the combined region, which is ranged from the downstream of the orifice to outlet of the mock-up core, to measure pressure loss in each region. The total measurement error is ±0.065% of the span, below 200 Pa. It is considered that the most relevant pressure losses are expected in these regions. The mock-up core has the largest pressure loss due to its three spacers with quite small flow area. Each spacer takes about 74% of the flow area in the core with 49.5 mm inner diameter. An orifice also results in comparatively large pressure losses associated to sudden area change. Thermocouples are installed in several locations to monitor fluid temperature distribution along the loop.

Acceptance of radioactive material
No

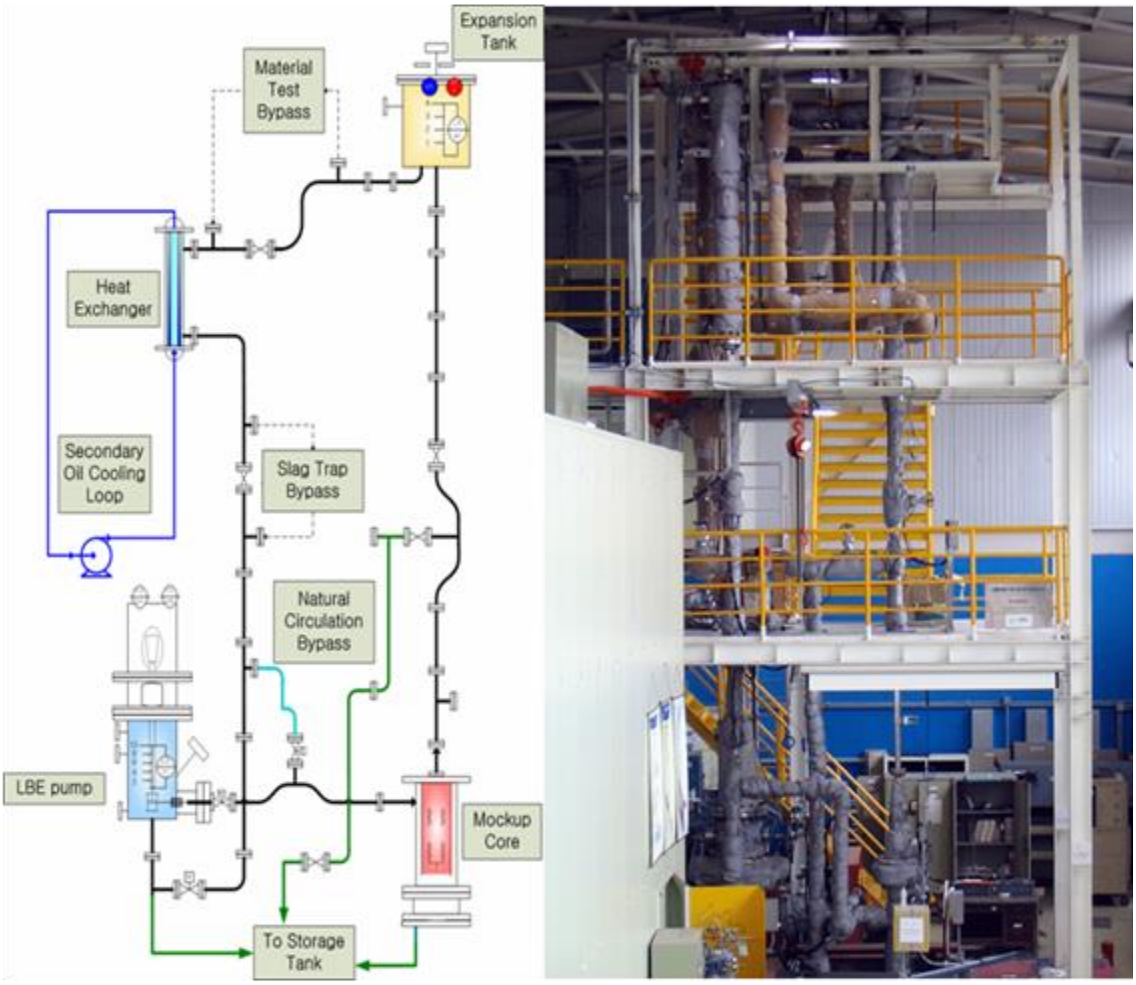

FIG. 1. Schematic diagram (left) and picture of HELIOS loop (right).

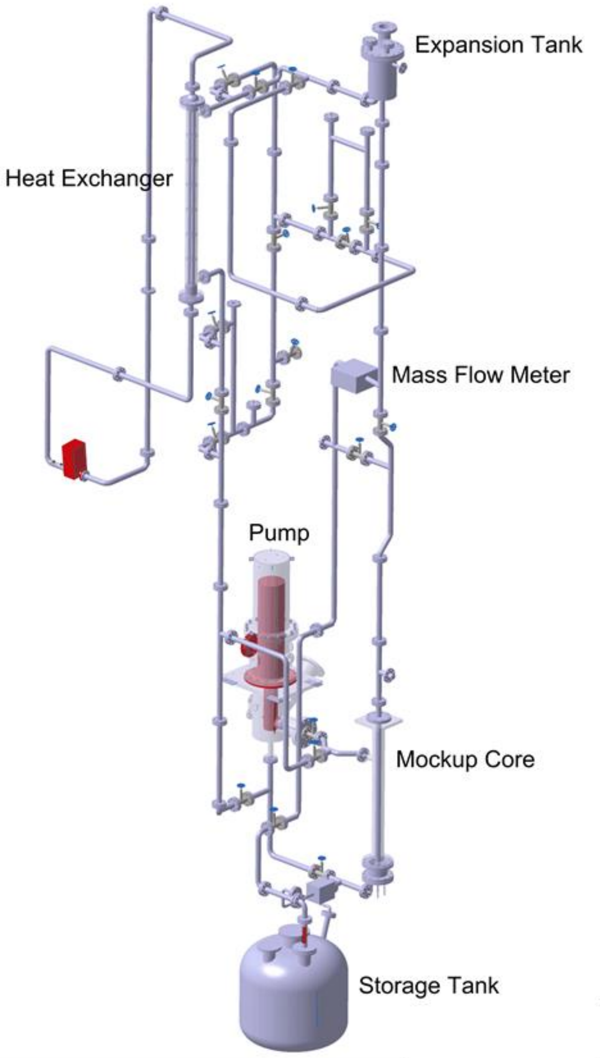

FIG. 2. 3D drawing of HELIOS primary and secondary loop.

Parameters table

Coolant inventory	About 2000 kg
Power	60.0 kW maximum power by main heater
Test sections	
Mock-up core	<u>*Characteristic dimensions*</u> 130.0 cm (height)
	<u>*Static/dynamic experiment*</u> Dynamic
	<u>*Temperature range in the test section (Delta T)*</u> 200-350 ^{o}C (about 50 ^{o}C of inlet-outlet temperature difference)
	<u>*Operating pressure and design pressure*</u> 0.1 MPa (operation), 1.0 MPa (design)
	<u>*Flow range (mass, velocity, etc.)*</u> 0-14kg/s for forced circulation, 0-3kg/s for natural circulation (lower than 2m/s)
Material test section	<u>*Characteristic dimensions*</u>

	Static/dynamic experiment Dynamic
	Temperature range in the test section (Delta T) 200-350 ^{o}C (about 50 ^{o}C of inlet-outlet temperature difference)
	Operating pressure and design pressure 0.1 MPa (operation), 1.0 MPa
	Flow range (mass, velocity, etc.) 0-14kg/s for forced circulation, 0-3kg/s for natural circulation (lower than 2m/s)
Instrumentation	Thermocouples, differential pressure meters, orifice flow meter, Coriolis flow meter

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Forced circulation tests had been performed from 2005 to 2011 to obtain pressure loss data from various loop components. These results were presented to OECD/NEA benchmarking programme called LACANES and used to suggest a best-practice guideline for computational modelling with one-dimensional system codes.

Natural convection tests have been conducted from 2011 to 2015 to generate not only short term but long term natural circulation data. Short term steady-state test results are presented to the second phase of LACANES benchmarking to prepare a best-practice guideline similar to the forced circulation cases.

PLANNED EXPERIMENTS (including time schedule)

Non-isothermal natural convection tests (during Feb. 2015)

Long-term natural circulation tests (right after the natural convection tests for LACANES benchmarking until May 2015)

TRAINING ACTIVITIES

Training activities can be arranged for students in Seoul National University, especially for the graduate students of Dept. of Nuclear Engineering.

REFERENCES (*specification of availability and language*)

1. CHO J.H., BATTA A., CASAMASSIMA V., CHENG X.,. CHOI Y.J,. HWANG I.S, LIM J., MELONI P., NITTI F.S., DEDUL V., KUZNETSOV V., KOMLEV O.,. JAEGER, SEDOV A., KIM J.H., PUSPITARINI D., Benchmarking of thermal hydraulic W loop models for Lead-Alloy Cooled Advanced Nuclear Energy System (LACANES), phase-I: Isothermal steady state forced convection, Journal of Nuclear Materials, Vol. 415, Issue 3, Pages 404-414, 2011.

2. JEONG S.H., BAHN C.B., CHANG S.H., OH Y.J., NAM W.C., RYU K.H., NAM H.O., LIM J.,. LEE N.Y,. HWANG I.S, Operation Experience of LBE loop: HELIOS, Proc. ICAPP 2006, Reno, Nevada, USA.
3. OECD/NEA, Benchmarking of Thermal–Hydraulic Loop Models for Lead-alloy Cooled Advanced Nuclear Energy Systems (LACANES) – Task Guideline for Phase 1: Characterization of HELIOS, 2007.
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