Profile LFR-4

HELIOS

BELGIUM

GENERAL INFORMATION

NAME OF THE FACILITY	HEavy LIquid metal Oxygen control System
ACRONYM	Helios III
COOLANT(S) OF THE FACILITY	Lead-Bismuth Eutectic (LBE)
LOCATION (address):	SCK•CEN, Boeretang 200, 2400, Mol, Belgium
OPERATOR	SCK•CEN
CONTACT PERSON (name, address, institute, function, telephone, email):	Dr. Kris Rosseel LBE-CCP Nuclear Systems Research Tel. +32 (0) 1433 8005 Email Kris.Rosseel@sckcen.be Cc to: Dr. Alexander Aerts LBE-CCP Nuclear Systems Research Tel. +32 (0) 1433 8018 Email Alexander.Aerts@sckcen.be
STATUS OF THE FACILITY Start of operation (date):	In operation
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

HELIOS3 is an advanced Lead Bismuth Eutectic (LBE) conditioning and storage setup, designed to deliver conditioned LBE (i.e. LBE with a pre-set oxygen concentration) to medium-sized experiments (~ 1 ton of LBE per batch). As a second purpose, it serves to investigate various schemes for optimisation of LBE conditioning. The third aim is to investigate calamity mitigation schemes, after e.g. steam ingress due to a tube rupture in a heat exchanger. Lastly, it aims to build-up conditioning know-how to facilitate a scale up to large facilities, such a MYRRHA.

In the present state, the geometry of the conditioning vessel is that of a bubble column. The method of bubbling gas with a given composition of Ar:H_2:H_2O through the LBE has been implemented using a removable sparger/impeller insert. The sparger injects sub mm bubbles, which are redistributed in the LBE by the impellers to improve the gas-LBE interaction. A gas recirculation system allows minimizing the conditioning gas consumption.

The gas delivery system has been greatly improved recently and consists now of a set of mass flow controllers in stead of rota-meters. This allows a much more precise control over the gas mixture composition and flow rate.

It is possible to adapt the conditioning vessel for other conditioning schemes, such as e.g. oxygen pumps, or to convert it to a counter flow bubble column. The vessel has a 100 mm diameter central port, which can accept various types of inserts. Sets of valves are foreseen for implementation of LBE recirculation.

Acceptance of radioactive material

No

Scheme/diagram

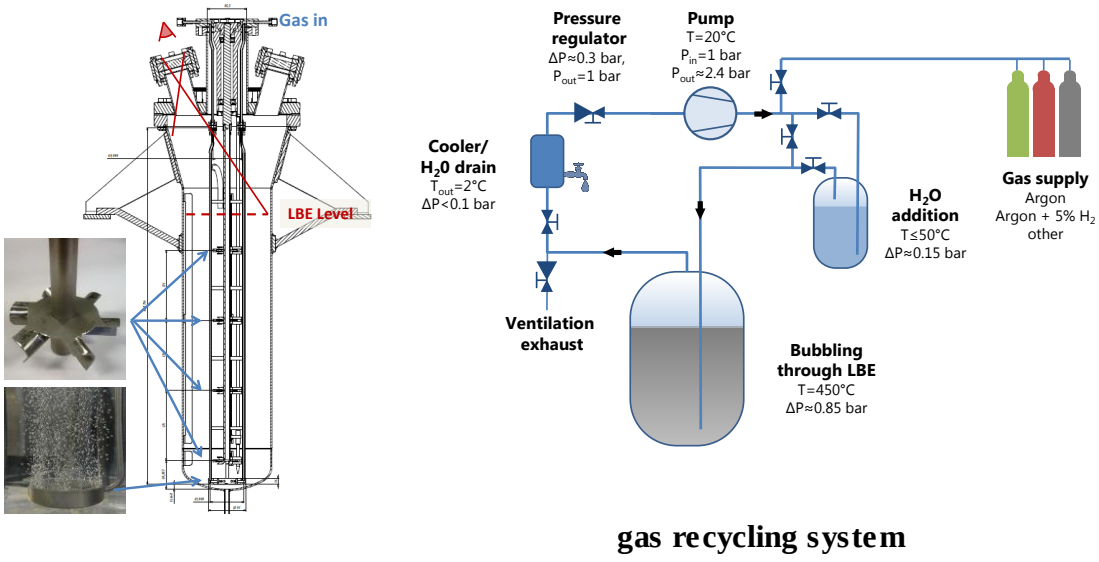

FIG. 1. Scheme of the HELIOS facility: conditioning vessel (left) and gas recycling system (right)

3D drawing/photo

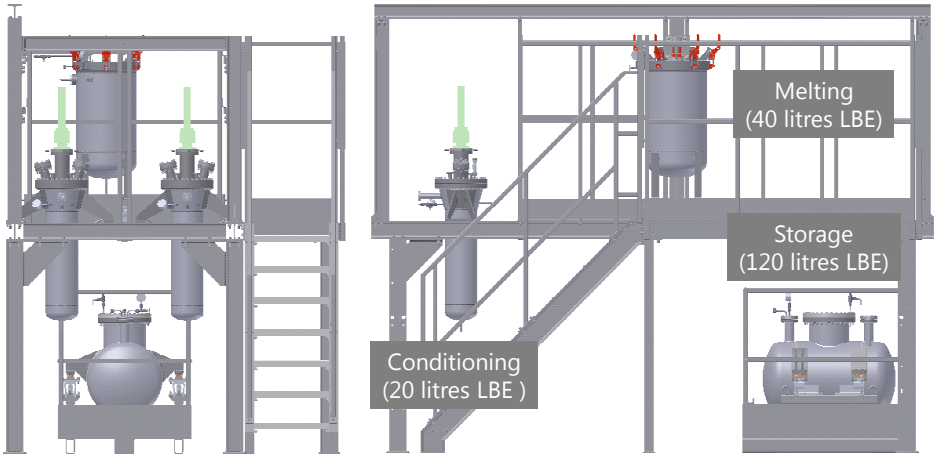

FIG. 1. View of the HELIOS facility

Parameters table

Coolant inventory	220 kg of LBE per conditioning vessel
Power	10 kW
Test sections	
TS #1	*Characteristic dimensions* 600 mm height, 200 mm diameter
	Static/dynamic experiment quasi-dynamic
	Temperature range in the test section (Delta T) max 450 °C, Delta T = 0
	Operating pressure and design pressure **0.5 bar overpressure, max 10 bar**
	Flow range (mass, velocity, etc.) 150 Nl/h of gas, 0 kg/s of LBE
Coolant chemistry measurement and control (active or not, measured parameters)	Active control of LBE conditioning; measured parameters: LBE oxygen concentration, LBE temperature
Instrumentation	Coolant chemistry measurement: -3 oxygen sensors (1 probing near the bottom of the vessel, 2 near the top) -humidity sensor -sensors for measuring the oxygen and hydrogen content of the bubble gas -view ports for visual inspection of the LBE surface

	Gas control: -Mass flow controller for precise control of gas mixture and gas flow rate -Humidification of the gas through a sparged water vessel. -PID control to be implemented Future additions - optical bubble size measurement - precise control of oxygen content through PID control of gas mixture and flow rate.

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

- Conditioning results
    - All results so far achieved for an LBE temperature of 450°C
    - Feasibility proven of sparger/impeller system; conditioning through gas bubbling achieved, using Ar:H_2:H_2O.
    - Reduction of excess oxides through gas bubbling of Ar:H_2 demonstrated
    - Gas recirculation feasibility proven
- Conditioned LBE delivered to the different medium sized setups at SCK-CEN, as well as for small scale experiments
- Redesign and implementation of the gas delivery system to allow a more precise control over the gas flow rate and mixture
- Improved filtering system for capture of entrainment products

PLANNED EXPERIMENTS (including time schedule)

Determination of mass transfer coefficients at various LBE temperatures for the current and future sparger/impeller system (2015-2016)

TRAINING ACTIVITIES

Training activities are possible, availability allowing and after prior agreement under supervision of SCK•CEN Qualified staff.

REFERENCES (*specification of availability and language*)