Profile LFR-5

HLM

BELGIUM

GENERAL INFORMATION

NAME OF THE FACILITY	Heavy Metals Lab
ACRONYM	HLM
COOLANT(S) OF THE FACILITY	LBE
LOCATION (address):	SCK•CEN, Boeretang 200, 2400, Mol, Belgium
OPERATOR	SCK•CEN
CONTACT PERSON (name, address, institute, function, telephone, email):	Dr. Alexander Aerts LBE-CCP Nuclear Systems Research Tel. +32 (0) 1433 8018 Email alexander.aerts@sckcen.be Cc to: Dr. Jun Lim LBE-CCP Nuclear Systems Research Tel. +32 (0) 1433 8015 Email Jun.Lim@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

The heavy metals lab (HML) finished construction end of 2012 and is equipped to perform chemistry experiments with heavy metals in a controlled and safe way. The HML houses an inert gas glove box which contains a so-called transpiration setup, used for the study of evaporation of impurities from LBE under various conditions of temperature and gas atmosphere composition. Typical impurities under investigation with this setup include fission products such as iodine and cesium which are important for the safety of LBE cooled accelerator driven nuclear systems. Recently a triple filter quadrupole mass spectrometer was connected to the evaporation setup, to study the gas-phase chemistry of evaporated molecules. Since the beginning of 2013, the HML also houses a home-made dedicated setup to study evaporation of mercury from LBE. Because mercury is a safety-critical contaminant in LBE cooled accelerator driven nuclear systems, its evaporation must be well-understood. Besides setups for evaporation studies, several small LBE setups are being used in the HML including several LBE autoclaves for oxygen sensor and oxygen-pump testing, a setup for electronic impedance spectroscopy studies of sensor membranes and autoclaves with oxygen control for corrosion studies under stagnant LBE conditions.

Acceptance of radioactive material

No

Scheme/diagram

3D drawing/photo

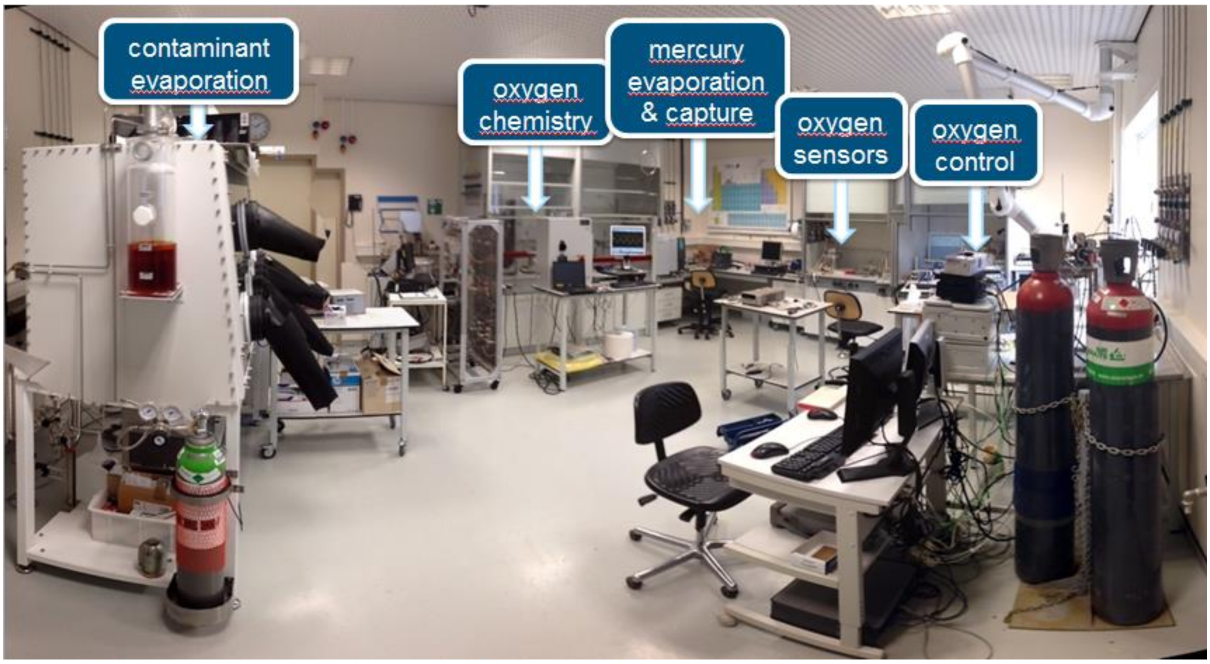

FIG. 1. View of the HLM facility

Parameters table

Coolant inventory	several autoclaves, 6 kg LBE each	
Power	1 kW autoclave heaters, 1 kW tubular furnace	
Test sections		
TS #1	*Characteristic dimensions* LBE autoclaves ϕ100 mm	
	Static/dynamic experiment static & dynamic (evaporation)	
	Temperature range in the test section (Delta T) up to 500 °C (conditioning and corrosion experiments), up to 1000 °C (evaporation setup)	
	Operating pressure and design pressure	
	Flow range (mass, velocity, etc.)	
Coolant chemistry measurement and control (active or not, measured parameters)	electrochemical oxygen pump, gas-liquid exchange oxygen control	
Instrumentation	oxygen sensors, mercury detector (fluorescence), mass spectrometer	

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

- Evaporation
  - Mercury: measurement of Henry constants of mercury impurity in solid and liquid LBE, mercury diffusion coefficients in solid LBE
  - Iodine: measurement of Henry constants of iodine impurity in liquid LBE
  - Cadmium: measurement of Henry constants of cadmium impurity in liquid LBE
- Oxygen measurement and control
  - calibration and testing of low-temperature (200 °C minimum) oxygen sensors for LBE
  - testing of electrochemical oxygen pumps

PLANNED EXPERIMENTS (including time schedule)

The following activities are planned in 2015-2016:

- Evaporation of fission products from LBE.
- Measurement and control of dissolved oxygen in LBE.
- Corrosion experiments in autoclaves with stagnant, oxygen-controlled LBE.

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*)

1. MANFREDI G., LIM J., ROSSEEL K., VAN DEN BOSCH J., DONEUX TH.,. BUESS-HERMAN C, AERTS A., Comparison of solid metal-metal oxide reference electrodes for potentiometric oxygen sensors in liquid lead-bismuth eutectic operating at low temperature ranges, Sensors and Actuators, 2015, 214, 20-28.
2. MANFREDI G., LIM J., ROSSEEL K., VAN DEN BOSCH J., AERTS A., DONEUX TH., BUESS-HERMAN C., Liquid metal/metal oxide reference electrodes for potentiometric oxygen sensor operating in liquid lead bismuth eutectic in a wide temperature range Proc. Eng. 2014, 87, 264-267.
3. LIM J., MANFREDI G., GAVRILOV S., ROSSEEL K., AERTS A., VAN DEN BOSCH J., Control of dissolved oxygen in liquid LBE by electrochemical oxygen pumping Sensor Actuat. B-Chem 2014, 204, 388-392.
4. AERTS, DANACI S., GONZALEZ PRIETO B., VAN DEN BOSCH J., NEUHAUSEN J. Evaporation of mercury impurity from liquid lead-bismuth eutectic J. Nucl. Mater. 2014, 448, 276.
5. LIM J., MARIËN A., ROSSEEL K., AERTS A., VAN DEN BOSCH J. Accuracy of potentiometric oxygen sensors with Bi/Bi2O3 reference electrode for use in liquid LBE J.Nucl.Mater. 2012, 429, 270.
6. MARIËN, LIM J., ROSSEEL K., VANDERMEULEN W., VAN DEN BOSCH J., Solid electrolytes for use in lead-bismuth eutectic cooled nuclear reactors J. Nucl. Mater. 2012, 427(1-3), 39-45.