Profile LFR-7

LIMETS1

BELGIUM

GENERAL INFORMATION

NAME OF THE FACILITY	LIquid MEtals Test Stand 1
ACRONYM	LIMETS1
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. Serguei Gavrilov Structural Material Research Laboratory for High and Medium Activity Tel. +32 (0) 1433 3067 Fax. +32 (0) 1432 1216 Email serguei.gavrilov@sckcen.be Cc to: Dr. Marlies Lambrecht Structural Material Tests Laboratory for High and Medium Activity Tel. +32 (0) 1433 3013 Fax. +32 (0) 1432 1216 Email marlies.lambrecht@sckcen.be

STATUS OF THE FACILITY In operation

Start of operation (date):

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

LIMITS1 is an experimental set-up designed for mechanical testing of materials in an LBE environment in order to investigate mechanisms and kinetics of material/liquid metal interactions that influence mechanical properties of the material. The vessel consists of an autoclave in which the experiments are performed and a dump tank. Oxygen control is done via a controlled gas flow of an adjustable argon Hydrogen mixture with an H_2 concentration of up to 20%. Oxygen control can be performed in both the autoclave and the dump tank. Each of these are equipped with two Bi/BiO2 oxygen sensors. The autoclave houses a mechanical testing device that can be operated in a gas atmosphere or under stagnant LBE. Possible tests include tensile tests, fracture toughness tests, slow strain rate tests, constant load tests and crack growth rate experiments. The maximum load of the device is 20kN and the displacement rates range between 3.10^{-6} to 9.10^{-2} mm/s. The temperature range from 550°C down to room temperature. Obviously, below the melting point of the coolant only experiments in a gas atmosphere are possible.

Acceptance of radioactive material

No

Scheme/diagram

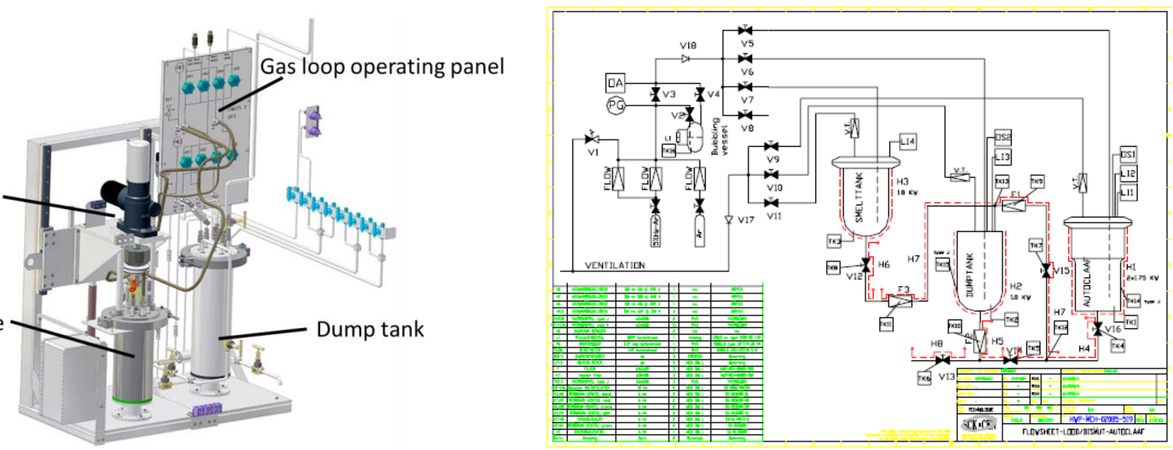

FIG. 1. Scheme of the LIMETS1 facility

3D drawing/photo

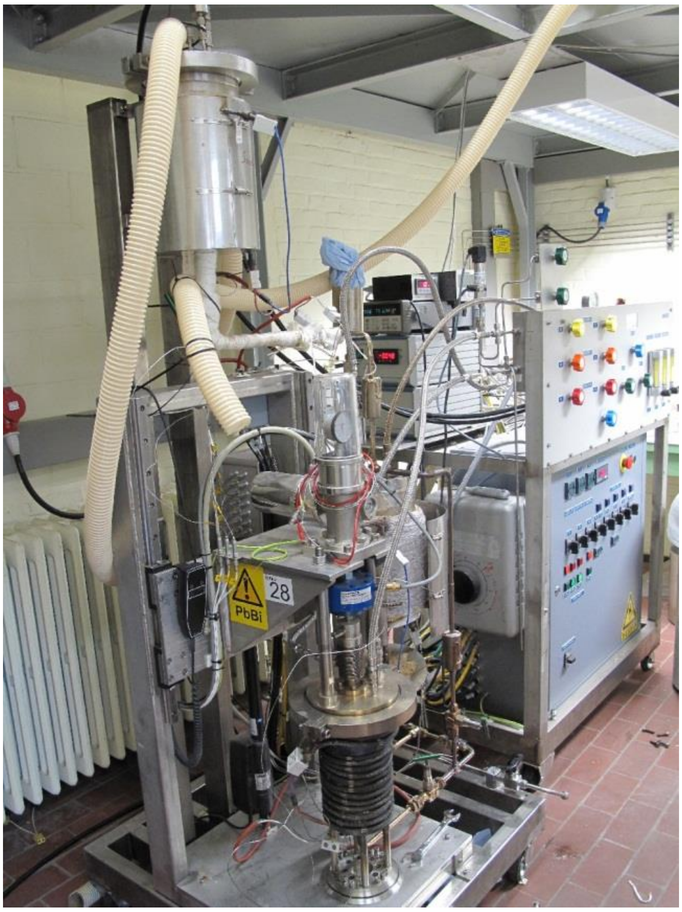

FIG. 2. View of the LIMETS1 facility

Parameters table

Coolant inventory	3,5 l
Power	3,5 kW
Test sections	
TS #1	*Characteristic dimensions* ϕ15cm x20 cm
	Static/dynamic experiment Static
	Temperature range in the test section (Delta T) 550°C-RT
	Operating pressure and design pressure **4 bar**
	Flow range (mass, velocity, etc.) Stagnant LBE
Coolant chemistry measurement and control (active or not, measured parameters)	Oxygen control via controlled gas flow Ar, Ar+5% H_2, Ar+20% H_2.. Double set of Bi/Bi0_2 sensors installed in both tanks

Instrumentation	Thermocouples, Oxygen sensors, Direct measurement of displacement on specimens, strain rate, load and frequency

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

LIMITS 1 was mainly used in the MYRRHA materials qualification programme and for various EU projects including FP6-EUROTRANS-DEMETRA, FP7 GETMAT and FP7 MATTER. The work focused on the assessment of Liquid metal embrittlement (LME) of austenitic and ferritic martensitic steels in LBE. An extensive set of tests were performed on various samples of T91- ferritic-martensitic steel and on 316L austenitic steel. Various possible influencing factors for LME embrittlement such as the applied strain rate, the surface preparation of the sample,the oxygen concentration of the melt, the test temperature and crack pretreatment were investigated. No evidence for the susceptibility of austenitic steels for LME embrittlement was found. Ferrritic-matensitic steels do show LME albeit that significant plastic deformation is necessary to initiate LME.

PLANNED EXPERIMENTS (including time schedule)

The planned experiments in LIMITS I are the following

- Mechanism of LME
- LBE effects on tensile, fracture toughness, s
- Screening tests for SCC
- Effect of irradiation on LME susceptibility
- Demonstration of austenitic stainless steel immunity to LME
- Usability range of T91

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. VAN DEN BOSCH J., BOSCH R.W., SAPUNDJIEV D., ALMAZOUZI A. " Liquid metal embrittlement susceptibility of ferritic–martensitic steel in liquid lead alloys" Journal of Nuclear Materials 376 (2008) 322–329
2. VAN DEN BOSCH J., COEN G., VAN RENTERGHEM W., ALMAZOUZI A. "Compatibility of ferritic–martensitic steel T91 welds with liquid lead–bismuth eutectic: Comparison between TIG and EB welds" Journal of Nuclear Materials 396 (2010) 57–64
3. VAN DEN BOSCH J., HOSEMANN P., ALMAZOUZI A.,. MALOY S.A "Liquid metal embrittlement of silicon enriched steel for nuclear applications" Journal of Nuclear Materials 398 (2010) 116–121
4. COEN G., VAN DEN BOSCH J., ALMAZOUZI A., DEGRIECK J. "Investigation of the effect of lead–bismuth eutectic on the fracture properties of T91 and 316L" Journal of Nuclear Materials 398 (2010) 122–128