Profile LFR-23

COLONRI I

CZECH Republic

GENERAL INFORMATION

NAME OF THE FACILITY	COnvection LOop NRI I
ACRONYM	COLONRI I
COOLANT(S) OF THE FACILITY	PbBi
LOCATION (address):	CVR, Hlavni 130 250 68 Husinec-Rez Czech Republic
OPERATOR	Centrum vyzkumu Rez s.r.o., CVR
CONTACT PERSON (name, address, institute, function, telephone, email):	Fosca Di Gabriele, Hlavní 130, 250 68 Husinec-Rez, Czech Republic, CVR, Senior Researcher, +420 266 17 2127, Fosca.Di_Gabriele@cvrez.cz

STATUS OF THE FACILITY	In operation
Start of operation (date):	2002

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 **COLONRI I** (**CO**nvection**LO**op **NRI**) is a test facility designed to perform experiments to investigate the interaction of materials with flowing PbBi eutectic. This is a vertical, natural convection loop. The loop was manufactured from the austenitic stainless steel AISI 321. The inner surface of the tube working at the highest temperature was covered with a molybdenum plate. The loop contains PbBi and can work up to a maximum of 500°C.

The facility (schematic below) consist of:

- High temperature experimental section and low temperature experimental section. The temperature difference maintained between two sections allows the liquid metal movement at the velocity up to about 2 cm/s. The two experimental sections can work at different temperatures with differences between T=50-150°C.
- Heating elements, thermocouples.
- Conditioning/drain tank.
- Facilities for the control of the gaseous mixture atmosphere inside the tubes that allow dosing of the inlet $Ar + H_2 + O_2$ mixture.
- An equalizing upper tank used also as a cold trap, where the oxides precipitates and float on the free surface of the liquid metal.
- Two sections to immerse specimens where the temperature is maintained constant. The specimen holders (4 for each experimental chamber) can contain three rows of specimens, for a total length of almost 200 cm.
- Thermocouples monitor the temperature along each leg with an accuracy of ± 1°C for testing legs and ± 3°C in the expansion tank
- Oxygen sensors monitor the oxygen content in the medium in the dosing tank and at least in one position along the main loop. These sensors are based on the Bi/Bi_2O_3 reference electrode.

Acceptance of radioactive material
No

Scheme/diagram

COLONRI I loop

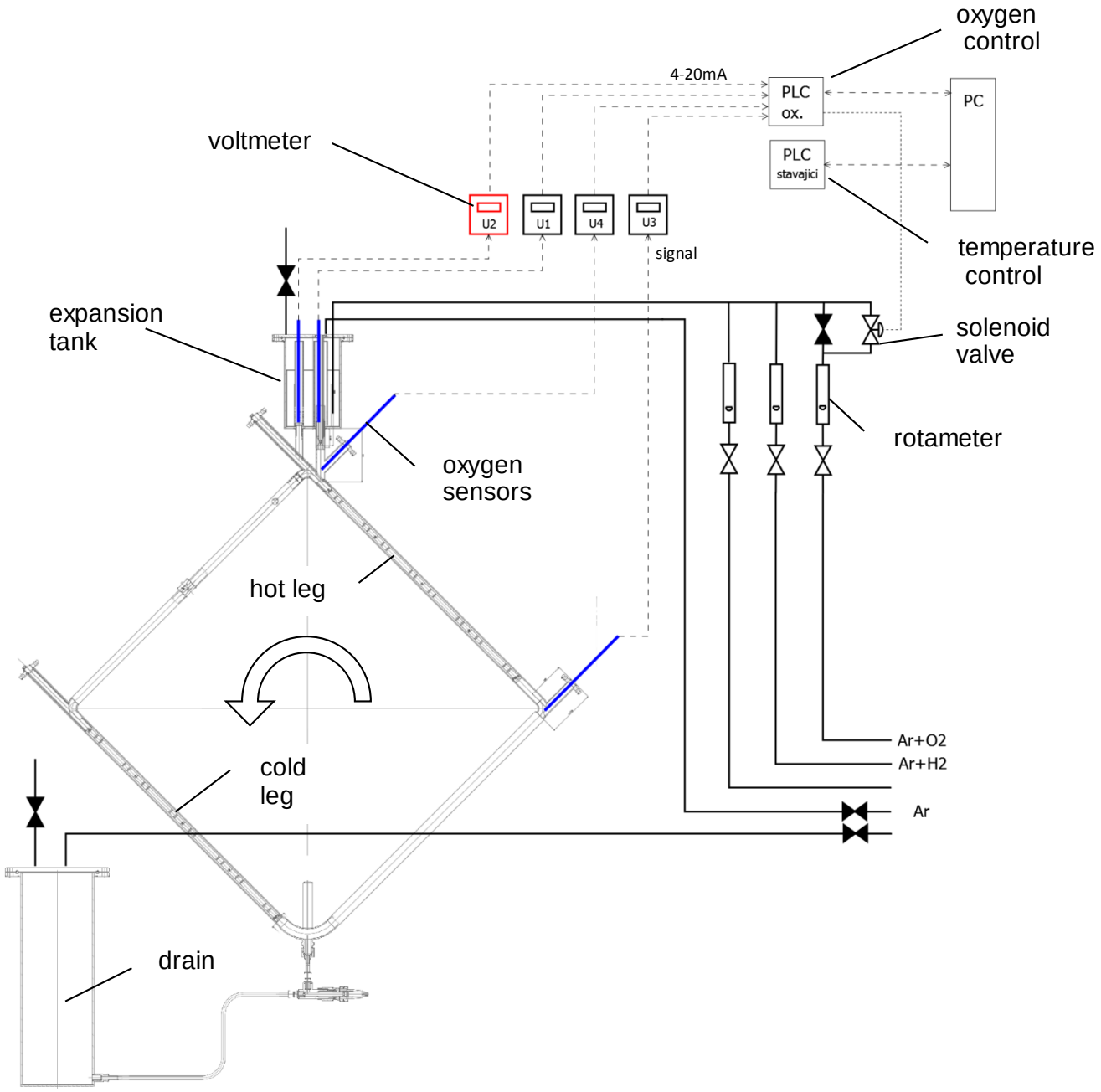

FIG. 1. Scheme of the COLONRI facility

3D drawing/photo

FIG. 2. View of the COLONRI facility

Parameters table

Coolant inventory	5.84 l
Power	Max. 7kW
Test sections	
TS #2	*Characteristic dimensions* 68cm (4 specimen holders per section), specimen cross-section 14.5x6 mm
	Static/dynamic experiment dynamic
	Temperature range in the test section (Delta T) Hot leg up to 500°C Cold leg 350° to 400°C
	Operating pressure and design pressure Atmospheric pressure
	Flow range (mass, velocity, etc.) 1-2 cm/s
Coolant chemistry measurement and	Simplified active oxygen control consisting of 3 YSZ electrochemical sensors (Bi/Bi2O3 ref) and PLC dosing Ar-O_2 gas into Ar/Ar-H_2 stream

control (active or not, measured parameters)	
Instrumentation	Thermocouple field and 3 to 4 YSZ oxygen sensors

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

FP6-EUROTRANS-DEMETRA: Corrosion of various alloys in COLONRI I. Focus on ferritic-martensitic steel T91 and austenitic 316L. Attempts were made to simulate accidental conditions, such as "hot spot" and "oxygen drop". Due to the lack of oxygen control, it was difficult to validate data and further experiments would be needed.

GACR Cz national grant: Corrosion of T91, 316L, and ODS steel in LBE (550°C, 400h, $O=10^{-7}$) and Pb (650°C, 400h, $O=10^{-7}$). The specimens were pre-oxidised in order to observe the effect of a protective oxide layer or the corrosion rates of the material. The steels with an initial layer of Cr_2O_3 performed the best.

FP7-GETMAT: Development of FeCrAlY coatings (5 and 11% Al) on T91, by HVOF+laser, and tests in COLONRI I (500h at 550°C) and COLONRI II (500h at 600°C). The coating deposition was able to produce thick coatings and overall improved the performance of the materials (T91 heavily damaged against coatings resistant to liquid metals).

PLANNED EXPERIMENTS (including time schedule)

GACR-AVOCADO (Cz national grant): oxidation/corrosion of ODS materials in COLONRI I and II. 2014-2017.

TRAINING ACTIVITIES

Internal training for operators. Available for external users.

REFERENCES (*specification of availability and language*)

1. DOUBKOVA A., KARNIK D., BURDA J., BRABEC P., GABRIELE F. DI, CHARACTERIZATION OF DAMAGE ON ALLOYS EXPOSED TO LIQUID Pb-Bi EUTECTIC, Proc. EUROCORR2006, Maastricht, The Nederlands 2006.
2. DOUBKOVA A., GABRIELE F. DI, BRABEC P., KEILOVA E., Corrosion behavior of steels in flowing lead-bismuth under abnormal conditions , Journal of Nuclear Materials, 376, 260-264 (2008).

3. BRISSONNEAU L., BEAUCHAMP F., MORIER O., SCHROER C., KONYS J., KOBZOVA A., GABRIELE F. DI,JCOUROUAU, .-L. Oxygen control systems and impurity purification in LBE: Learning from DEMETRA project, Journal of Nuclear Materials 415, 348–360 (2011).
4. GABRIELE F.DI, KOSEK L., Oxygen monitoring in the natural convection loop Colonri I, Proc. ICONE21, Chengdu (China) 2013.