

Profile LFR-2

CRAFT

BELGIUM

GENERAL INFORMATION

NAME OF THE FACILITY Corrosion Research for Advanced Fast reactor Technology
ACRONYM CRAFT
COOLANT(S) OF THE FACILITY Lead-Bismuth Eutectic (LBE)
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STATUS OF THE FACILITY In operation
Start of operation (date): 2014

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

CRAFT is a large scale corrosion loop that is used for materials corrosion research for MYRRHA. It is designed to be able to provide representative (or conservative) conditions in terms of temperature, oxygen concentration and flow. The loop is divided in a cold leg, containing the cooler, a filter set, the pump and a flow meter, and a hot leg. Here, the heater, the oxygen control system and the test sections are housed. The boundary of the two sections is formed by the heat recuperator. The design temperature of the cold leg is down to 200°C while the hot leg can be heated up to 550°C.

The central part of the facility are two replaceable test sections of 1 m length each. The internal diameter of each test section is 50 mm which is large enough to house a 7 pin mock-up of the MYRRHA fuel assembly including the first and second row of sub-channels. However, the specific arrangement of samples in the test section is experiment dependent on the experimental conditions required. In each test section an insert can be installed to locally increase the flow velocity. At the top of each test section, an access flange is foreseen that is placed inside an atmosphere controlled glove box. This allows sample exchange with a minimal impact on the chemistry control of the loop.

Oxygen control is done via gas-surface exchange in a dedicated oxygen control box. Depending on requirements, an appropriate mixture of Ar, H₂ and O₂ is allowed to interact with the LBE. Electronic mass flow controllers allow an automated oxygen control. Oxygen measurement is provided by a total of 12 oxygen sensors that are grouped in sets of 3. In the hot section, 9 sensors are placed while the cold section houses 3 sensors. A 30 kW heater placed upstream from the oxygen control tank the hot leg brings up the temperature of the LBE to the desired working level.

After passing the test section the LBE enters the recuperator. Here heat is passed from LBE leaving the hot leg to LBE entering the hot leg. In this way both parts get pre-cooled and pre-heated respectively. After the recuperator the LBE is cooled further via a high power LBE-air cooler to reach the set temperature in the cold leg. Subsequently the LBE is passed through a set of filters placed at the coldest part of the loop. The flow in the loop is provided by a 7,5 kW permanent magnet magneto-hydrodynamic pump that can create a pressure difference of 3 bar. The flow rate is measured by a Coriolis-type flow meter.

A PLC based computer driven automatic control system of processes and safety related interruptions is also installed to allow completely unsupervised operation of the loop. This system automatically performs oxygen control, LBE flow regulation and emergency dumps and cooldown of the loop. For this purpose pneumatic operated valves are operated over the entire loop.

Acceptance of radioactive material

No

Scheme/diagram

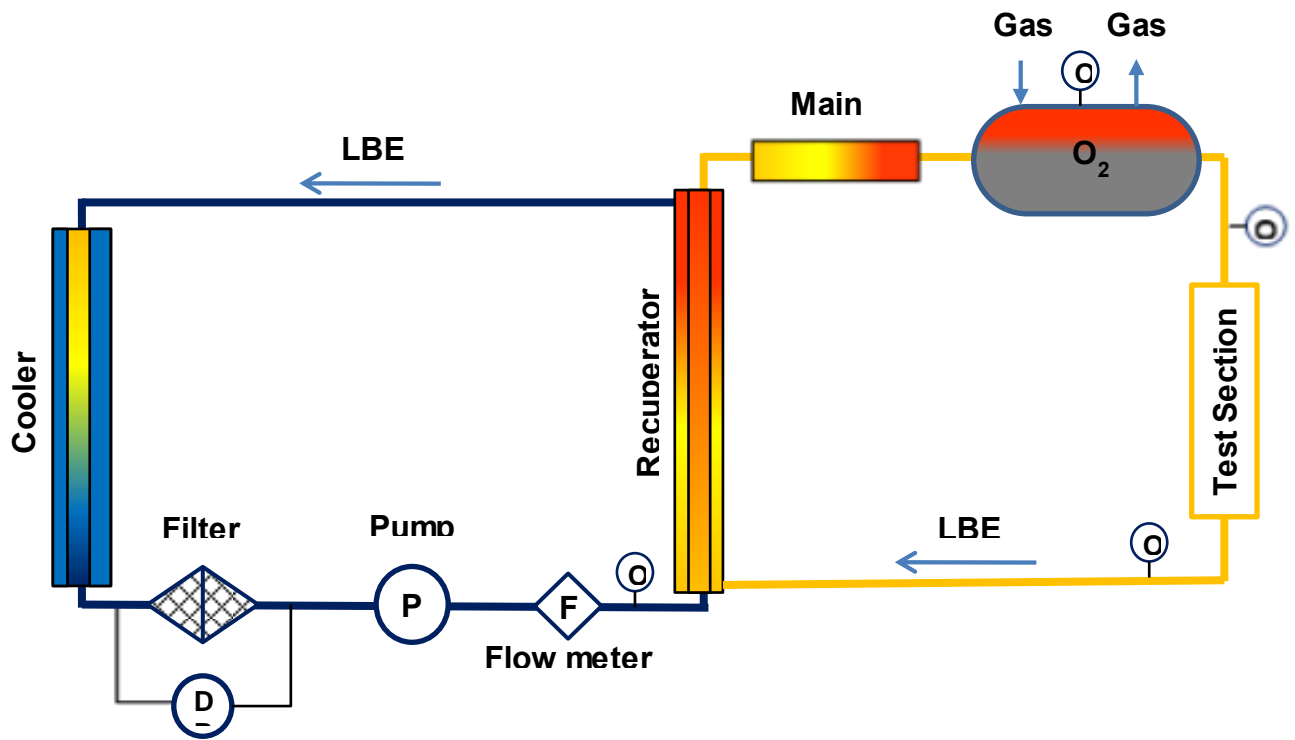


FIG. 1. Scheme of the CRAFT facility

3D drawing/photo

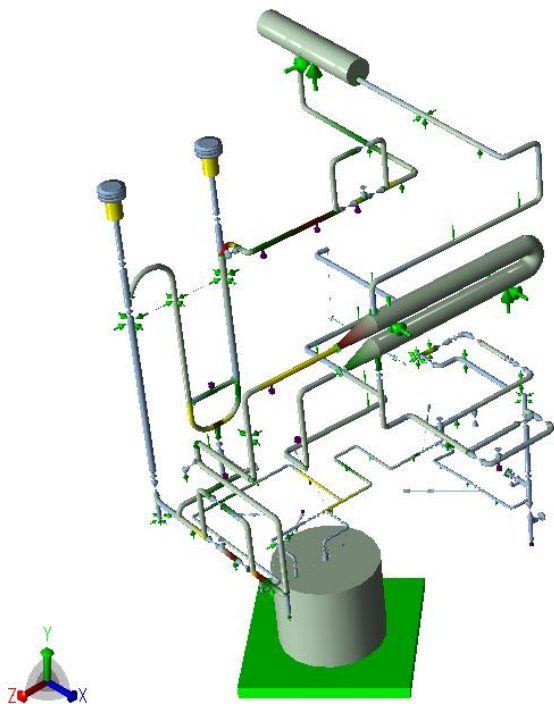


FIG. 2. View of the CRAFT facility

Parameters table

Coolant inventory	8000 kg
Power	60 kW
Test sections	
TS #1	<u>Characteristic dimensions</u> 2 Test sections ϕ 50 mm x 1000mm. Insert used for flow pattern definition
	<u>Static/dynamic experiment</u> Dynamic
	<u>Temperature range in the test section (ΔT)</u> 550-200°C
	<u>Operating pressure and design pressure</u> 10 bar
	<u>Flow range (mass, velocity, etc.)</u> flow velocity up to 5 m/s
Coolant chemistry measurement and control (active or not, measured parameters)	Automated Oxygen control via gas-surface interaction in a dedicated interaction tank. Oxygen concentration is monitored via 12 oxygen sensors in the loop.
Instrumentation	Thermocouples, oxygen sensors (12), Coriolis flow meter, power monitoring on loop and pump

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

First experimental campaign ongoing (see Section on planned experiments)

PLANNED EXPERIMENTS (including time schedule)

The CRAFT loop will be used for the research programme on corrosion on structural materials for MYRRHA in view of licencing. In the first phase the focus will be on developing a robust methodology and on the reproducibility of the results. Also the difference between materials and the effect of surface preparation (polished and as fabricated) will be studied. Planned materials are 316L, 1.4970, T91. Exposure times will be up to 5.000 h and the temperature and oxygen concentration setting are planned to be 470 °C and [O]: 10^{-7} wt.% respectively.

In the second phase the main goal will be the study of the development of the corrosion layer on reference cladding material in MYRRHA representative conditions. The exposure time is planned to be up to 17.000 h (2 years) at T: 470 °C and [O] : $10^{-7} \div 10^{-6}$ wt.%. The material will be actual 1.4970 fuel clad tubes produced by (Sandvik) in both pressurized and non-pressurized conditions. It is clear that the particular exposure conditions may be modified on the basis of the results from phase 1. In the third phase the work will be focused on long term

corrosion applications in MYRRHA. The goals here include the effect of flow velocity, LMC of the HX, the effect of a temperature gradient along corroded surface, new cladding candidate materials for the second MYRRHA core, ...

TRAINING ACTIVITIES

Due to the long time scale of the operation of CRAFT training opportunities are limited. 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., LIM J., MARIËN A., ROSSEEL K., GAVRILOV S., Operational experience during commissioning and start-up of the corrosion loop CRAFT at SCK•CEN, Proceedings of the 4th conference “Heavy liquid metal coolants in nuclear technologies”, Obninsk, 2013.