GENERAL INFORMATION

NAME OF THE FACILITY: DIADEMO Na
ACRONYM: DIADEMO Na
COOLANT(S) OF THE FACILITY: Sodium, Nitrogen and Lead-Lithium eutectic
LOCATION (address): CEA Cadarache
13108 Saint Paul Lez Durance
FRANCE
OPERATOR: CEA
CONTACT PERSON: O. GASTALDI
(name, address, institute, function, telephone, email):
CEA Cadarache
Building 208,
13108 Saint Paul Lez Durance, FRANCE
Sodium Technology and Components Project Manager
+33 4 42 25 46 40
Olivier.gastaldi@cea.fr

STATUS OF THE FACILITY: In operation
Start of operation (date): 2013

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 DIADEMO-Na facility has been adapted by creation of a complete liquid sodium loop in complement to existing gas and PbLi eutectic circuits initially called DIADEMO. This facility allows, among others, the test of a sodium/gas heat exchanger mock-up with 40 kWth power.

In the design of the additional sodium loop, an independent sodium pot and a test section with circulating sodium (few m.s\(^{-1}\)) have been included to enlarge this facility potentiality. Specific
instrumentation or small components prototype will be tested in this sodium pot and in the dynamic test section (flowmeters, valves...).

Two configurations are possible: gas exchanging heat with the Pb-Li loop or gas exchanging heat with the sodium circuit. This test platform is mainly composed of:

- a sodium circuit,
- a gas pressure circuit,
- a test section containing a plate machined heat exchanger Na / gas,
- a test instrumentation section Na,
- a Pb-Li system with its test section containing a model of heat exchanger diving in Pb-Li and wherein the gas flows,
- a cooling water circuit,
- a compressed air circuit feeding the electropneumatic valves (valves circuit sodium valves gas circuit).

Acceptance of radioactive material
No

Scheme/diagram
3D drawing/photo
### Parameters table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant inventory</td>
<td>300 L of Na, 55 L of PbBi</td>
</tr>
<tr>
<td>Power</td>
<td>40 kWth for heat exchange</td>
</tr>
<tr>
<td><strong>Test sections</strong></td>
<td></td>
</tr>
</tbody>
</table>
| TS #1 – Heat exchanger mock-up| **Characteristic dimensions**  
About 1.2 x 0.2 x 0.2 m  
**Static/dynamic experiment**  
Dynamic experiment in steady state and transient conditions  
**Temperature range in the test section (Delta T)**  
For sodium: between 340°C and 550°C  
**Operating pressure and design pressure**  
For nitrogen circuit, operating pressure: 80 bar and design pressure: 100 bar  
For sodium circuit: operating pressure < 500 mbar and design pressure: 3 bar  
**Flow range (mass, velocity, etc.)**  
For sodium: Flow rate: 2 m³/h, Velocity depends on the design of mock-up in test section  
For nitrogen: Mass flow rate: 200 g/s |
| TS #1                          | **Characteristic dimensions**  
1.2 m x 0.025 m diam. in the current configuration  
**Static/dynamic experiment**  
Dynamic  
**Temperature range in the test section (Delta T)**  
200 to 550°C  
**Operating pressure and design pressure**  
operating pressure < 500 mbar and design pressure: 3 bar  
**Flow range (mass, velocity, etc.)**  
Sodium flowrate: 2 m³/h |
| Coolant chemistry measurement and control (active or not, measured parameters) | Active coolant quality measurement and control (purification on a by passed flow: 1 m³/h and impurities level < few ppm) |
| Instrumentation               | Thermocouples  
In sodium pressure measurement  
Inductive level probes  
Electromagnetic flowmeters for sodium and PbLi  
Gas flowmeter  
Gas pressure sensors |

**COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS**

Test campaigns on four PMHE heat exchanger mock-up were performed between 2013 and 2018.
PLANNED EXPERIMENTS (including time schedule)

<table>
<thead>
<tr>
<th>N° Mock up</th>
<th>Designer / provider</th>
<th>Manufacturing process</th>
<th>Fluids</th>
<th>Pattern</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CEA / CEA</td>
<td>DB-HIP* (type 1)</td>
<td>Na / N₂</td>
<td></td>
<td>2013</td>
</tr>
<tr>
<td>1 bis</td>
<td>CEA / CEA</td>
<td>DB-HIP* (type 1)</td>
<td>Na / N₂</td>
<td>Wavy channel</td>
<td>2014</td>
</tr>
<tr>
<td>2</td>
<td>DB-HIP* (Type 2)</td>
<td>Na / N₂</td>
<td></td>
<td></td>
<td>2015-2016</td>
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<tr>
<td>2bis</td>
<td>Na / N₂</td>
<td>Wavy channel</td>
<td></td>
<td></td>
<td>2016-2018</td>
</tr>
<tr>
<td>3</td>
<td>CEA / CEA</td>
<td>DB-HIP* (Type 2)</td>
<td>Na / N₂</td>
<td>Straight channel</td>
<td>2020-2021</td>
</tr>
<tr>
<td>4</td>
<td>CEA / CEA</td>
<td>DB-HIP* (Type 2)</td>
<td>Na / N₂</td>
<td>To define</td>
<td>2022-2023</td>
</tr>
<tr>
<td>5</td>
<td>CEA / CEA</td>
<td>DB-HIP* (Type 2)</td>
<td>Na / H₂O</td>
<td>To define</td>
<td>2025-2027</td>
</tr>
<tr>
<td>6</td>
<td>CEA / CEA</td>
<td>Additive manufacturing</td>
<td>Na / N₂</td>
<td>or Na / H₂O</td>
<td>To define</td>
</tr>
</tbody>
</table>

*DB-HIP: diffusion bonding by hot isostatic pressure

In the next years, a study is planned to add a pressurized water circuit on the DIADEMO facility to be able to qualify sodium / water heat exchanger.

TRAINING ACTIVITIES
Possible, but no specific training activities

REFERENCES (specification of availability and language)


Patents:


L. Cachon, C. Galati, X. Jeanningros and A. Molla « Module d’échangeur de chaleur a plaques dont les canaux intègrent en entrée une zone de répartition uniforme de d’ébit et une zone de bifurcations de fluide » patent FR16 57543, 3 August 2016.