

Profile SFR-10

CARNAC

FRANCE

GENERAL INFORMATION

NAME OF THE FACILITY	CARNAC (Continuous sodium (Na) Carbonation)
ACRONYM	CARNAC
COOLANT(S) OF THE FACILITY	Sodium
LOCATION (address):	CEA Cadarache, 13108 Saint Paul Lez Durance FRANCE
OPERATOR	CEA
CONTACT PERSON (name, address, institute, function, telephone, email):	CEA Cadarache Building 710, 13108 Saint Paul Lez Durance, FRANCE Sodium Technology and Components Project Manager +33 4 42 25 37 87 Olivier.gastaldi@cea.fr

STATUS OF THE FACILITY	In operation
Start of operation (date):	1998

MAIN RESEARCH FIELD(S)	<input type="checkbox"/> Zero power facility for V&V and licensing purposes
	<input type="checkbox"/> Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
	<input type="checkbox"/> Thermal-hydraulics
	<input checked="" type="checkbox"/> Coolant chemistry
	<input type="checkbox"/> Materials
	<input type="checkbox"/> Systems and components
	<input type="checkbox"/> Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

CARNAC facility was designed to study the smooth chemical metallic sodium transformation (progressive reaction) into a more stable chemical compounds in near-normal temperature and pressure conditions. This kind of process is needed to treat residual metallic sodium before maintenance operations to be done in air conditions for example.

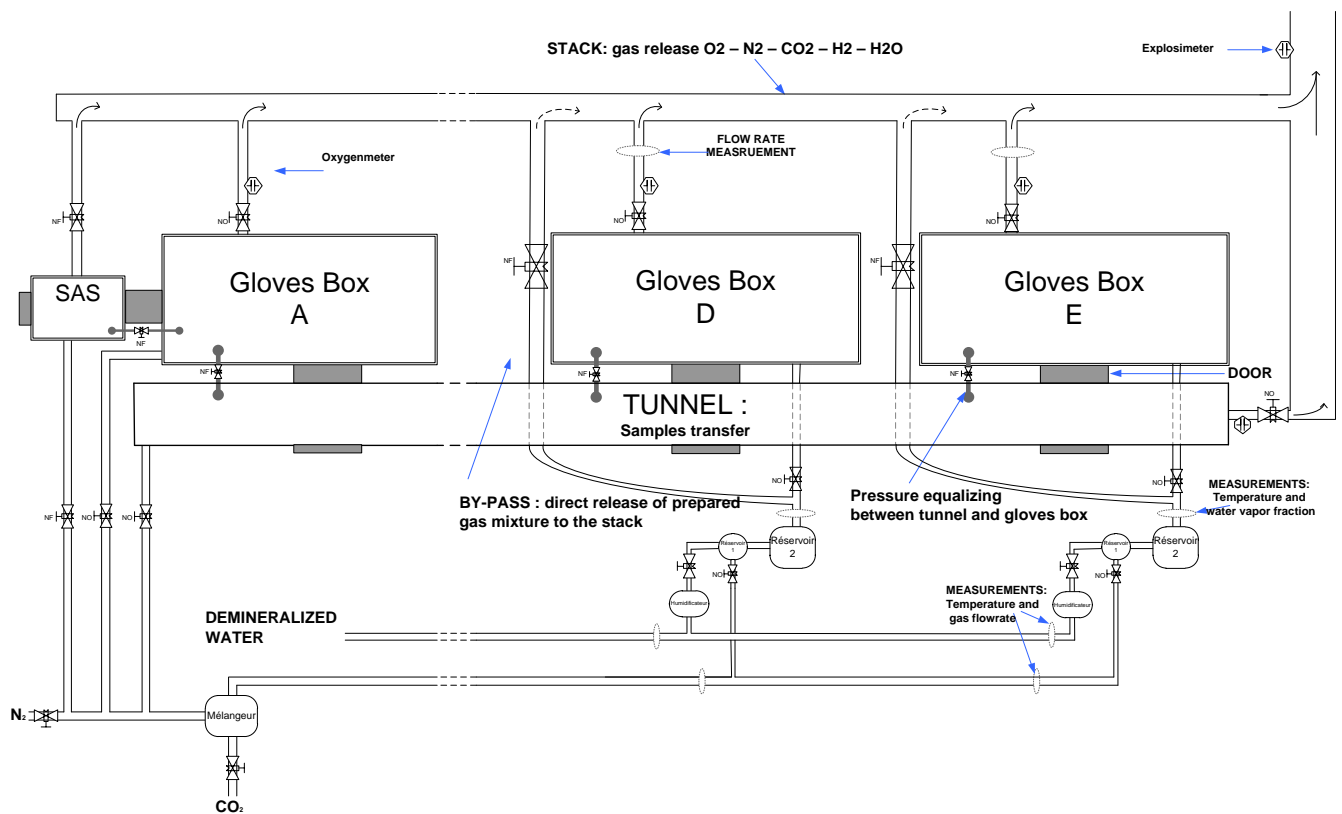
CARNAC facility is composed of a series of glove boxes in which the atmosphere composition is controlled:

- 4 independent glove boxes (500 L each) in which reaction tests are done. Each glove box has its own regulated alimentation in gases (nitrogen, carbon dioxide, air and/or water) and its own temperature regulation from 25 to 70°C;
- 1 inerted glove box (700 L) for preparation of samples and test;
- 1 tunnel for the transfer from the preparation box to one of the testing glove boxes;
- 1 analysis system (gas micro chromatography and mass spectroscopy) in charge of the speciation of the atmosphere of glove boxes;
- 1 system for video acquisition and image treatment in order to observe the formation of the different reaction products.

Acceptance of radioactive material

No

Scheme/diagram



3D drawing/photo



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Parameters table

Coolant inventory	50 L
Power	N.A.
Test sections	
TS #1 (4 equivalent test sections)	<u>Characteristic dimensions</u> Volume: 500 L Available surface: around 1 x 0.5 m Maximum mock-up size limited by tunnel and sas: around 250x250x500 mm
	<u>Static/dynamic experiment</u> Static sodium, flow of reactive mixture
	<u>Temperature range in the test section (ΔT)</u> 20°C to 60°C
	<u>Operating pressure and design pressure</u> Maximum operating pressure: 100 mbar rel.

	<p><i>Flow range (mass, velocity, etc.)</i></p> <p>Gas flowrate : from 50 to 1000 L/h, with :</p> <ul style="list-style-type: none"> • water fraction in the gas: from 0.3 molar % to 5.9 molar %, • carbon dioxide fraction in the gas: from 0 molar % to 40 molar %, • nitrogen fraction : complement to 100 molar %
Coolant chemistry measurement and control (active or not, measured parameters)	<p>No control of sodium chemistry (solid phase only)</p> <p>Oxygen monitoring in gas to detect air ingress (leakage of the gloves box)</p>
Instrumentation	<p>Temperature measurement</p> <p>Pressure measurement</p> <p>Gas content analysis (N₂, CO₂, H₂O, H₂) by μ-gas chromatography</p>

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Originally CARNAC has been used for the study of sodium carbonation (with a mixture of carbon dioxide, nitrogen and water vapour). It allows to determine what is the best mixture of nitrogen, carbon dioxide and water vapour to obtain a rather good kinetic when keeping reaction products in solid phase. These tests have defined:

- The influence of the various parameters: temperature, reaction gas concentrations, etc.;
- The carbonated sodium thicknesses versus time;
- The type of sodium carbonates that are produced: NaHCO₃ or/and Na₂CO₃

With the best set of parameter the order of magnitude of the kinetic is about 7 mm of metallic sodium treated within 100 hours. Long duration carbonation tests were made during over four months long. It appears that there was only a slow decrease of the kinetic mainly due to sodium carbonate that expands, cracks everywhere and therefore creates new crevices giving access to the residual metallic sodium and then humid gas can continue the sodium carbonation process.

Optimisation of the operating conditions of sodium carbonation in various specific configurations has been realised and is still running.

The CARNAC facility has been used to study the oxidation of natural air by sodium (more or less humid).

Experiments like NaK carbonation have been performed.

PLANNED EXPERIMENTS (including time schedule)

The future planned experiments need an upgrade of the facility. This work will be done in 2019.

TRAINING ACTIVITIES

No

REFERENCES (*specification of availability and language*)

G. RODRIGUEZ, O. GASTALDI, F. BAQUE

Recent sodium technology development for the decommissioning of the RAPSODIE and SUPERPHENIX reactors and the management of sodium wastes

Nuclear Technology, Volume 150, Number 1, April 2005, Pages 100-110

RODRIGUEZ. G., GASTALDI. O.,

Sodium carbonation process development in a view of treatment of the primary circuit of Liquid Metal Fast Reactor (LMFR) in decommissioning phases,

ICEM'01, 8th International Conference on Radioactive Waste Management and Environmental Remediation, Bruges (Brugge), Belgium, 30 Sept - 4 Oct, 2001

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Decommissioning of Fast Reactors after Sodium Draining