

Profile SFR-66

PROTVA-1

RUSSIA

GENERAL INFORMATION

NAME OF THE FACILITY Sodium facility "Protva-1"
ACRONYM Protva-1
COOLANT(S) OF THE FACILITY Sodium, Sodium-Potassium
LOCATION (address): Institute for Physics and power Engineering, Obninsk, Russia
OPERATOR «Rosatom»
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STATUS OF THE FACILITY In operation
Start of operation (date): 1983, 2011 – renovation.

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

Protva-1 facility composed of two liquid metal circuits, technological equipment and test sections. Coolant of the first circuit is sodium, of the second one - sodium-potassium alloy (eutectic) which serves for cooling test section. Circulation of the sodium throughout the main circuit is provided by electromagnetic pump. Operational temperature is provided by the main heater of adjustable power, which is located on bypass of the main circuit. Purification of sodium is performed by 200 l cold trap cooled by air. There is a drain tank expansion tanks in the circuit. Pipes of the main circuit are made of austenite steel Ch18N10T and Ch18N9; primary pipes have dimensions 83×4 mm and secondary – 40 × 3.5 mm.

Electromagnetic pumps

Electromagnetic pump CLIP (Cylindrical Linear Inductive Pump) serves for support circulation of sodium throughout Protva-1 circuit. CLIP-4/200 (4 kg/cm² – pressure, 200 m³/h – flow rate) works in the temperature range 450 – 650 °C.

Also several auxiliary pumps available in the circuit: VIN-4/2.5, U = 380 V and vacuum pumps VN1MG and VM-461-MG.

Heaters of test sections

Main heater of Protva-1 facility is SPM-240/5.8 (U₁ = 380 B, U₂ = 12 B) serves for heating up sodium coolant in the primary circuit up to 580 °C. Main heater powered by thyristor regulator RNTT-330-600. Power of the main heater is 180 kWt.

Test section

Test section is located at the high temperature part of the circuit and serves for experimental investigation of the corrosion products mass transfer in the sodium at the temperature 750 °C.

The main components of the circuit is a recuperator with heat and mass transfer tube, filter of sodium, heater of the section and source of corrosion products with the places for coupons for structure materials investigation.

Test section works as follows: sodium out of Protva-1 circuit goes to the recuperator at the temperature 450-750 °C and got heated up to 650 °C, and then goes to the heater. After heater sodium has temperature around 750 °C and goes to the chamber of the impurities source and then to the cooled surface of the recuperator, where crystallization occurs.

Recuperator is a heat exchanger with sodium-sodium counter flow composed of inside iron tube (12×1 m) and outer tube (25×2.5, Ch18N10T steel). Main heater is a four segment coil composed out of EI732 steel and has a length 6 m. Source of the corrosion products is a metal cylinder, filled with steel shavings.

Cold traps

Cold traps serves for purification of the sodium coolant from the oxygen and hydrogen. The work of the cold traps is based on the crystallization of impurities out of supersaturated solution. Cold trap of the Protva-1 facility has a volume of 200 l and cooled by air from the outside.

Sampling devices

Sampling devices designed for taking a sample from the circulation loop and sodium-potassium alloy, sodium (100g), followed by distilling it and determining the oxygen content in oxides. There are two sampling devices on the Protva-1 facility.

Plugging meter

Concentration of the impurities in the sodium coolant is measured by plugging meter and electrochemical sensors and sampling device. Plugging meter has a 64 channels (0,5×0,5 mm, S= 16 mm²). Flow rate through the plugging meter is 150 l/h.

Acceptance of radioactive material

No

Scheme/diagram

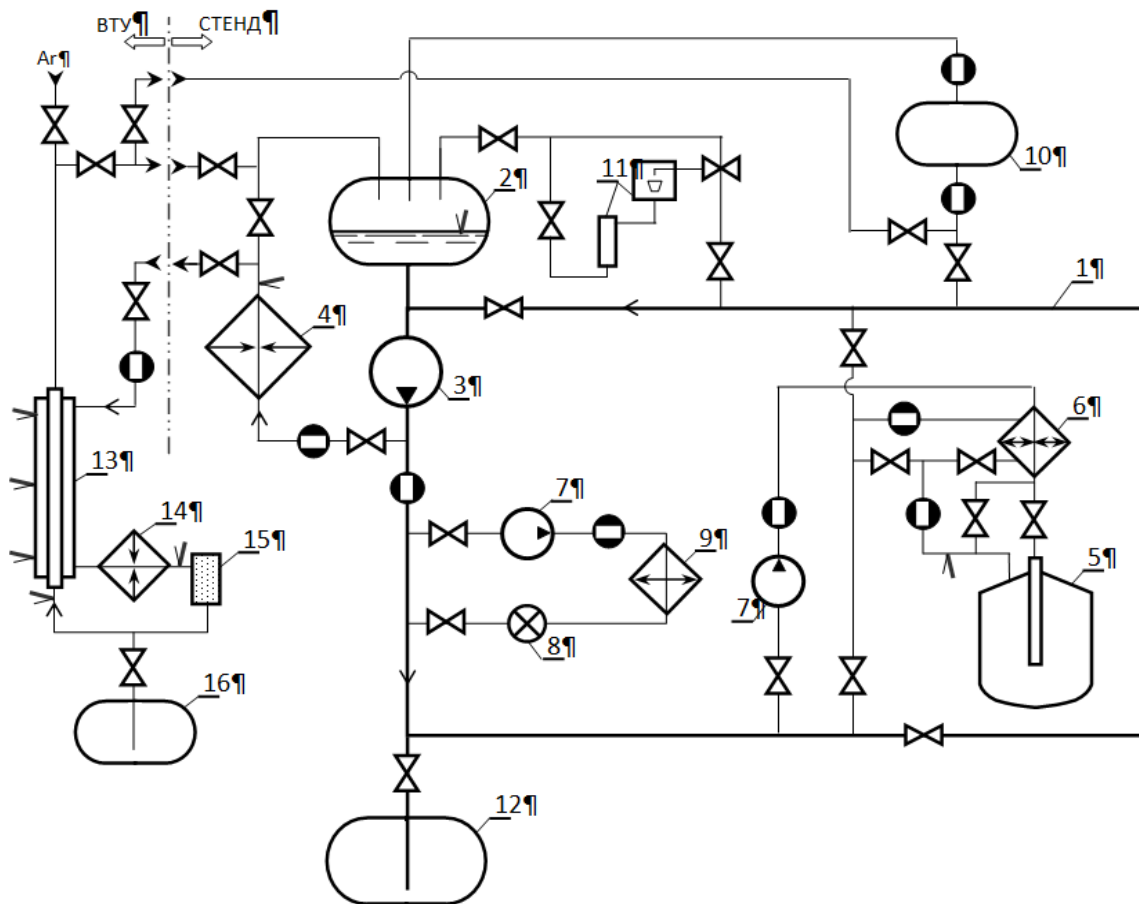


FIG.1 Scheme of the Protva-1 facility and very high temperature test section

1 – main pipe of the circuit, 2 – expansion tank, 3 – electromagnetic pump CLIP-4/200, 4 – main heater SPM-240/5.8, 5 – cold trap, 6 – recuperator for the cold trap, 7 – auxiliary pump VIN-4/2.5, 8 – plugging meter, 9 – heat exchanger for PM, 10 – measuring tank, 11 – sampling device with condenser, 12 – drain tank.

Very High Temperature Section

13 – heat and mass transfer tube unit, 14 – heater, 15 – source of the impurities (Cr, Fe, Ni), 16 – drain tank.

○ – flow meter, > thermocouple, - - - - arbitrary boundary of the Protva-1 facility and test section.

3Ddrawing/photo



FIG. 2. Protva-1 facility, first level.



FIG. 2. Protva-1 facility, second level.

Parameters table

Coolant inventory	Na – 900 kg, Na-K – 150 kg
Power	800 kWt
Test sections	
TS #1	<u>Characteristic dimensions</u> Main pipes 83×4 mm ; axillary – 40 × 3.5 mm
	<u>Static/dynamic experiment</u> Dynamic
	<u>Temperature range in the test section (Delta T)</u> 450 - 780 °C
	<u>Operating pressure and design pressure</u> Na - 0,06 MPa, Na-K – 0,06 MPa
	<u>Flow range (mass, velocity, etc.)</u> Na - 200 m ³ /h, Na-K – 10 m ³ /h
Coolant chemistry measurement and control (active or not, measured parameters)	Plugging meter Sampling device Cold trap The systems for supplying water, hydrogen and oxygen in the sodium loop Electrochemical sensors
Instrumentation	Thermocouples, pressure transducer, Oxygen sensor, Mass exchanger, Gas injection system, Electromagnetic flow meter, Level gauge measurement system, sensors for measuring pressure in the circuits such as "Sapphire", "Metran-2". <u>Main components of the facility:</u> 1. Electromagnetic pump CLIP 4/200. 2. Main heaterSPM-240/5.8. 3. Expansion tank (V=400 l). 4. Draintank (V=500 l). 5. Measuringtank (V=100 l). 6. Test sections. 7. Coldtrap(V=200 l). 8. Sampling device. 9. Plugging meter. 10. Electromagnetic pump ENIV-3. 11. Expansion tank of the IIcircuit. (V=60 l). 12. Drain tank of the IIcircuit (V=400 л). 13. Heat exchangers “sodium potassium– air “and “sodium – sodium potassium”.

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

1. Mass transfer of Ch18N10T steel corrosion products in sodium has been investigated and mass transfer constants of such a process were obtained.
2. The experimental investigations and analysis of the processes regarded with contamination of sodium with oil were performed.
3. Device for intensive purification of sodium from products of sodium-water interaction was tested
4. Investigations connected with choose in acoustic sensors for steam generators leaks detection system were performed

PLANNED EXPERIMENTS (including time schedule)

1. Experimental investigation of physical – chemical processes of mass transfer in high temperature non-isothermal system “structural materials – sodium”
2. Experimental tests of integrated cold trap mockup for advanced fast reactor
3. Investigation of new principles of primary circuit sodium coolant purification (without integrated in the reactor cooling system)

TRAININGACTIVITIES

All train in activities of specialists and experimentations on liquid metals facilities must be agree with “Rosatom” corporation.

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