

Profile SFR-65

PLUTON

RUSSIA

GENERAL INFORMATION

NAME OF THE FACILITY: Facility "Pluton" for investigation of thermal interaction of corium simulators with sodium

ACRONYM: Pluton

COOLANT(S) OF THE FACILITY: Sodium

LOCATION (address): State Scientific Centers of Russian Federation – Institute of Physics and power Engineering after A.I. Leypunsky

OPERATOR: Rosatom

CONTACT PERSON (name, address, institute, function, telephone, email): Zagorulko Yury Ivanovich
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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

Facility "Pluton" basically consists of sodium circuit, located inside of special box and incorporates an experimental part and technological units for sodium purification from impurities before filling of the experimental part. It is supplied by devices for sodium technological purity control.

Sodium circulation in the circuit (pipe 32×3.3 mm) is effectuated by means of electromagnetic pump VIN 8/10. Temperature regime in the circuit is maintained by means of main heater (MH) with regulated power (SPM – 150/7.5) as well as by circuit heaters. Sodium cleaning is performed by means of 40 – litres cold trap (CT) with air cooling. To

control impurities content in sodium a plugging meter (PM) is used. The experimental part (EP) is supplied by the unit for corium simulator injection and equipped by measuring devices.

- Sodium respiration tank: is designated to provide sodium circulation in the circuit; volume of 0.1 m^3 ; maximum pressure of 0.25 MPa; maximum sodium level of 420 mm.
- Drainage tank: is designated for sodium drainage (in case of accidental situations and after completion of the experiments; volume of 0.1 m^3 , maximum pressure 0.25 MPa, maximum sodium level of 600 mm.
- Electromagnetic pump VIN 8/10: is designated to provide sodium circulation in the circuit; maximum pressure of 0.4 MPa; flow $2.5 \text{ m}^3/\text{h}$.
- Cold trap: is designated for sodium cleaning of sodium oxide and sodium hydride; volume of 0.04 m^3 ; air cooling.
- Main heater: is designated for sodium heating in the circuit; is designed as a secondary winding of current transformer; it is supplied by heat recuperation unit; power of 150 kWt.
- Mixer: is designated to mix high- and low-temperature sodium flows to exclude thermal shocks at circuits pipelines and technological units.
- Plugging meter: is designated to measure impurities content in sodium; it is supplied by heat-exchanger sodium/air.
- Recuperation unit: is designated to provide power saving.

The sodium circuit is supplied by shut-off and cut-off valves and devices of circuit technological parameters control (magnetic flow-meters, thermocouples, sodium level meters, pressure sensors).

Facility is supplied by the auxiliary systems: gas-vacuum system; system of circuit units air-cooling; ventilation system; system of circuit heaters.

- Experimental part: is designated for investigation of corium simulators (melt ZrO_2+Fe ; $\text{Al}_2\text{O}_3+\text{Fe}$; UO_2+Mo) thermal interaction with sodium and fuel thermal elements claddings damage at ULOF accident conditions. In the investigation of corium simulators/sodium thermal interaction energy release effects there are used melts produced in thermite mixtures reactions, initiated by means of electric heating. The operation is performed in thermite camera of the experimental part. In the experiments with fuel elements simulators (as free suspended bundles or fuel elements assembly mock-up) the corium simulators melts are generated directly inside of fuel elements simulators by means of current heating.

The principal unit of the experimental part is the reaction chamber, equipped by pressure pulsation sensors. It is supplied by the bypass line with magnetic flowmeter to measure sodium relocation. At the bottom of reaction chamber is situated filter unit to collect corium fragments. Fuel elements bundles or subassemblies mock-ups are mounted inside of reaction chamber before its filling with sodium. Depending on the subassemblies geometry there can be used the reaction chambers of various diameter.

Acceptance of radioactive material

^{238}U could be used in quantities up to 120 g.

Scheme/diagram

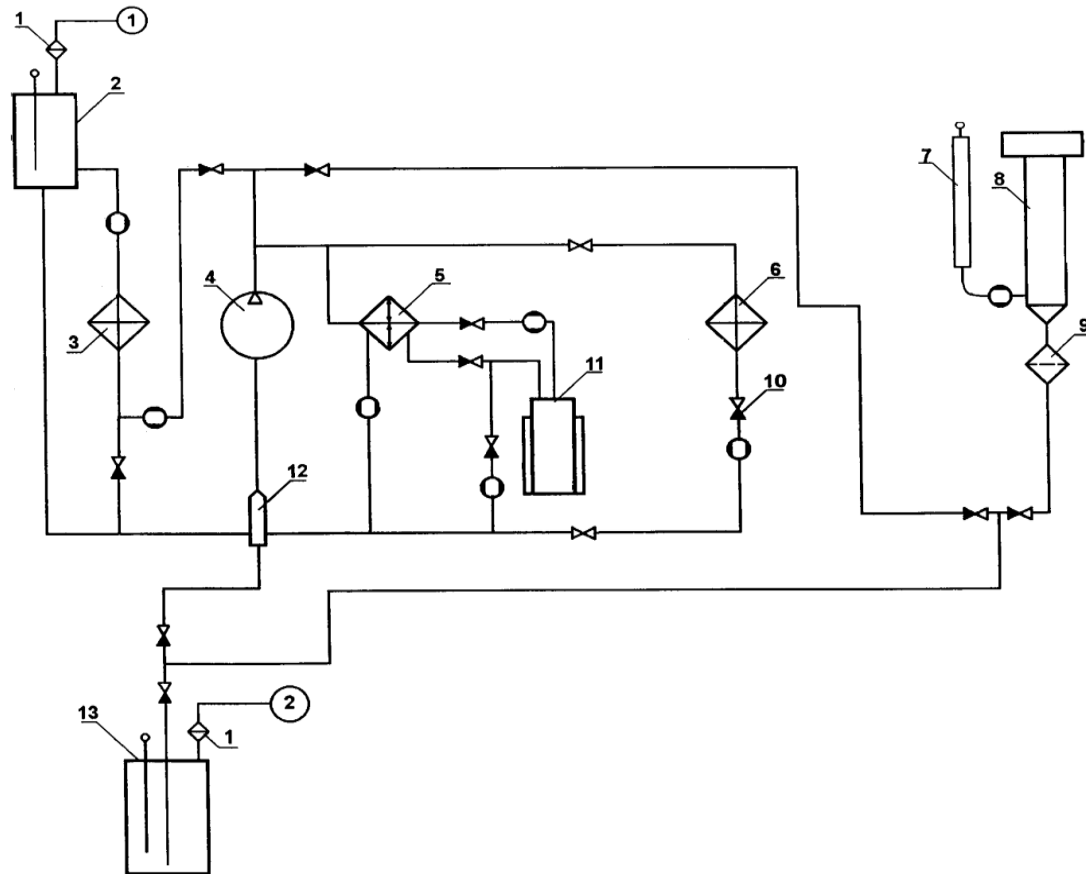


FIG. 1. Principal scheme of the PLUTON facility

1 – sodium vaporous trap; 2 – respiratory tank; 3 – main heater; 4 – pump VIN 8/10;
5 – recuperation heat-exchanger; 6 – heat-exchanger of PM; 7 – sodium level meter of EP;
8 – EP; 9 – filter unit; 10 – valve of PM; 11 – CT; 12 – mixer; 13 – drainage tank

3D drawing/photo



FIG. 2 Overall view of the PLUTON facility (upper platform)

Parameters table

Coolant inventory	Sodium, volume 0.12-0.14 m ³
Power	150 kWt
Test sections	
TS #1	<u>Characteristic dimensions</u> Inner diameter of 108 mm Overall height of 900 mm
	<u>Static/dynamic experiment</u> Static experiments
	<u>Temperature range in the test section (ΔT)</u> 300-650°C
	<u>Operating pressure and design pressure</u> Operating pressure 0.5 MPa Design pressure 2.5 MPa
	<u>Flow range (mass, velocity, etc.)</u> 0 (experiments are performed in static conditions)
Coolant chemistry measurement and control (active or not, measured parameters)	A cold trap is used for sodium purification in the circuit and experimental part. At circuit operation electric power; sodium flow rate, pressure and temperature are controlled. Sodium sampler-distillator is used to determine impurities content by sodium chemical analysis methods (designed and fabricated by SSC RF IPPE)
Instrumentation	<ul style="list-style-type: none"> • temperature sensors of various design (designed and fabricated by SSC RF IPPE) • modified sensors of "Saphir" and "Metran" type for pressure measurement • pressure pulsation sensors (type DPS-12) • sodium level meters of contact type (designed and fabricated by SSC RF IPPE) • magnetic flow-meters

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

There were investigated dynamic characteristics and energy release effects in the processes of corium simulators (melt ZrO_2+Fe ; Al_2O_3+Fe ; UO_2+Mo) thermal interaction with sodium in dependence of initial experimental parameters (sodium initial temperature; melt/sodium contact mode; mass ratio m_{Na}/m_{corium} ; interaction space conditions (bundle geometry of fuel elements) etc.

Investigation of fractional content, morphology and size (mass) distributions of corium simulators final fragments.

Investigation of fuel elements claddings damage in conditions of ULOF accident.

PLANNED EXPERIMENTS (including time schedule)

Investigation of materials relocation in volume of fuel elements subassembly and blockage phenomena in conditions of ULOF accident

Interaction of corium with structural materials at their boundaries.

TRAINING ACTIVITIES

Activity on training of specialists-researchers at liquid metal and thermohydraulic facilities should be approved with State Corporation "Rosatom".

REFERENCES (*specification of availability and language*)

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