Profile LFR-65

TT-2M

RUSSIA

GENERAL INFORMATION

NAME OF THE FACILITY	Liquid metal facility "TT-2M" to study physical and chemical processes caused by interaction of liquid metal coolant Pb-Bi with water, air, ceramic and composite materials, carbon
ACRONYM	Liquid metal facility "TT-2M"
COOLANT(S) OF THE FACILITY	Lead-bismuth (44.5% Pb – 55.5% Bi).
LOCATION (address):	Federal State Unitary Enterprise "State Scientific Centre of the Russian Federation – Institute for Physics and Power Engineering named after A.I. Leypunsky", State Corporation "Rosatom", Russian Federation.
OPERATOR	State Corporation "Rosatom"
CONTACT PERSON (name, address, institute, function, telephone, email):	Storozhenko Aleksey Nikolayevich Bondarenko Sq. 1, Obninsk, Kaluga Region, 249033, Russia. Head of Laboratory, Cand. Sc. (Physics and Mathematics), phone.: +7 484 399-45-02, fax: +7 484 399-53-69, e-mail: anstor@ippe.ru.

STATUS OF THE FACILITY	In operation
Start of operation (date):	Commissioning – 1971, substantial upgrading – 1981, upgrading – 2011-2012.

MAIN RESEARCH FIELD(S)

- ☐ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☐ Thermal-hydraulics
- x Coolant chemistry
- x Materials
- x Systems and components
- ☐ Instrumentation & ISI&R

TECHNICAL DESCRIPTION

The TT-2M facility is a set of three loops: a liquid metal loop, a water loop and a gas system.

The liquid metal loop has an inventory of 200l LBE, flow rates up to 5m³/h, a maximum pressure of 1.5MPa and a temperature range from 200°C to 550°C. The electrical power is 220kW.

The main coolant circulation loop consists of the following components: TsN-5/15 pump, recuperator-1, recuperator-2, heating loop, hot sections, recuperator-2, recuperator-1, heat exchanger and the cold sections. The main loop is made of stainless steel. The main loop pipe diameter is 48×4 mm.

The ejector, measuring tank, sampler and buffer tank are located in the by-pass lines and are cut off from the main loop by relevant valves. The by-pass lines are also made of stainless steel, with diameters of 32×3.5. The coolant from these by-pass lines is drained to the dump tank. The ejector is cut off from the loop gas system by the liquid metal valve. The coolant flow rate in the by-pass lines and sections is controlled by means of the liquid metal valves from the upstream side, and in the main loop it is controlled by valve 1 and through adjustment of centrifugal pump motor shaft speed. The dump tank is cut off from the main loop by liquid metal valves. During the facility operation the dump tank and drain lines should be constantly heated up to 250-300°C in case of emergency dump of the coolant. The facility is heated by nickel-chrome heaters. Gas pressure in the pump reservoir, dump tank, sampler, buffer tank and gas header is measured by vacuum pressure gauges placed above the gas distributing header.

The service water loop is designed to cool the facility components with the aim to maintain the normal temperature regime of operation. Service water is used to cool down the TsN-5/15 pump motor stator and bearings, heating loop current leads, heat exchangers “Harmonica”, gas-water heat exchanger, level meter gaskets and the working section for deposits monitoring.

Inert gas is used to displace the coolant from the dump tank with the aim to fill the liquid metal loop, to put the pump reservoir and the dump tank under excess pressure in order to prevent any possible contact of coolant with air, to blow down the loop after coolant dumping in order to clean it from the coolant left, to make binary gas mixtures in the pump reservoir (buffer tank).

Acceptance of radioactive material

No

Scheme/diagram

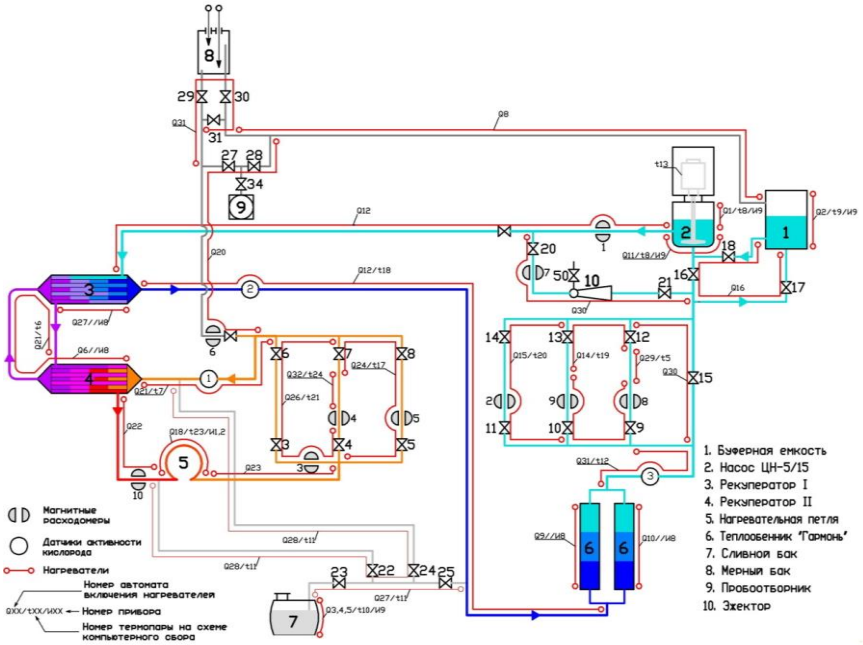

FIG. 1. TT-2M Liquid Metal Facility Process Scheme:
1 – buffer tank, 2 – TsN-5/15 pump, 3 – recuperator 1, 4 – recuperator (2), 5 – heating loop,
6 – heat exchanger "Harmonica", 7 – dump tank, 8 – measuring tank, 9 – sampler, 10 – ejector
(sensors: magnetic flow meters, oxygen activity sensors, heaters, automatic heater switch number, Instrument number, thermocouple number in the computerized, data acquisition schematic)

3D drawing/photo

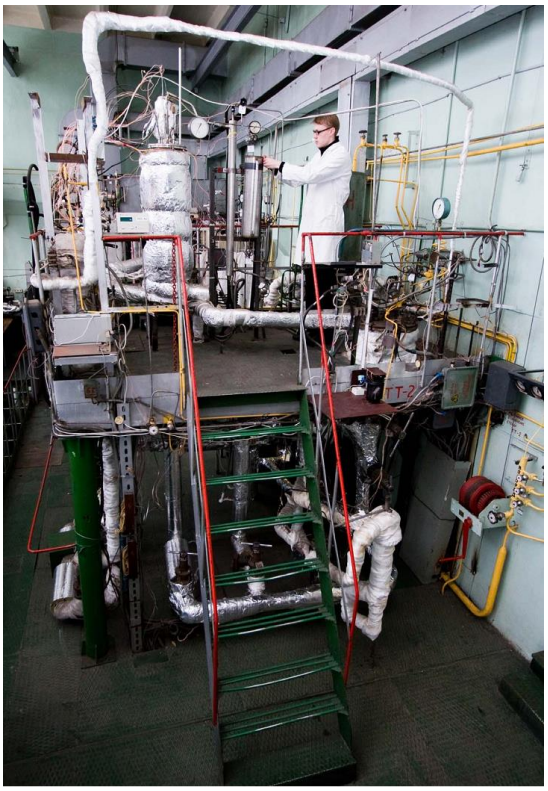

FIG. 2. General view of the TT-2M facility

Parameters table

Coolant inventory	Lead-bismuth (44.5% Pb-55.5% Bi)
Power	220 kW
Test sections	
TS #1	*Characteristic dimensions* Loop volume of 200 litres
	Static/dynamic experiment Static and dynamic experiments
	Temperature range in the test section 200-550°C
	Operating pressure and design pressure P_{max} = 15 kg/cm^2
	Flow range (mass, velocity, etc.) Coolant flow rate in the loop up to 5 m^3/h
Coolant chemistry measurement and control (active or not, measured parameters)	In the course of the facility operation the following parameters are under control: consumed electric power, coolant flow rate, pressure and temperature, thermodynamic activity of oxygen in the coolant, hydrogen and oxygen concentration in the gas system, impurity contents in the coolant (by means of samplers), humidity level in the gas system.
Instrumentation	• thermal sensors of various designs; • electronic pressure sensors; • differential pressure transducers; • contact level meters (developed and manufactured in the FSUE "SSC RF – IPPE"); • electromagnetic flow meters (developed and manufactured in the FSUE "SSC RF – IPPE"); • sensors to measure thermodynamic activity of oxygen in the coolant; flow switches; • gas phase humidity detector.

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

The following issues and systems related to Pb-Bi coolant technology have been worked out: maintenance of purity of the coolant and loop surfaces; structural material corrosion resistance; monitoring, diagnostics and prediction of the coolant state (hydrogen regeneration, supply of mixtures of various compositions to maintain the required quality of the coolant and loop, coolant composition regeneration by different mass-transfer systems); automated coolant quality control system, coolant filtration system, various sensors and other means of control.

PLANNED EXPERIMENTS (including time schedule)

To test pilot or prototype equipment models, namely: a sensor to measure oxygen thermodynamic activity in lead, a hydrogen detector to monitor hydrogen in gas, an oxygen sensor to monitor oxygen in gas, a mass-transfer apparatus, reactor primary coolant

purification filter, gas filters (low-temperature, high-temperature). To conduct endurance tests. To test BREST-OD-300 reactor hydrogen igniters.

To conduct experimental work with the aim to justify direct-contact devices (direct heating by liquid metal coolant) designed to reprocess a broad variety of liquids.

TRAINING ACTIVITIES

The activity dedicated to training specialists as experimentalists at the liquid metal facilities should be agreed upon with the State Corporation "Rosatom".

REFERENCES (*specification of availability and language*)

1. MARTYNOV P.N., ASKHADULLIN R.SH., SIMAKOV A.A., KUMAEV V.Ya. Controlled oxide dissolution processes in Pb-Bi and Pb coolants and mass exchange apparatus for monitoring the oxygen regime // The 11th International Topical Meeting on Nuclear Reactor Thermal-Hydraulics (NURETH-11), Avignon, France,2-6, 2005, p. 208. (En)
2. SYSOEV YU.M., MARTYNOV P.N., ASKHADULLIN R.SH., SIMAKOV A.A. RF Patent No. 2246561 dd. 20.02.2005 for inventing "Method of maintaining the corrosion resistance of steel circulation loop with lead-containing coolant and a mass transfer device for its implementation (variants)". (Rus)
3. MARTYNOV P.N., ORLOV YU.I., EFANOV A.D. et al. Lead-bismuth coolants technology for nuclear reactors // Proceedings of the International Workshop "Thermophysical Properties of Materials", June 11-15, 2001, Nalchik, p. 110. (Rus)
4. LAVROVA O.V., MARTYNOV P.N., GULEVSKY V.A., IVANOV K.D. Effect of dynamic processes in gaseous and liquid on oxidation of HLMC surface // Book of abstracts of Eleventh international topical meeting on nuclear reactor thermal hydraulics (NURETH 11), October 2-6, 2005, Avignon, France, p. 222. (En)
5. PAPOVYANTS A.K., ORLOV Y.I., MARTYNOV P.N., BOLTOEV Y.D. Hydrodynamics of heavy liquid metal coolant processes and filtering apparatus// Book of abstracts of Eleventh international topical meeting on nuclear reactor thermal hydraulics (NURETH 11), October 2-6, 2005, Avignon, France, p. 223. (En)
6. MARTYNOV P.N., ASKHADULLIN R.SH., SIMAKOV A.A. et al. Development of an automated system for monitoring, forecasting and controlling the state of lead-bismuth (lead) coolant and the loop surfaces of nuclear energy systems // Novye Promyshlennye Technologii, 2008, No. 4, p. 43-48. (Rus)
7. MARTYNOV P.N., CHERNOV M.E., STOROZHENKO A.N. Oxygen and hydrogen control sensors based on solid-electrolyte nanostructured oxygen sensors in NPP liquid metal coolants // Novye Promyshlennye Technologii, 2008, No. 4 (Rus)
8. MARTYNOV P.N., ASKHADULLIN R.SH., SIMAKOV A.A.,. CHABAN A.YU, LEGKIKH A.YU. Designing mass exchangers for control of oxygen content In Pb-Bi (Pb) coolants in various research facilities // Proceedings of the 17th International Conference on Nuclear Engineering (ICONE17), July 12-16, 2009, Brussels (Belgium), No. 75506. (En)
9. MARTYNOV P.N., ASKHADULLIN R.SH., ORLOV YU.I., STOROZHENKO A.N. Current issues and challenges of heavy liquid metal coolants (lead, lead-bismuth) in nuclear energy systems // Book of abstracts of the International Conference "Heavy Liquid Metal Coolants in Nuclear Technologies (HLMC-2013)", Obninsk, September 23-26, 2013. –p. 7. (Rus)