NIZHNY NOVGOROD STATE TECHNICAL UNIVERSITY N.A. R.E. ALEKSEEV

IAEA-CN-327-236

EDUCATION THROUGH SCIENCE. NNSTU MASTER'S PROGRAM «NUCLEAR POWER PLANTS WITH SMR»

Aleksandr Dobrov, Maksim Legchanov, Aleksandr Khrobostov
Nizhny Novgorod State Technical University n.a. R.E. Alekseev, Minin 24, Nizhny Novgorod, Russia
dobrov@nntu.ru, legchanov@nntu.ru, khrobostov@nntu.ru, www.nntu.ru

Since 2020, in cooperation with the Technical Academy of Rosatom, NNSTU (Nizhny Novgorod, Russia) implemented a project to prepare the full-fledged master's program «Nuclear Power Plants with SMR» in English. This is a two-year master program, a graduate of which is ready to do research, design and engineering work in the field of nuclear energy, including the subject of NPP with SMR, has the necessary skills to analyze design and engineering documentation.

The topics of study of the Master's degree program are focused on:

- Innovative approaches in the design and construction of nuclear power plants;
- NPP Safety Assurance;
- Hydrodynamics and heat transfer in equipment of NPP;
- Methods for solving engineering problems in R&D of NPPs with SMR;
- Tribological aspects of power plant design and construction;
- Modelling of heat and mass transfer processes in R&D for the creation of NPPs with SMR;
- Rosatom production system in the design and construction of power plants;
- Economic assessment of decision-making efficiency in the energy sector;
- Organization and conduct of scientific researches.

It should be noted that for many years NNSTU has been implementing the "**Education through Science**" program. Thanks to this program, all bachelors and master's students have the opportunity to gain experience in operation in unique research facilities. Students conduct experimental research on these facilities, create new models and upgrade them while working on their master's thesis.

Aerodynamic facility FT-50

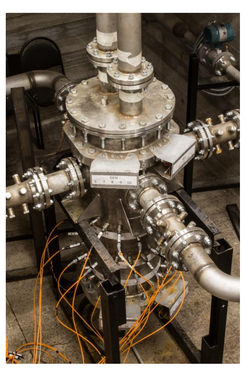
To study the characteristics of the coolant flow in the models of fuel assemblies RITM-200, KLT-40S, PWR and WWER, there is an aerodynamic experimental facility FT-50, which is an open-loop circuit through which air is pumped. Air is pumped into the receiver tank by means of a high-pressure radial fan and then, after passing through the flow meter manifold and the experimental model of fuel assembly, it flows into the atmosphere. Multihole pressure probes are used for measuring flow local velocities.

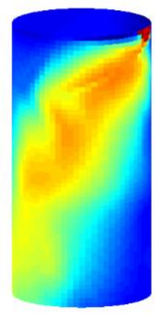
Experimental complex FT-40 with a capacity of 1.5 MWe

FT-40 is a test facility for research of the thermal-hydraulic parameters of water coolant flow in the main equipment of NPPs. This facility allows to carry out the following types of research:

- investigation of mixing processes of isothermal and non-isothermal coolant flows in reactor vessel in steady state and transient conditions;
- study of the thermal hydraulics of the coolant flow in the main equipment of the nuclear power plant, such as pumps, valves, filters, pressurizers;
- research of thermal-hydraulic and resource characteristics of high-stress heat-exchange elements.

Nowadays, NNSTU scientists and students are investigating the features of the coolant flow in a SMR model.





Experimental model of SMR vessel and the temperature field measured during experiment

Test facility FT-4 and prototype of the axial-flow pump for liquid lead-coolant made in NNSTU

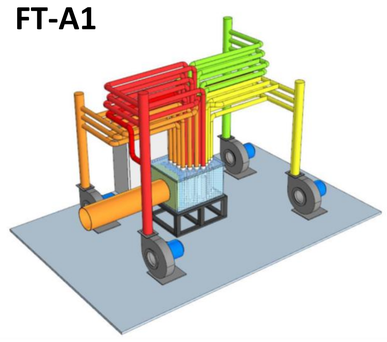
Research laboratory "Technology and thermal physics of liquid metal coolants" for research of heat transfer in the heavy liquid metal coolant. Large multipurpose circulation test facility with a lead coolant consumption of 2000 t/h allows to carry out the following types of research:

- study of the thermophysical characteristics of the lead coolant with the thermal operational conditions such as in a reactor BREST-300 (temperature ~500 °C);
- study of the features of the interaction of lead coolant with various construction materials;
- study of the features of the flow of liquid metal coolants in a magnetic field.

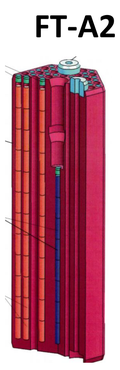
Facilities FT-A1 and FT-A2 for modelling HTGR coolant hydrodynamics

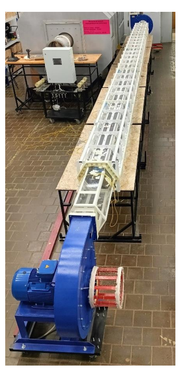
In 2021 there was created a new laboratory for Simulation of Gas Dynamics in HTGR. Now there are two new test facilities FT-A1 and FT-A2. The first one is devoted to the study of the processes of mixing helium flows from different temperatures in the bottom collecting vessel of the HTGR. Another facility FT-A2 is related to the study of hydrodynamic processes in the prismatic core of the nuclear reactor and is made in full scale, including models of fuel assembly and control rod.

FT-A1



FT-A2



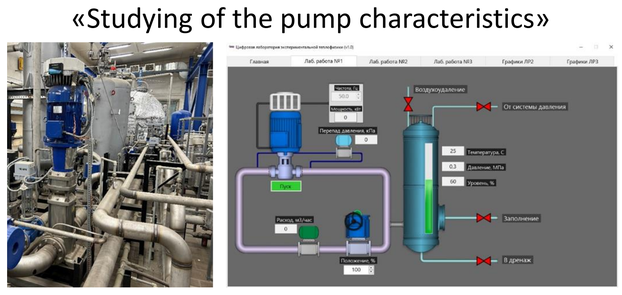


At each of these facilities, in addition to scientific research, a series of laboratory work is planned, devoted to studying the characteristics of the equipment, its design, and methods for processing experimental data. Students of the master's program «NPP with SMR» are also involved in the design and assembly of research facilities, that's why students gain unique experience and practical skills.

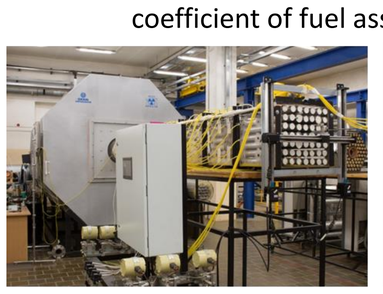
Virtual laboratory works (VLW)

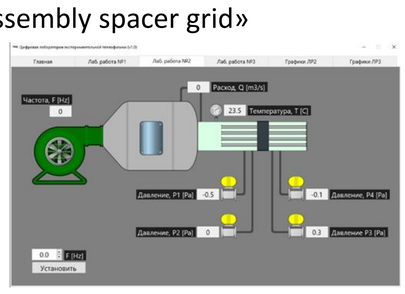
Unfortunately, not all students have opportunity to study face-to-face. That's why NNSTU specialists decided to create digital analogues of test facilities in the form of computer applications. This technology is based on the real experimental data. All parameters and variables are recorded in steady state and transient modes of operation. This is not a simulation, but a real recording of a huge number of experimental data. Each VLW is accompanied by video material, which presents the facilities, as well as the methodology of obtaining and processing the results. This technology during the Covid-19 pandemic allowed not to stop practical training in working with real equipment.

Main coolant pump of FT-40 facility and VLW «Studying of the pump characteristics»



FT-50 facility and VLW «Investigation of pressure loss coefficient of fuel assembly spacer grid»





Students-made test facility and VLW «Investigation of heat exchanger effectiveness with intensifiers»