Abstracts
Journal "Problems of Nuclear Science and Engineering. Series: Physics of Nuclear Reactors", issue No.5, 2020

UDC 621.039.56

On the Limits of Oscillatory Instability of Pulsed Reactors of Periodic Operation

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On the basis of experimental and model researches carried out at the IBR-2 and IBR-2M reactors, it has been shown that pulsed reactors of periodic operation (PRPO) have fundamental limitations on stability. At the same time degradation changes in the core of the PRPO lead to a strong weakening of the fast power feedback, which causes the appearance of oscillatory instability. For safe purposes, the PRPO power even for fresh fuel is limited to 2–3 MW. There is also a strong instability of fast power feedback parameters with energy production, which leads to corresponding changes in the dynamics of the pulsed reactor. Comprehensive research to ensure safe operation of the IBR-2M is required.

Key Words: pulsed reactor of periodic operation, IBR-2M, power feedback, stability, dynamics model, transient process

UDC 621.039.5

SUHAM-3D-TD Code for Solving the 3D Non-Stationary Neutron Transport Equation for Reactors with Square Lattice, Description and the First Calculational Results

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New SUHAM-3D-TD code realizing 3D non-stationary finite-difference surface harmonics method equations with three transversal and two longitudinal trial matrices for reactor with square lattice is described. System of codes SUHAM is developed in Kurchatov Institute for solving the stationary and non-stationary neutron transport equations in nuclear reactors of different types. SUHAM-3D-TD code apparently is the first code in which 3D space kinetics equations on the base of Surface Harmonics Method (SHM) are realized. When constructing SHM non-stationary equations, an algorithm for construction of the stationary equations implemented in the SUHAM-3D code was used. The first calculations were carried out using the SUHAM-3D-TD code of five three-dimensional tests of the international non-stationary benchmark C5G7-TD, namely the calculations of the tests TD4-1, TD4-2, TD4-3, TD4-4 and TD4-5. All tests of the C5G7-TD benchmark are "blind", i.e. the results of calculations of these tests will be suitable for comparisons only after a certain time, when most of the participants involved will calculate these tests. As the results of the calculated tests, the distributions on time of the total power of the calculated object and the reactivity according to Henry are given. Key Words: surface harmonics method, non-stationary neutron transport equation, code system SUHAM-3D-TD, non-stationary benchmark C5G7-TD, reactivity according to Henry.

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UDC 621.039

Program Hortitsa-M. Stability of Solution of the Reconstruction Equation to Perturbation of Input Data

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The stability of solution of the reconstruction equation to perturbation of input data in the program Hortitsa have been reviewed. Results of numerical experiments confirm the stability of solution to pertrubation of input data.

Key Words: Hortitsa code, in-core detector, power distribution, VVER, current, measurement.

UDC 621.039.46

Axial Distributions of Fission Reaction Rates in the Annular Core of the ASTRA Critical Facility with Poison Profiling Elements in the Internal Reflector

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Computational modeling of experiments on measurement of axial distributions of fission reaction rates in configurations of the ASTRA critical facility simulating a HTGR with annular core is performed. Absorbing elements were installed in the internal reflector of critical assemblies to flatten the neutron flux density radial distribution. Measurements of the fission reaction rates were performed both in a configuration with a flattened neutron field and in a configuration with control rods inserted in an external graphite reflector.

Key Words: HTGR, ASTRA critical facility, axial fission rates reaction distribution, buckling, 3D model.

UDC 621.039.5

Fast Reactor with High Excess Production of Fissile Nuclides in Two-Component Nuclear Power Engineering with U–Pu and Th–U–Pu Fuel Cycle

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The focus of this paper is the concept of sodium cooled fast reactor with U–Pu metal fuel in the core and U or Th metal fuel in the blankets. Neutronic simulation demonstrates achieving of desired system requirements for initial fuel loading and excess fuel production. Thermo-hydraulic and thermo-mechanic simulation demonstrates acceptable fuel pin behavior. Several scenarios for the development of a dual-component Russian nuclear energy system based on VVER type thermal neutron reactors with traditional dioxide fuel and fast neutron reactors with promising metal fuel are considered.

***Key Words*:** fast reactor, metal fuel, nuclear energy system development scenarios, dual-component nuclear energy system.

UDC 621.039.4

Physical Aspects for the Waste of Re-Enrichment Utilization of the Recycled Uranium from VVER-1000/1200 Spent Fuel Reprocessing in Molten Salt Reactors

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The physical issues of the utilization of waste from the re-enrichment of regenerated uranium from the 232U isotope in a reactor with a circulating liquid fuel based on melts of metal fluoride salts are discussed. The effect of the isotopic composition of the purification cascade selection fraction on the spectrum and reactivity coefficients in a liquid-salt nuclear reactor, depending on the content of the 235U isotope, is studied. It is shown that compositions with a high content of the 235U isotope on the one hand are more promising, since less minor actinides are formed due to the low content of the 238U isotope. On the other hand, more favorable reactivity effects are provided with moderate enrichment of the 235U isotope.

Key Words: closed nuclear fuel cycle, spent nuclear fuel, VVER-1000/1200, recycled uranium, isotope separation, separation cascade, dual cascade, enrichment, molten salt reactor.

UDC 621.456.2

Examination of the Possibility of Nitride Fuel Application in Nuclear Thermal Propulsion Engine Cooled by Ammonia-Water Mixture

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The paper considers the possibility of using a water-ammonia mixture as a working fluid in a nuclear thermal propulsion engine. The applicability was considered by evaluation of fuel resistance towards chemical corrosion. Conventional carbide fuel does not withstand aggressive chemical effects of the water-ammonia mixture for sufficient time (1— 8 hours). Uranium nitride with the addition of oxide is proposed as an alternative composition of fuel. A preliminary assessment of the stability of this composition under considered conditions is carried out on the basis of chemical thermodynamics and kinetics.

Key Words: uranium nitride, chemical resistance, nuclear fuel, nuclear thermal propulsion.

УДК 621.039.577:537.58:53.023

The Principle of Switching Thermionic Fuel Elements in the Core of the Thermionic Reactor-Converter

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The electrical power of the thermionic reactor-converter is determined by various parameters of the thermionic fuel element and reactor core, as well as by formation of the electrical branch that connects the thermionic fuel elements according to various criteria. The formation of electric branches is possible in various ways. The number of branches is determined by the specified characteristics of the thermionic fuel element and the required electrical power. While the thermionic fuel element in the branches are connected electrically in series, and the branches themselves are connected in parallel. The selection of an electrical branch in the reactor core is based on the characteristics of each thermionic fuel element. The paper contains the evaluation of the characteristics of the thermionic reactor-converter with various options for switching thermionic fuel elements.

Key Words: thermionic reactor-converter, reactor core, volt-current characteristics, thermionic fuel element, electrical switching.

UDC 621.039.5

Nuclear Energy Under COVID-19 Pandemic

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Coronavirus pandemic had a considerable impact on both the global economy and its energy sector. This paper discusses the role the nuclear industry plays today, when some countries started considering nuclear energy as a key part of their critical infrastructures necessary to ensure sustainable energy supplies in these extreme conditions. So far, none of IAEA Member States faced the need to close their NPPs because of the pandemic's impact on the workforce or supply chain. At the same time, lower electricity demand due to economic constraints has somewhat reduced electricity generation by NPPs. Though some sites face certain delays, NPP construction goes on and even shows positive trends in some countries. This paper also discusses a variety of "looks beyond COVID-19" that focus on issues such as energy supply sustainability, the need to use all low-carbon energy technologies, and the possibilities the tandem of nuclear and renewables offers to create flexible energy systems. This paper confirms the conclusion that governments will have to take a realistic account of nuclear energy in the future period of inevitable revision of both energy policies and investment choices.

Key Words: nuclear energy, coronavirus pandemic, energy systems.