Abstracts
Journal "Problems of Nuclear Science and Engineering. Series: Physics of Nuclear Reactors"
issue No.4, 2013

UDC 621.039.5

Two-Dimensional Surface Harmonics Method Equations for Solving the Space-Time Neutron Kinetics Problems of Square-Lattice Nuclear Reactors

V.F. Boyarinov, A.E. Kondrushin, P.A. Fomichenko
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182.

Two-dimensional time-dependent finite-difference equations of Surface Harmonics Method (SHM) for the description of neutron transport have been obtained for square-lattice reactors. Obtained equations are realized in SUHAM-TD code. Verification of derived equations and the developed code have been carried out, capacities and efficiency of SHM have been demonstrated in application to solution of the 2D time-dependent neutron transport equation in diffusion approximation. Obtained results have shown essential advantage of SHM in computation costs over direct finite-difference modeling.

Key Words: SHM, Time-Dependent Neutron Transport Equation, Space-Time Neutron Kinetics, SUHAM - TD Code, Verification.

UDC 621.039.51

Features of Monte Carlo Method Application for Large RBMK Reactors Calculation and Model Correction Using Indications of In-Core Detectors

I.E. Ivanov, N.V. Schukin
National Research Nuclear University "MEPhI", 31, Kashirskoe Sh., Moscow, 115409
S.A. Bychkov, V.E. Druzhinin, D.A. Lysov, Yu.V. Shmonin
JSC "VNIIAES", 25, Ferganskaya St., Moscow, 10950
M.I. Gurevich
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182.

It was made the qualitative and quantitative analysis of statistical error of neutron fields sampling in a physically large systems like RBMK. The recommendations for the choice of calculation parameters are presented. A new method of RBMK reactor Monte Carlo calculation using model correction by the in-core detectors was developed. Specialized software based on software and hardware CUDA platform have been developed to carry out computational researches. The results of methods and software testing for real RBMK reactors calculations are presented.

Key Words: Monte Carlo Method, CUDA, Graphic Processor Unit, RBMK, In-Core Detectors.

UDC 621.3.002

The Application of Metric Analysis for Power Distribution Determination in a VVER-440 Core Using In-Core Monitors Data

A.V. Kryanev, D.K. Udumyan
National Research Nuclear University "MEPhI", 31, Kashirskoe Sh., Moscow, 115409
A.Yu. Kurchenkov, A.A. Gagarinskiy
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

Problems of power distribution determination in VVER-440 core on the basis of neutron-physical calculation and in-core monitors are considered. The new mathematical scheme using the metric analysis is offered. This method in comparison with existing mathematical scheme raises accuracy and reliability of the power distribution.

Key Words: VVER-440 Core, Power Distribution, Metric Analysis, Accuracy.

UDC 621.039.516.25

Computational Analysis of Reactivity Coefficient Measurements Performed on VVER-1000 of the 3-rd Unit of Kalinin NPP

V.G. Zimin, S.B. Vygovskiy, A.A. Semyonov
National Research Nuclear University "MEPhI", 31, Kashirskoe Sh., Moscow, 115409
V.D. Davidenko, V.F. Tsibul'skiy
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

Reactivity coefficient measurements performed on hot zero power conditions of VVER-1000 are analysed by computer code PROSTOR. Temperature and density reactivity coefficients and boron acid reactivity coefficients are computed. A method to analyse the consistency of the temperature reactivity coefficients and density reactivity coefficients is proposed.

Key Words: VVER-1000, Reactivity Effects, Two-Group 3D Diffusion Calculations, Nodal Method, Hexagonal Geometry, Validation, PROSTOR, NEKST, UNK.

UDC 621.039

Measurements of Control Rods Efficiency in RBMK Critical Assembly under Droping of the Rods

V.E. Zhitarev, V.M. Kachanov, A.Yu. Sergevnin, G.V. Lebedev
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

Efficiency of the control rods in the RBMK critical assembly was measured. One manual-control rod (MCR) is droped from a steady critical state, in 44 seconds several MCR are droped in addition. The measured number of neutrons in the assembly in time and after dropping of the rods were used to calculate the values of efficiency of the rods from system of point kinetics equations. Different methods of the initial data treating for determination of the desired values of reactivity without the calculated corrections are used.

Key Words: Reactivity, Control Rods, Efficiency of the Rod, Critical Assembly, Inverse Kinetic Method.

UDC 621.039.526

Testing of Improved Method of Irradiation Heat Rate Calculation at the BOR-60 Core Periphery

A.V. Varivtsev, I.Yu. Zhemkov
JSC "SSC RIAR", Ul′yanovsk region, Dimitrovgrad-10, 433510.

The application of improved method for calculating heat rate in components of an experimental rig located at the BOR-60 core periphery resulted in less discrepancy between the computational and experimental data. It proves the advantage of the specified technique as compared to the previously used one.

Key Words: Experimental Rig, Radiation Heat Rate, Calorimeter, Gamma Quantum, Gamma Radiation, Fission Products.

UDC 621.039.534

Analytical Generalization of Integral Forms for Friction, Heat- and Mass Transfer Factors of Non-Equilibrium Two-Phase Flows. Annular Channels and Pin Bundles

Yu.N. Kornienko
FSUE "SSC RF- IPPE", 1, Bondarenko Sq., Obninsk, Kaluga Region, 249033

A new approach to the development of generalized closure relationships of the flow – wall friction, heat and mass transfer coefficients for the flow of complicated structure with heterogeneous distribution of local parameters in pipes, annular channels and subchannels is presented. The method relies on the quasi-one-dimensional description of the inhomogeneous distribution of not only axial, normal, and azimuthal profiles, but also of sources/sinks effect of substance (momentum, mass and heat). The obtained analytical relationships meet the "correspondence principle". Example of verification is demonstrated.

Key Words: Friction, Heat- and Mass Transfer, Non-Equilibrium Drift Flux Model, Annular Channels, Pin Bundles.

UDC 621.039.54

The Kinetics of Silver Release from Microfuel with the Effect of Limited Solubility

A.S. Ivanov, A.A. Rusinkevich
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

The influence of limited solubility of silver in silicon carbide on its release from microfuel with TRISO coating is studied. It is shown that the limited solubility substantially affects the concentration profile and Ag release from microfuel at wide temperature range. Also it is developed the technique of obtaining concentration profiles of fission products in the microfuel and graphs of flow and integral release of fission products on the basis of neutron-physical calculation, thermodinamic calculations by code Ivtanthermo and kinetics calculations by code FP-Kinetics. This technique takes into account the limited solubility of fission products in protective coatings of microfuel.

Key Words: Microfuel, Fission Products, Solubility, Burnup, Diffusion.

UDC 621.039.54, 621.039.526

The Diffusion of Uranium and Cesium in the Fuel Cladding of Electro Generating Channel

I.V. Vasil'ev, A.S. Ivanov, V.A. Churin
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

Results of reactor test of fuel carbonitride with monocrystalline cladding molybdenum based alloy can be used in support of operational reliability of the fuel elements for the drafting megawatt space nuclear power plant. In this paper, the interpretation of the results of the pilot study of the penetration of uranium and cesium in a single-crystal membrane fuel element with carbonitride fuel is done. Those fuel elements were tested in the pilot plant Ya-82 during 8 300 hours at temperature of about 1 500 °C. It is shown that the diffusion coefficients of uranium substantially coincide with the diffusion coefficients measured before for the diffusion of uranium in polycrystalline molybdenum. It was found that the skin penetration of uranium apparently realized only by direct contact of cladding and fuel. An explanation for the experimentally observed non-monotonic concentration profiles of uranium is done on the preferential diffusion of uranium at the grain boundaries. It is shown that a significant non-monotonic uranium concentration profile observed in our experiments can be explained by the presence of a polycrystalline structure in the surface region of the cladding from the inner side. The estimation of the diffusion coefficient of uranium at the grain boundaries has been completed. The estimation of the diffusion coefficients of cesium has been completed.

Key Words: Nuclear Power Tests, the Fuel Cladding, Grain-Boundary Diffusion, the K-Ratio.

UDC 621.039.7

Methods of Leakage Control of Fuel Cladding in Boiling Water Rreactor VK-50

A.S. Kurskiy
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

The results of inherent radiation safety properties studies for the VK-50 reactor are shown. The features of radioactivity phase transfer in the boiling water reactor allow to determine the defects in the fuel cladding. The method is developed for a cladding leakage control on operating and shutted off reactor.

Key Words: Vessel-Type Boiling Water Reactor, Gaseous Fission Products, Radiation Monitoring Systems.

UDC 621.039.7

Substantiation of Boiling Water Reactors Safety in Case of Large Coolant Leakage – the Case of VK-50 Reactor

A.S. Kurskiy
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182.

There are presented the results of radiolytic processes and radiation safety of the VK-50 reactor facility investigations. VK-50 is the reactor with natural circulation of coolant. The features of the catalytic combustion systems in accidents are described. The feature of radioactivity phase transfer can limit the consequences of severe accidents on the boiling water reactor. The method is developed for determining the radioactive situation in the emergency box. The technological scheme and the operating conditions prevent the emergencies with explosions in equipment and shut out the accident with outlet of radioactive substances into the environment.

Key Words: Vessel-Type Boiling Water Reactor, Radioactive Corrosion Products, Gaseous Fission Products, Radiation Monitoring System.

UDC 621.039.58

Problems of Safety and Efficiency of Nuclear Power in the Light of Modern Science and Practice

A.G. Aseev, S.A. Subbotin
NRC "Kurchatov Institute", 1, Kurchatov Sq., Moscow, 123182

The problems of security are considered in a new way. It is shown that the human race will be longer exist, the more will face challenges and risks that were not before. The article suggests new approaches and solutions to this problem – from global to local.

Key Words: Safety, Risk, Energy, Innovative Technology.

Seminar "Physics of Nuclear Reactors"

The seminar "Physics of Nuclear Reactors" is working.in the NRC "Kurchatov Institute" since 1999 under the direction of the head of the Nuclear Reactors Physics Department S. M. Zaritskiy.

By the time of this journal issue there were 133 seminar meetings, the theme of which is not limited by the fact stated in seminar title.

The speakers and participants of the seminar are the scientiests from NRC KI and other Institutions.

The information about the seminar is located on the site of NRC "Kurchatov Institute" (www.nrcki.ru), and is sending to the participants.

In 2012 there were 13 meetings of seminars, information on them was published in journal issue number 1 for 2013.

In 2013 there were 11 meetings of seminars (from 123 till 133). Information on 123-127 meetings was published in issue No.2 for 2013.

This issue contains the information about 128 – 133 seminar meetings and abstracts of reports provided by speakers.