AIR-PLASMA DISPOSAL OF SPENT NUCLEAR FUEL REPROCESSING WASTE

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Reprocessing of spent nuclear fuel after the extraction cycle produces reprocessing waste (RW SNF) in the form of an aqueous nitrate solution (raffinate) with the following composition: [1]: 18.00 % HNO_3, 0.07 % Fe, 0.11 % Nd, 0.10 % Mo, 0.06 % Y, 0.058 % Zr, 0.04 % Na, 0.039 % Ce, 0.036 % Cs, 0.031 % Co, 0.026 % Sr, remaining – H_2O.

According to available technology, the RW SNF is concentrated by evaporation, filled into stainless steel tanks and sent to long-term storage that does not offer reuse of precious metals.

It has been proposed to treat RW SNF in the form of a water-organic nitrate (HNO_3) dispersion solution containing organic components (alcohols, ketones) and having an adiabatic combustion temperature (T_{ad}) of at least 1500 K in an air plasma stream. [2].

The effects of spent nuclear fuel content (RW SNF) and organic constituents from reactor waste on Tad for aqueous organic nitrate solutions based on ethanol (a) and acetone (b) are shown in Figure 1.

Characteristic equilibrium composition of the main products of air plasma treatment of RW-SNF in the form of a solution of WONC-1 ($T_{ad} \approx 1500$ K) based on acetone (65 % RW-SNF): 35 % Estone) with air mass fractions of 65 % (a) and 70 % (b)) are shown in Fig. 2.

Air plasma utilization of RW SNF in the form of WONC-1 solution results in the formation of oxides of various metals, including magnetic iron oxide (Fe_3O_4) in the condensed phase, increasing the

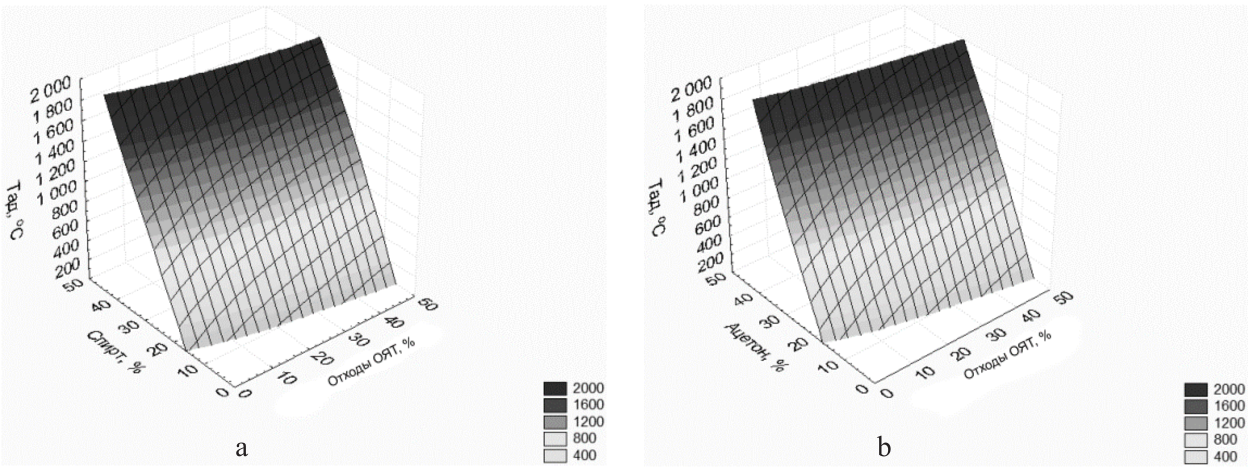

Fig. 1. *Effect of RW content of SNF on Tad in (a) ethanol – and (b) acetone-based aqueous organic nitrate solutions (WONCs)*

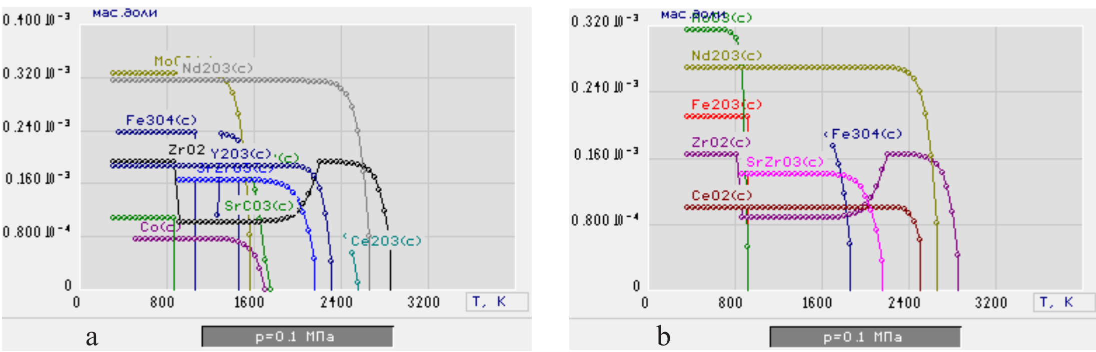

Fig. 2. *Effect of temperature on the equilibrium composition of air plasma-enhanced products of RW-SNF in the form of WONC-1 solutions with air mass fractions of 65 % (a) and 70 % (b)*

air mass fraction from 65 to 70. Mass fraction of air 65 % (a). It leads to the formation of non-magnetic iron oxide Fe_2O_3 (c). Based on the results obtained, the following optimal conditions for the air plasma (b).

Decomposition process of RW-SNF can be recommended.

Temperature (1500 ± 100) K; Composition of WONC-1 (65 % RW SNF: 35 % Etone); Phase-mass-ratio (65 air: 35 WONC-1) %.

References

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2. *Karengin A. G., Karengin A. A., Novoselov I. Yu., Tundeshev N. V. Calculation and Optimization of Plasma Utilization Process of Inflammable Wastes after Spent Nuclear Fuel Recycling // Advanced Materials Research, 2014. – Vol. 1040. – P. 433–436.*

NEUTRON DISTRIBUTION DURING THE OPERATION OF VVER REACTOR 1000-MW

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Water-water Power reactor design (VVERs) are Reactor safety standards such as peak power factor during life of the reactor. Coupling of neutron calculations, Thermal-hydraulic calculations and other nuclear reactors requires multi-physics software to model phenomena Solve different reactor equations and solve them simultaneously No need to use separate computer code [1].

COMSOL Multi-physics Can Solve Multi-group Neutrons Diffusion equation using the finite element method. Of Further use of current distribution from output Thermal hydraulic calculation [1].

The core consists of 3 types of fuel Element and control rods. 3D model represents one eighth of the reactor, four control rods completed or partially inserted throughout the core [2].

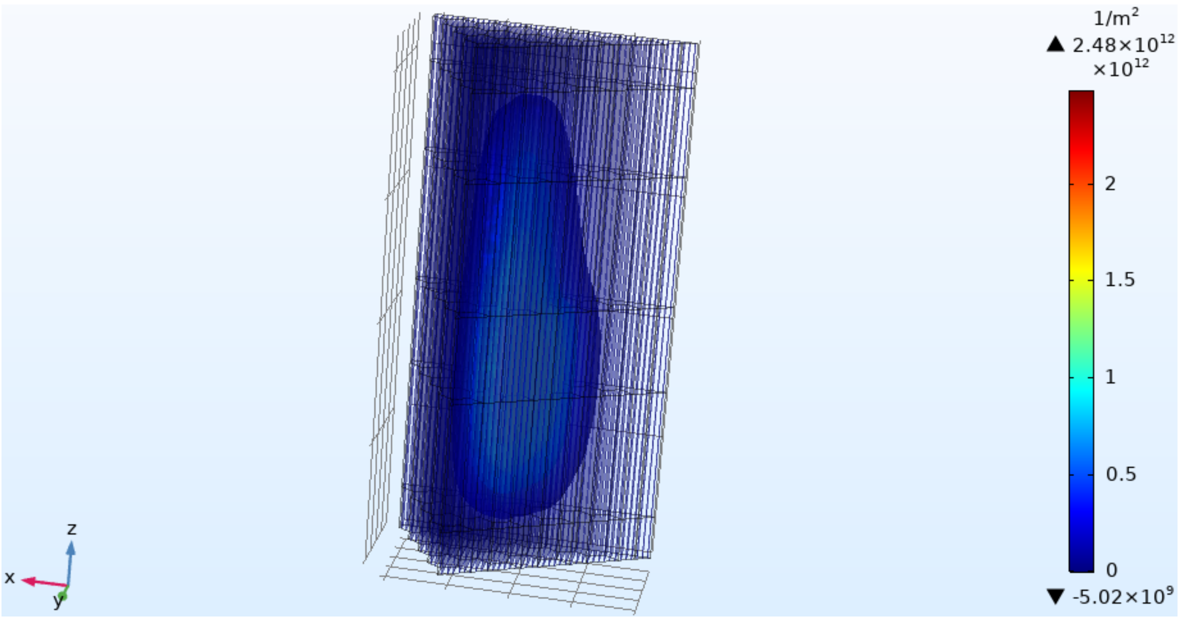

Fig. 1. *Thermal Neutron Flux distribution through the volumetric section of VVER reactor pressure vessel using COMSOL simulation*