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"EXPERIMENTAL AND THEORETICAL RESEARCH OF THE PECULIARITIES OF TRANSMUTATION OF LONG-LIVED FISSION PRODUCTS AND MINOR-ACTINIDES IN SUB-CRITICAL ASSEMBLY DRIVEN BY A NEUTRON GENERATOR

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The sub-critical assembly of YALINA facility is uranium - polyethylene multiplying system with $k_{max} < 0.98$, located inside graphite reflector of parallelepiped configuration with side dimension 1000 and 1200 mm that is arranged of high purity "reactor graphite" blocks with side dimension 200×200×500 mm. The core of the assembly is of parallelepiped configuration too with side dimension 400×400×600 mm and consists of "bare" polyethylene sub-assemblies where fuel rods of EK-10 type (UO_2 of 10% enrichment by U-235) are located. On the whole fuel subassembly contains 9 blocks (in height) made of polyethylene ($\gamma = 0.927$ g/cm^3) with side dimension 80×80×63 mm and 16 fuel rods of EK-10 – type located in channels with diameter D = 11 mm. Fuel rods' spacing equal 20 mm is close to the optimal value for multiplying medium with polyethylene moderator and fuel rods EK-10.

Neutron generator is linear accelerator of deuterium ions produced at duoplasmatron and accelerated to energy Ed = 250 keV. Accelerator magnet system separates D^+ ions only that by means of electromagnetic lenses are directed towards the $Ti^3H_{1.5—1.8}$ or $TiD_{1.5—1.8}$ targets where in reactions $d(T,n)^4He$ and $d(D,n)^3He$ neutrons are generated with energies in the ranges E_n = 13-15 MeV and E_n = 2.5-3.0 MeV, respectively. At present highly effective water-cooled targets with diameters 230 and 45 mm are used in experimental program.

One of the important problems in physics of sub-critical systems driven by external neutron sources is development of experimental methods and techniques of neutron flux density monitoring and sub-criticality level determination without special procedure of criticality state

achievement. Moreover it is important to verify the applicability of experimental methods used in physics of critical reactors for measurements of neutron-physical characteristics of systems both with thermal and fast neutron spectra.

The reactivity measurements at sub-critical systems driven by external neutron sources have been carried out with application of developed for critical systems methods such as:

- Pulse neutron source method
- Sjöstrand method (area method)
- Gozani method (modified method of Sjöstrand
- Source jerk method.

The results of the measurements will be presented.

Further investigations in the field of ADS-technology at the NAS of Belarus will be performed on the basis facility YALINA-B consisting of sub-critical cascade reactor system driven by neutron generator NG-12-1. Distinguishing feature of such a nuclear system is that core consists of booster zone, where due to usage of highly enriched metallic and dioxide uranium fuel fast neutrons flux is formed and of thermal neutron spectrum zone. These zones are coupled each other by one-directional way of coupling due to the intermediate zone (thermal neutron absorber zone) where thermal neutrons escaping from thermal zone are absorbed. Such peculiarity of the core structure allows essentially increase power of the external neutron source, to generate fission pulses being many times shorter and intensive than those at traditional reactor systems, to carry out the experiments for study of the peculiarities of nuclear waste transmutation in conditions of fast and thermal neutron spectra and kinetics investigation of such systems by pulse mode of external neutron source (neutron generator) operation. Program of the experimental investigation includes development of methods of sub-criticality level monitoring, measurement of long-lived fission products and minor-actinides transmutation rates, study of sub-critical systems dynamics, measurements of spectral indices etc. Experimental data obtained at these facilities are important from the point of view of codes and nuclear data libraries validation, for sub-critical systems calculation, for investigation of kinetics peculiarities of systems with external neutron sources etc. Simulation of booster sub-critical system neutronics based on Monte-Carlo method have shown that neutron energy spectrum in the booster zone, as well as neutron life time, time neutron flux response are very close to those obtained at SAD facility, consisting of sub-critical blanket with MOX fuel driven by high energy proton (Ep = 660 MeV) accelerator (JINR, Dubna, Russia).