METHODOLOGY FOR CONDUCTING IN-PILE EXPERIMENTS TO STUDY SPECTRAL-TEMPORAL CHARACTERISTIC OF GAS MEDIA UPON EXCITATION BY THE $^{6}Li(n,\alpha)^{3}H$ NUCLEAR REACTION*

K.K. SAMARKHANOV[1], E.G. BATYRBEKOV[2], M.U. KHASENOV[1,3], YU.N. GORDIENKO[1], A.N. KOTLYAR[1], A.A. MILLER[1], V.K. TSKHE[1], YE.A. MARTYNENKO[1], Z.B. KOZHABAYEV[1]

[1] *Institute of Atomic Energy Branch of the National Nuclear Center of the Republic of Kazakhstan, IAE NNC RK, Kurchatov, Kazakhstan*
[2] *National Nuclear Center of the Republic of Kazakhstan, NNC RK, Kurchatov, Kazakhstan*
[3] *School of Sciences and Humanities, Nazarbayev University, Nur-Sultan, Kazakhstan*

The study of optical (laser and spontaneous) radiation from a nuclear-excited plasma, formed by the products of nuclear reactions is interesting for developing a method of energy output from a nuclear reactor by direct conversion of energy into light [1, 2]. The direct pumping of active media is carried out, as a rule, by the products of nuclear reactions with thermal neutrons of a nuclear reactor: $^{3}He(n,p)^{3}H$, $^{10}B(n,\alpha)^{7}Li$, $^{235}U(n,f)F$ or others. The laser-working medium must contain ^{235}U, ^{3}He or ^{10}B, or a compound with these isotopes is deposited on walls of the laser chamber. Less studied was $^{6}Li(n,\alpha)^{3}H$ nuclear reaction.

The National Nuclear Center of the Republic of Kazakhstan currently operates two research reactors: IVG.1M [3] and IGR [4]. The main results of a series of reactor experiments performed at the stationary reactor IVG.1M are given in [5-7]. Based on the experience of the in-pile experiments at the IVG.1M reactor and considering the specificity of experiments at the pulsed reactor IGR of a thermal neutron flux density up to $7{\cdot}10^{16}$ n/cm^{2}s, the principal scheme of the experimental setup and the methodology of in-pile experiments were developed. Experimental facility functionally consists of gas-vacuum system, optical radiation registration system, irradiation device with a lithium layer, and systems of registration and temperature control of the device housing. The design of the irradiation device (ID) was developed to conduct in-pile experiments at the IGR reactor. Irradiation device, coated with a lithium layer will be loaded into the central channel of the IGR reactor and filled with the test gas mixture. The light radiation will be outputted from reactor core using a fiber, then split into individual beams. Luminescence spectra will be recorded using the optical spectrometer. Spectral-temporal characteristics will be recorded using a monochromator, tuned to the wavelength of the investigated atomic transition, a photodiode and PMT.

Neutron-physical and thermal-physical calculations, using MCNP5 and Ansys Fluent software, respectively, were performed to justify the irradiation device design and safety conducting of in-pile experiments. The calculations were performed at a thermal power level of the IGR reactor equal to 1 GW and a pulse duration of 0.12 s. Based on the results of the performed neutron-physical calculations, the specific power of the energy release of the main elements of the ID design, as a result of neutron and gamma irradiation at the IGR reactor was determined. It was determined, with the IGR reactor power, equal to 1 GW, the total ratio of lithium energy release to energy release in the reactor is $8.23{\cdot}10^{3}$ W/g. Based on the results of the performed thermal-physical calculations, the temperature field of the experimental cell of the ID was determined.

REFERENCES

[1] S.P. Mel'nikov, A.N. Sizov, A.A. Sinyanskii, G. H. Miley, Lasers with Nuclear Pumping. Springer, New York, NY, USA, 2015.

[2] E. Batyrbekov, "Converting nuclear energy into the energy of coherent optical radiation," Laser and Particle Beams, vol. 31, no. 4, 2013.

[3] R.A. Irkimbekov, L.K. Zhagiparova, V.M. Kotov, A.D. Vurim, V.S. Gnyrya, "Neutronics Model of the IVG.1M Reactor: Development and Critical-State Verification," Atomic Energy, vol. 127, no 2, pp. 69–76, 2019.

[4] V. Vityuk, A. Vurim, "Method for determining the energy parameters in pulse reactor experiments," Annals of Nuclear Energy, vol. 127, 2019.

[5] E. Batyrbekov, M. Khasenov, Yu. Gordienko, K. Samarkhanov, Yu. Ponkratov, "Optical radiation from the sputtered species under gas excitation by the products of the 6Li(n,α)3H nuclear reaction," Journal of Luminescence, vol. 220, Article Number 116973, 2020.

[6] K. Samarkhanov, M. Khasenov, E. Batyrbekov, I. Kenzhina, Ye. Sapatayev, V. Bochkov, "Emission of Noble Gases Binary Mixtures under Excitation by the Products of the 6Li(n,α)3H Nuclear Reaction," Science and Technology of Nuclear Installations, vol. 2020, 2020.

[7] K. Samarkhanov, M. Khasenov, E. Batyrbekov, Yu. Gordienko, Yu. Baklanova, I. Kenzhina, Ye. Tulubayev, I. Karambayeva, "Optical radiation from sputtered species under excitation of ternary mixtures of noble gases by the $^{6}Li(n,\alpha)^{3}H$ nuclear reaction products," Eurasian Chemico-Technological Journal, vol. 23, no. 2, pp. 95–102, 2021.

* This work was supported by the Ministry of Energy of the Republic of Kazakhstan (Program "Development of nuclear energy in the Republic of Kazakhstan for 2021–2023 years"),