

APPLICATION OF NEUTRON ABSORPTION METHOD OF THE ANALYSIS ON THERMAL NEUTRONS FOR THE CONTROL OF SUBSTANCES AND PRODUCTS CONTAINING BORON IN A NUCLEAR POWER ENGINEERING AND INDUSTRY

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The nuclear physical methods of analysis using the absorption effect of ionising radiation, should satisfy to the following requirements at practical realisation in an industry. First, the ionising radiation should have high penetrating ability in the researched environment to ensure the representative data and reliability of the analysis. Secondly, the absorption degree of radiation should be sufficient for maintenance of sensitivity and accuracy of measurements. Besides, to maintain necessary selectivity the neutron absorption analysis on thermal neutrons is applied on chemical elements and their isotopes with an anomalously high absorption cross section of about ($10^2 \div 10^4$) barn. To such elements belong Gd, Sm, B, Cd, Hg and others.

On the basis of the exponential law of absorption for thermal neutrons the analytical expression has been obtained for concentration of a determined element depending on the flow of an elapsed neutrons and it is pointed to the necessity to account a number of interfering factors such as the matrix effect of filling agent, the scattering of neutrons, the dispersion of density and temperature of the environment, background radiation. Owing to the difference between the experimental calibration dependence and the exponential one, the methods of its mathematical approximation, for example, polynomial function and partially hyperbolic one are considered.

The scheme realisation of the method is feasible in geometry «on passage» and «on reflection» of the neutron flow. As a sources of neutron radiation the radio nuclide Pu-Be sources based on nuclear reaction of (α, n) type are preferable. Detectors used for registration of slow neutrons are gas discharge corona ^3He -filled counters. Hydrogen-containing substances with good scattering properties are utilised as moderator of fast neutrons.

The neutron absorption method has showed a broad application in the nuclear power engineering and atomic industry. This method is intended for continuous automatic monitoring of contents of the boron-10 isotope in the coolant of the primary circuit and other technological solutions of the boric acid in the power blocks utilising PWR (Pressurised Water Reactor type of VVER). The purpose of the control is the maintenance of nuclear safety and reliability of NPP (Nuclear Power Plants). The measurement results of the isotopic concentration are used for realisation of boron regulation. This measurements in the stream are provided with the normalised accuracy within the range from 1% to 2.5% and no more than 0.5% with sampling at the contents of H_3BO_3 up to 50 g/dm^3 . Also, the same method is used for monitoring of absorption degree of thermal neutrons in items made from boric steel for storage of the spent nuclear fuel. The definition error of absorption factor for thermal neutrons in hexahedral tubes made from of boric steel constitutes ± 0.025 for the range of factor from 0.8 to 1.0.