THE POWER MEASUREMENTS OF THE CRITICAL ASSEMBLY "PHYSICAL MODEL OF THE PIK REACTOR"

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The critical assembly "Physical model of the PIK reactor" has been put into operation at LNPI and is operated at present. Results of investigations by means of critical facility are necessary for experimental devices design, determination of burden radiation for planning experiments at the reactor, for

determination of service life of reactor elements, for testing calculating programs and for solving numbers of other problems.

The calculations of neutron fluxes and energy release in structural materials in the reactor channels requires a lot of expenditures on the program elaboration and computer time. For this reason it is worth while to measure radiation characteristics in conditions of complex real geometry at the critical assembly modeling the reactor. In such measurements it is important to determine the power of the critical assembly.

In this paper the power measurement technique on the critical assembly with the 3 per cent mistake by activity of fission fragments in the fuel elements has been developed. The possibility of measurement of fuel unit activity has been proved.

As the critical assembly power (P) is equal to the product of the fission reaction rate in the volume of the core and fission energy (E_f) per one fission the power can be calculated after measuring the number (N) of fission fragments with (χ) thermal and epithermal fission yield during the assembly operating time (t)

$$P = (N \cdot E_f)/(\chi \cdot t)$$

In our work the assembly power has been determined according to the number of ^{140}Ba nuclei. The summary ^{140}Ba yield per one ^{235}U fission by thermal and epithermal neutrons in the core of the assembly PIK is equal to $\chi = (6.32 \pm 0.06) \cdot 10^{-2}$ [1—3]. The consideration of the ^{235}U and ^{238}U fission by fast neutrons and of fragment nuclei reactions by neutrons give minor correction $-2 \cdot 10^{-4}$in ^{140}Ba yield. This minor correction has been included into the measurement error.

^{140}Ba disintegrates in ^{140}La. The number of ^{140}Ba nuclei has been measured by the count rate of gamma-quantum with the energy $E_\gamma = 1596\ keV$ which has been formed during ^{140}La decay. The lanthan activity has been measured, usually, per $\tau \geq 10$ days after 1—2 hours of the assembly operating time at constant power level. In such a case practically all ^{140}La nuclei decay which have been formed during fission with $0.005 \cdot 10^{-2}$ yield [2,3] and out of barium decays during radiation time. The number of lanthan nuclei formed when barium decays after the completion of radiation reaches almost maximum. For $\tau \geq 10$ days the ratio of daughter ^{140}La activity $A_2(\tau)$ and ^{140}Ba activity $A_1(\tau)$ is equal to

$$A_2/A_1 = \lambda_2 \cdot (1 - \exp(-(\lambda_2 - \lambda_1)\ \tau))/(\lambda_2 - \lambda_1)$$

where λ_1, λ_2 — decay constants of ^{140}Ba and ^{140}La.

The fuel elements activity has been measured with multichannel gamma-spectrometer with a 60 cm^3 germanium-lithium detector.

The fuel elements activity measurement technique requires a lot of expenditures and much time in order to disassemble the fuel units, to place the fuel elements into the measurement frame, to assemble the fuel units. The measurement of fuel inits activity excludes from the subsidiary time and allows to measure the total fuel elements more promptly. Because a fuel unit is the absorber gamma-quantasource. The absorption of gamma-quanta has been taken into account in the measurement of the fuel units activity. The average gamma-quantum rate of furl units gas been computed from two measurements: one-fuel unit has been placed relatively detector in the direction of the core radius and two-units have the reverse direction. This measurement method permit to level the shad coefficient fuel elements layers.

The calculated and experimental analysis have indicated too slight dependence (to 1%) of the shade coefficient of fuel unit activity distribution.

References

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