POSSIBILITY OF INCREASING THE RATIO OF MAXIMUM THERMAL NEUTRON FLUX DENSITY TO REACTOR'S POWER IN RESEARCH REACTOR'S REFLECTOR

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One of main requirements to a research reactor for physical research is to get the greatest possible density of the thermal neutron flux in a reflector, the given reactor power being (Φ_{th}/P).

The possibility of increasing the value Φ_{th}/P by means of a compound reflector has been investigated in this paper (the PIK [1] reactor being a model).

The idea of the compound reflector is to place an intermediate layer of the material with higher moderating power ($\xi\Sigma_s$) than in the material the reflector is made of; this layer is placed between the core and the reflector.

To calculate the thermal neutron flux density MCU [2], DOT-3.5 [3] and XSDRNPM [4] codes have been used. The moderating power of light water is 7.5 times greater than the one for heavy water [5]. Therefore, if we take heavy water as a reflector light water will be an effective material for the intermediate layer.

The thickness of the intermediate layer must not be greater than the diffusion length of the thermal neutron in it. Calculations showed that the optimum thickness of the lightwater intermidiate layer equalled ≈ 1.5 *cm*.

Absolute values of Φ_{th} in the reflector and in the CEC of the PIK reactor calculated by MCU code are given in Table 1; experimental values Φ_{th} from the paper [6] are also given there. As seen from the table if there is no H_2O layer, the calculated values Φ_{th} in HEC-4 and in CEC are in a good accord with the experimental data. After putting the lightwater intermediate layer 1.5 *cm* thick thermal neutron flux density increases 1.4 ± 0.5 times in maximum; in HEC-4 1.3± 0.3 times; in CEC — 1.1± 0.2 times.

Table 1

Calculated and experimental values of Φ_{th} with different thickness of lightwater intermediate layer

Thickness of H_2O layer, *cm*	Φ_{th}, 10^{12} $n/(cm^2 \cdot s \cdot MW)$					
	max		HEC-4		CEC	
	calc.	exper.	calc.	exper.	calc.	exper.
0.0	12 ± 2.1	—	8 ± 1.7	9 ± 1.3	45 ± 7.6	45 ± 6.7
1.5	17 ± 1.6	—	10 ± 1.2	—	51 ± 8.1	—

Distribution of thermal neutrons flux density in the reflector has been calculated by DOT-3.5 code in R—Z geometry. The calculation has been made with lightwater intermediate layer 1.5 *cm* thick as well as without it. Experimental channels have not been taken into account. The maximum Φ_{th} increase equals 1.3 ± 0.1 times and agrees with the calculation made by MCU code (table 1). Calculations show that maximum Φ_{th} displaces from $\approx$ 31 *cm* to $\approx$ 26 *cm* (for $\approx$ 5 *cm*) toward the vessel. However, at great distances (where the experimental channels are located) from the vessel in the compound reflector Φ_{th} is no less than in heavy water.

The data obtained were partially confirmed in the following experiment. A horizontal aluminium channel 21 *mm* in diameter was installed in the reflector of Physical model of the PIK reactor [7] at the level of the core's centre. The channel at the distance of 21 *cm* and 22 *cm* from the core centre Φ_{th} has been measured

this space being filled with polyethelene disk 18 *cm* in diameter (light water initation) and with heavy water. The results of these measurements and calculations are summarezed in table 2. Calculations have been made for the full-sized intermediate layer of polyethelene. This accounts for the difference in calculated and experimantal data in the point where the calculated value is naturally greater.

Table 2

Calculated and experimental values of Φ_{th} om special experimental channel

Material of compiund layer $d = 1$ *cm*	Φ_{th}, 10^{12} $n/cm^2 \cdot s \cdot WM$			
	R = 21 *cm*		R = 22 *cm*	
	calc.	exper.	calc.	exper.
D_2O	5.5 ± 0.4	5.7 ± 0.8	6.8 ± 0.5	6.2 ± 0.9
$(CH_2)_n$	6.4 ± 0.6	5.9 ± 0.8	11.3 ± 0.8	9.9 ± 1.3

References

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