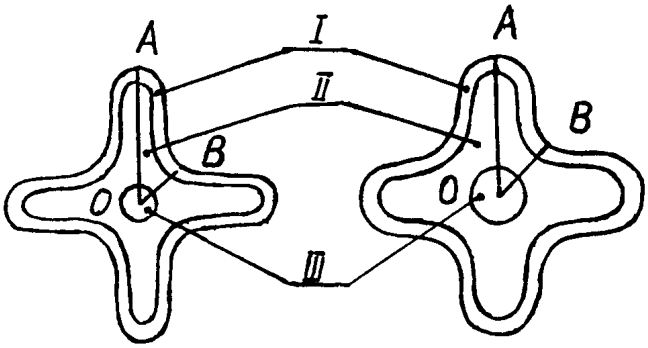
ZIRCONIUM FUEL ELEMENT OF REACTOR PIK

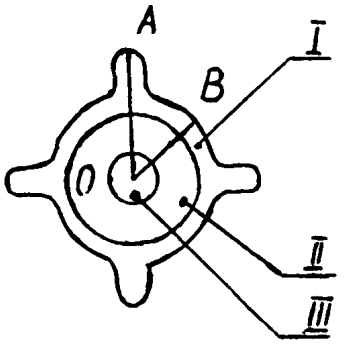
VI.Didenko, A.S.Zaharov, B.V.Kislitsin, K.A.Konoplev

One of the constraints limiting the attainable power density of the reactor core is high fuel center line temperature and as a result considerable temperature stresses due to difference between fuel and cladding material. It is possible to incre ase power density by using another cladding material with high strength, but usually it is not feasible because such materials have low thermal conductivity.High velocity head causes the loss of mechanical stability in going to thin elements (for example thin plates) [1], therefore such fuel assemblies are equipped with clamping elements. Crosswise fuel pins (CFP) forms mechanical stable fuel assembly stipulated with the same design. But cooling conditions leads to high spatial nonuniformity of heat removal [2], therefore power increasing is limited by the same temperature constraints similar to fuel plates. It is useful to replaced in part of fuel with nonfissionable material, as a result the temperature of fuel and its nonuniformity will be decreased. Sometimes it is useful to put into practice poison material as replaced one. In such a way manufacturing of thin elements and replacing fuel in CFP are connected with adding of structural material, only in the first case it is made for location of elements, in the second for temperature equalization. The choice of structure design is connected with manufacturing possibility.

The distribution of temperature in fuel elements (fig.1,2,3) were calculated by means of finite elements method. There are shown calculated area, its choice was caused by form symmetry. Zirconium was considered as cladding material, because of it advantage for high power density active core of reactor PIK. It took into consideration thermal conductivity dependence on temperature.

The main results of temperature calculations, spatial nonuniformity coefficient of the heat removal (K_p) for found optimum radius of replaced zones are shown in the Table. The most effective replacement is forCFP elements (fig.1,2). Its center line temperature decreases by 300—400°C, and surface temperature of cladding by 60° C, coefficient K_p decreases 1.3—1.4 times stresses decreases 3 times.





F ig.1 Fig.2 Fig.3

Sectional view: I — cladding, II — fuel, III — replaced zone, OBA — calculated area.

Table

Fuel elements	Radius of replaced zone *mm*	Fuel center line temperature °C	Surface cladding temperature °C	K_p	Efficiency of heat transfer surface cm^{-1}
1	0	891	293	2.13	3.38
	0.7	561	239	1.66	4.33
2	0	977	265	1.78	3.77
	1.3	589	202	1.26	5.33
3	0	962	220	1.44	5.5
	0.7	712	220	1.44	5.0

References

1. Bat' G.A., Kochenov A.S., Kabanov L.P. Issledovatel'skie Jadernye Reactory, Moskva, Attomizdat, 1972.
2. Garusov E.A., Grach'ov C.D. Report LNPI-660, Leningrad, 1981.