TEMPERATURE CONDITIONS OF WWR-M5 TYPE FUEL ASSEMBLY IN CB-12 CONTAINER

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A fuel assembly (FA) rechargings from a main storage to an additional one, to hot chambers and to a biological reactor are carried out by means of a transport container CB-12. Fig.1 shows its cross-section. As a rule, four single FA or one threefold assembly (an assembly made up of three single FA) with one single FA are loaded in this container. For technical validation of recharging operation safety it is necessary to be convinced that long switching off the crane transporting the container with FA (i.e. long stay of the FA

in the container) does not lead to a loss of a leaktightness and to a fission yield out of the container. In other words, it is necessary to estimate temperaturetime dependence for fuel elements loading in the container and having a known value of residual power which is defined by the history of this assembly (its operating time and power in the reactor and its decay time).

Necessity of experimental measurements of the fuel elements temperature in the container CB-12 as an energy dependence is explained by uncertainty of the heat transfer mechanizm from FA to container which considerably influences the temperature calculations results.

This investigations have been carried out on the WWR-M5 type FA model [1]. Each its element was equipped by heaters and thermocouples. The threefold FA type WWR-M2 model was used as an imitator of the neighbour fuel elements. It was equipped with the heater placed in the central tube.

Fig.2 shows a cross-sections of the single FA and threefold FA and an arrangement of the heaters and thermocouples. All assemblies were placed in the pail and lifted in the container by a winch. In this way the real conditions of the heat transfer in the container were provided. Fig.3 presents the dependence of the hottest and coldest fuel elements temperature over the room temperature on the residual power P (Wt). The maximum fuel element temperature may be approximated by the quadratic polynomial

$$T_{\max} = 0.89 + 4.63 \cdot P - 0.028 \cdot P^2 \qquad (1)$$

The calculation by this formula in the power range $10 \div 45$ Wt gives the temperature differences from experimental values neither more than $\pm 2°C$.

It is necessary to take into consideration that in the FA unloading from the active core gamma-energy of the fission products amounting 47 per cent is only partial absorbing by itself. It reduced the residual power in unloading FA by 30 per cent in comparison with its power in the active core.

Fig.4 presents the dependence of the ratio of the hottest fuel element current temperature to the steady-state one as a function from time. The relative values of the hottest fuel element current temperature for different values of the power release describe satisfactorily the same dependence on time

$$\frac{T}{T_{\max}} = 1 - e^{-1.45 \cdot 10^{-2} \cdot \tau}, \qquad (2)$$

where τ is time in minutes counting from FA recharging to the container.

In Fig.4 one can see that the time of the steady-state condition coming for FA in the container makes approximately $4 \div 5$ hours and is considerably (three times) more than the time for the FA in the open air [2]. It may be connected with the big container warm-up time.

Dependences 1 and 2 allowed to estimate the hottest fuel element temperature when residual power of FA and stay time of FA in a container are known [3].

These investigations show that accident with the crane switch off and a consequence a long stay of FA in the container don't lead to the fuel elements overheating more than the limit temperature 200°C when the residual power of the FA is less than 50 Wt. It corresponds to the FA endurance in the storage no less than 15 days after its two week exploitation operation in the reactor WWR-M the power being 18 MWt.

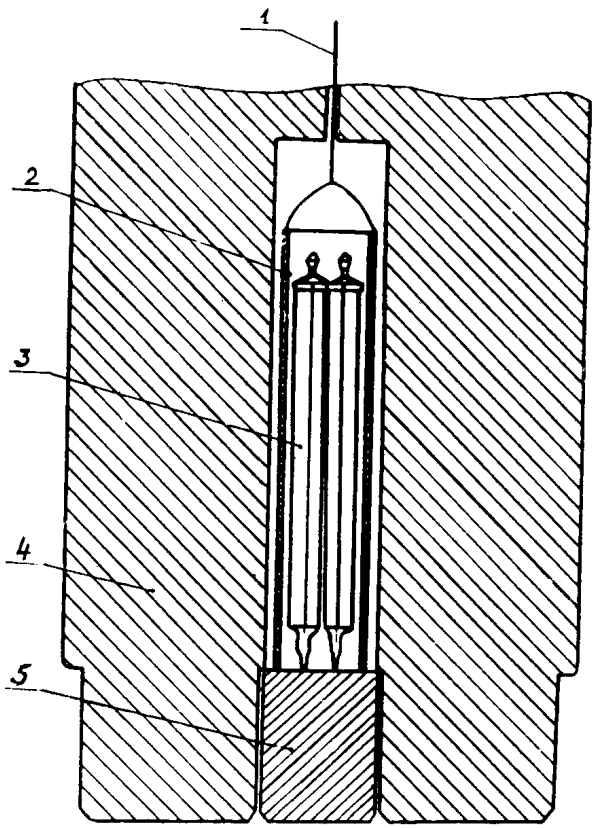

Fig.1. Cross-section of container CB-12:
1 — rope of winch, 2 — pail, 3 — fuel assembly (FA), 4 — container, 5 — core

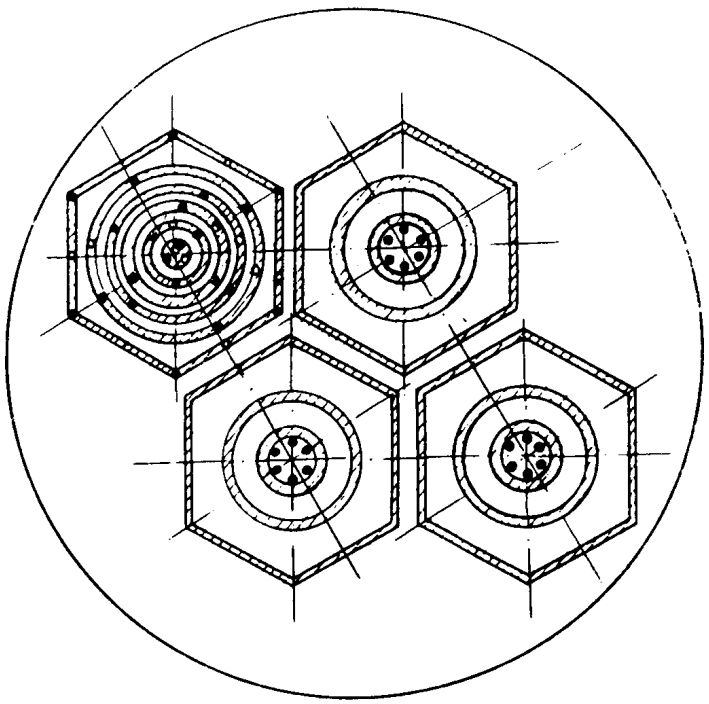

Fig.2. Scheme of relative position of fuel elements in container. Location of the heaters and thermocouples in fuel elements of FA type WWR-M5. Designation: o — heater, • — thermocouple

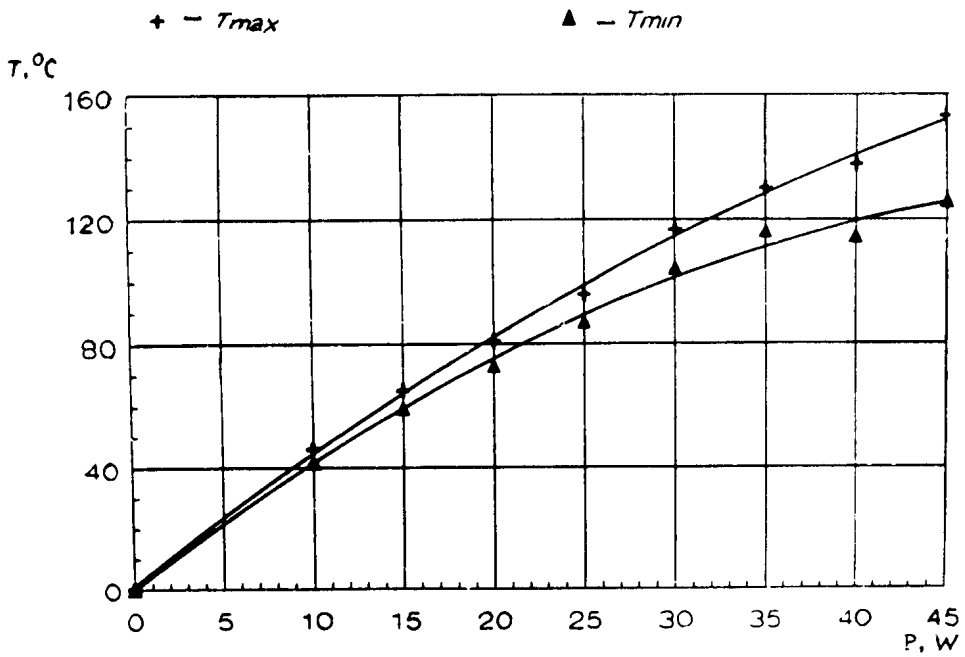

Fig.3. Dependence of temperature of inner (T_{max}) and outer (T_{min}) fuel elements of FA type WWR-M5 on residual power

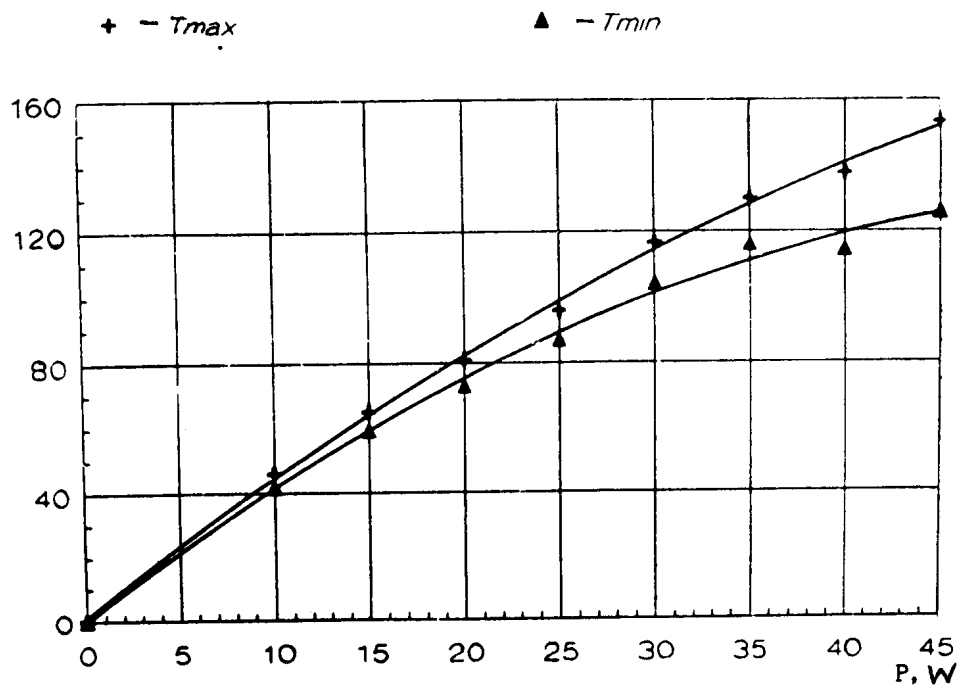

Fig.4. Dependence of relative temperature of hottest fuel element on time for different values of residual power

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