MEASUREMENTS OF THERMAL CONDUCTIVITY OF POWDER MATERIALS BEING REACTOR PIK CONTROL ROD FILLERS

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A powder of the europium dioxide (Eu_2O_3) is used as the reactor PIK absorber rod filler. A main limitation for this powder using is maximum permissible temperature whose value is equal to 1900 K. Measurements of thermal conductivity of a europium dioxide powder and powder mixtures of europium dioxide with molybdenum and chromium powders have been made to evaluate the operational reliability of the reactor PIK absorber rods construction and to search ways of the operating temperature decrease. Measurements were made on special plant by the method of an infinite-dimensional cylinder which allowed to measure the effective thermal conductivity coefficient in an average temperature range from 400 K up to 1100 K both in vacuum and in a helium atmosphere [1].

Thermal conductivities of the powder of Eu_2O_3 which was packed into the test space to the density $\rho = 5.29$ g/cm^3, of the powder of (87.5 per cent of Eu_2O_3 and 12.5 per cent of Mo) which was packed to the density $\rho = 4.14$ g/cm^3, of the powder of (75 per cent of Eu_2O_3 and 25 per cent of Cr) which was packed to the density $\rho = 4.86$ g/sm^3 are measured [2].

Mathematical processing the measurements data permits to obtain empirical dependences for the thermal conductivity coefficients of the powders on temperature.

The following dependences were obtaned:
for the powder of Eu_2O_3 in vacuum

$$\lambda(T) = 0.058 - 1.71 \cdot 10^{-4}T + 1.91 \cdot 10^{-7}T^2, \tag{1}$$

for the powder of (Eu_2O_3 and Mo) in vacuum

$$\lambda(T) = 0.054 - 2.12 \cdot 10^{-4}T + 2.44 \cdot 10^{-7}T^2, \tag{2}$$

for the powder of (Eu_2O_3 and Cr) in vacuum

$$\lambda(T) = 0.082 - 2.50 \cdot 10^{-4}T + 2.59 \cdot 10^{-7}T^2. \tag{3}$$

During the thermal conductivity coefficients measurements in the helium atmosphere it was found that the powder thermal conductivity appreciably changed after the exposure of the experimental plant at temperature 1500 K on the hot side of the measurement section.

At first the temperature dependence of the thermal conductivity coefficient of the powder of Eu O in the average temperature range from 400 to 1100 K could approximated as

$$\lambda(T) = 0.1265 + 3.09 \cdot 10^{-4}T. \tag{4}$$

of the powder of (Eu_2O_3 and Mo) as

$$\lambda(T) = 0.0385 + 2.31 \cdot 10^{-4}T, \tag{5}$$

of the powder of (Eu_2O_3 and Cr) as

$$\lambda(T) = 0.1325 + 3.85 \cdot 10^{-4}T \tag{6}$$

but after the experimental plant was exposed at the high temperature experimental results were approximated for the powder of Eu_2O_3 as

$$\lambda(T) = 0.0615 + 3.07 \cdot 10^{-4}T, \tag{7}$$

for the powder of (Eu_2O_3 and Mo) as

$$\lambda(T) = 0.087 + 2.58 \cdot 10^{-4}T \tag{8}$$

for the powder of (Eu_2O_3 and Cr)

$$\lambda(T) = 0.1745 + 2.48 \cdot 10^{-4}T \tag{9}$$

The random error was defined by comparison of the value

$$\Lambda_t = \int_{T_1}^{T_2} \lambda(T)dT \tag{10}$$

which was calculated by means of the finding dependences l(T) with the value

$$\Lambda_e = \frac{q_l}{2\pi} \ln(R_1/R_2) \tag{11}$$

which was defined by means of the experimental measurement data q_l, T_1, T_2. This error does not exceed 10 per cent.

After the experimental plant was exposed at the cold state the replication measurements of a powders thermal conductivity were made in the same measurement section in vacuum and in a helium atmosphere.

Replication measurements showed that the powder thermal conductivity kept the previous value in vacuum (as before the exposure at temperature 1500 K), but experimental data of replication measurements in a helium atmosphere corresponded to value of the thermal conductivity coefficients after warming.

In all cases replication measurements data coincided with the primary measurements data.

The experimental plant was disassembled after measurements. The disassembly showed that the visible gap was formed among the powder material and the inner tube whose temperature exceeded 1500 K.

Thus, there is the volatilization of the powder material from the hot surface. Apparently it changes the thermal conductivity coefficient of filling in a helium atmosphere.

REFERENCES

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