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#5-295 Determination Of The Rate Of Corrosion Of Heat-Emitting Elements On A Rotating Disc Electricity By The Potentiometric Method

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The potentiometric method for determining the corrosion rate of heat-emitting elements is one of the most effective methods for monitoring the condition of nuclear reactor heat-emitting elements materials. It is based on measuring the electrode potential, which is a function of the corrosion potential. The corrosion process is accompanied by changes in the composition of the heat-emitting elements surface layer, in particular, the formation of oxide films or the destruction of the protective layer, which affects the electrode potential. This makes it possible to evaluate the corrosion rate and the state of the protective layer in real operating conditions using potentiometric methods.

To reproduce the conditions of heat-emitting elements operation in the reactor as accurately as possible, potentiometric studies take into account hydrodynamic aspects: pressure distribution, fluid resistance, coolant flow rate, and cooling efficiency. These factors have a significant impact on corrosion intensity, especially in high temperature and aggressive chemical environments. The research is carried out on a rotating electrode, which allows to simulate turbulent fluid flow close to the actual conditions of coolant circulation in the reactor.

For such studies, we use modern equipment, including the MTech SPG-500F galvanostat, which is a Ukrainian-made device. This device provides high measurement accuracy, electrode potential monitoring and corrosion current recording. Thanks to such devices, it is possible to reproduce various operating conditions and study the impact of changes in environmental parameters on the corrosion resistance of heat-emitting elements.

The corrosion resistance of the material of heat-emitting elements made of E110 alloy (zirconium alloy with the addition of niobium) is determined by the polarization resistance method. This approach involves the recording of anode and cathode voltammetry, which is constructed by gradually shifting the electrode potential to values close to the corrosion potential (up to 50 mV).

The corrosion resistance of the heat-emitting elements material (E110 alloy) was determined by the polarization resistance method by recording anode and cathode voltammetry. The corrosion current density jcor was determined by extrapolation at the point of intersection of the linear sections of the partial anode and cathode polarization dependences near the corrosion potential Ecor (sections up to 50 mV) in the Tafel coordinates lgj-ΔE based on the known value of the corrosion current, the depth index of the corrosion rate kh was calculated.

Alloy E110 demonstrates high corrosion resistance due to the formation of protective oxide layers such as ZrO_2 and Nb_2O_5. These oxides form passivating films on the surface of the material, which significantly reduce the corrosion rate and prevent the dissolution of the base material in aggressive environments. In particular, zirconium is highly resistant to water vapor at high temperatures, and the addition of niobium improves mechanical properties and resistance to acids.

The use of potentiometric methods is especially relevant for the comparative analysis of heat-emitting elements from different manufacturers, such as Westinghouse, and heat-emitting elements manufactured in the Russian Federation. Westinghouse heat-emitting elements have slightly different chemical and mechanical properties due to the use of alternative zirconium alloys. Potentiostatic studies allow to assess the stability of these materials under specific operating conditions of VVER reactors.

Studies of fuel element corrosion resistance are critical to ensure safe and efficient operation of nuclear reactors. The high accuracy of potentiometric methods in combination with modern equipment provides valuable information on the durability of heat-emitting elements. This, in turn, helps to optimize the design of fuel elements, increase their reliability and ensure stable operation of reactors even in difficult operating conditions.

Thus, the potentiometric method is an indispensable tool for assessing the corrosion rate of fuel rods. It allows for a comprehensive analysis of the influence of the environment and design features of heat-emitting elements, providing the necessary data to improve their stability and safety of nuclear power units.

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