Development of a Corrosion Model Ofthermal Elenents of Nuclear Power Plants

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Abstract. Nuclear power plants (NPPs) result in accumulation of a significant amount of radioactive products during the process of their storage and the presence of a potential release of radioactive products, in the case of an accident that is a source of potential hazard and risk of radiation impact on the personnel, population and environment in general. The paper shows the microgalvanic corrosion element formed on the inner wall of fuel rods made of Zr + 1%Nb alloy and pellets made of uranium oxides, as well as the outer galvanic element of fuel rods and structural materials of the reactor made of steel of different grades. The hazards caused by corrosion damage and release of hazardous radioactive substances from the reactor based operating area are analyzed. The possibility of predicting the rate of corrosion damage using a mathematical model on the thermodynamic approach is determined and established.

1 Introduction

Evolutionary trends in the world energy sector at the beginning of the new century have become one of the most pressing problems of the civilized world [1, 2]. Current trends in the development of the global market indicate a transformation of the structure of the energy industry from traditional thermal power to nuclear power. Nuclear energy is favored by its relative low cost, accessibility, absence of emissions of combustion products, and availability of sufficient global uranium reserves. For example, China has approximately 50-60 thousand tons of natural uranium reserves, which is theoretically enough to supply its nuclear power plants for several decades [3].

At present, nuclear power is based mainly on light water reactors - pressurized and boiling water reactors - which account for about 85% of all electricity generated. In terms of classification, reactors are divided into:

- by the energy of neutrons that cause fission (thermal, fast and intermediate neutron reactors);
- by the nature of nuclear fuel decay (homogeneous and heterogeneous);
- by the moderator used (light water (H2O), heavy water (D2O), graphite (C), beryllium (Be, BeO), organic (biphenyl and similar)). Characteristics of some thermal neutron moderators are given in Table 1;
- by purpose (energy, research).

Table 1. Properties of thermal neutron moderators [4]

Retarder	Density, [g/cm^3]	Slowing down ability, [cm^{-1}]	The factor of deceleration
H_2O	1.00	1.35	71
D_2O	1.10	0.176	5670
Graphite	1.60	0.0,60	192
Be	1.85	0.158	143