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Thermodynamic analysis of the metals oxidation in steam at NPP and thermal power plants

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When designing modern power units it is necessary for reliability to solve the problem of the materials choice and prediction of their resistance by oxidation in a wide range of temperatures and concentrations of oxidants such as oxygen and steam. The main problem is the oxidation of steel pipelines and equipment in the steam during long-term operation of thermal and nuclear power plants. And specific task is the oxidation of fuel cladding during loss of coolant at nuclear power plants (LOCA accident). These problems have been studying for a long time, the alloys are mainly chosen and used in industry. The results of experimental study of the oxidation kinetics are published and summarized. Empirical equations are proposed by different authors to predict the corrosion of materials. These equations are based often on the small amount of experimental data performed by different techniques. It is difficult to compare the results of different tests. Although there is an extensive foundation of experimental data, its use in most of the program codes remains at the preliminary level, and the justification of the use is inadequate. This paper presents the results of a thermodynamic approach to the analysis of experimental data and equations of the kinetics of high temperature oxidation of alloys on the base of iron (when operating at thermal power plants and NPP) and Zirconia (with LOCA in NPP) in the steam. The method of data "sorting" and criteria of authenticity and of belonging to the chosen set of the results of isothermal tests at specified temperatures, times and the composition of the medium oxidation are proposed. The models of influence of zirconium alloys composition on their corrosion in steam are created. The models verification is made on a basis of reliable data. Oxidation kinetics of E110, Э110opt, Э110М, Э635 (on the spongy base) alloys is calculated and a comparison with the oxidation kinetics of Zry-4 and M5 is performed. The established regularities can serve as the basis for the development of the account code module of physical condition change of the zirconium claddings in the process of the accident, which is determined by such phenomena as oxidation, creep deformation and rupture.

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