Accepted Manuscript

Corrosion of zirconium alloys demonstrated by using impedance spectroscopy

Veronika Renčiuková, Jan Macák, Petr Sajdl, Radek Novotný, Aneta Krausová

PII: S0022-3115(18)30546-4

DOI: 10.1016/j.jnucmat.2018.08.005

Reference: NUMA 51128

To appear in: *Journal of Nuclear Materials*

Received Date: 17 April 2018

Revised Date: 2 August 2018

Accepted Date: 5 August 2018

Please cite this article as: V. Renčiuková, J. Macák, P. Sajdl, R. Novotný, A. Krausová, Corrosion of zirconium alloys demonstrated by using impedance spectroscopy, *Journal of Nuclear Materials* (2018), doi: 10.1016/j.jnucmat.2018.08.005.

Corrosion of zirconium alloys demonstrated by using impedance spectroscopy

Veronika Renčiuková[a,c,*], Jan Macák[a], Petr Sajdl[a], Radek Novotný[b], Aneta Krausová [a]

[a] Power Engineering Department, University of Chemistry and Technology Prague, Technická 3, 166 28 Prague 6, Czech Republic

[b] JRC-IET, Westerduinveg 3, 1755 LE Petten, The Netherlands

[c] Institute of Physics of the Czech Academy of Sciences, Na Slovance 1999/2, 182 21, Prague 8, Czech Republic

Abstract

Corrosion rate of zirconium alloys is primarily studied using weight gain method. We present a complementary procedure of a continuous and instantaneous monitoring of the corrosion rate using in-situ Electrochemical Impedance Spectroscopy (EIS), which does not disturb corrosion process in an autoclave. Two zirconium alloys, Zry-4 and Zr1Nb, were exposed in a non-active VVER primary coolant at 340 °C for almost 700 days. Measurements were aimed at passing through transition. To characterize corrosion kinetics, impedance spectra were approximated using simple models of an equivalent circuit with both the resistive and capacitive elements which described corrosion phenomena and oxide growth over the whole exposure. This way the cyclic nature of the corrosion kinetics of Zry-4 was confirmed. Oxide thickness, as a form of a cumulative corrosion rate, was obtained by combining Faraday's law and Stern-Geary approximation (FLSG). Comparing instantaneous and cumulative corrosion rate, potential inaccurate determination of transition time was demonstrated. Arrhenius interpolation was applied to correlate oxide thickness calculated based on the FLSG and weight gains. It was showed that the application of FLSG is valid.