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ASSESSMENTS OF DELAYED HYDRIDE CRACKING PHENOMENON FOR THE FUEL PRESSURE TUBE OF THE CERNAVODĂ NUCLEAR POWER PLANT

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Abstract. *A critical review of the DHC (Delayed Hydride Cracking) phenomenon in the specific case of the pressure tube subcomponent of the fuel channel assembly of the Cernavodă Nuclear Power Plant is presented. For the both stages of DHC –initiation and propagation- the models are discussed and an appropriate numerical assessment was implemented into CANTUP computer code. A first task of the present work is to couple the routines for DHC initiation and propagation steps for better modeling of the characteristics of this damaging phenomenon. Finally, the assessment of DHC rates in the case of various locations of the virtual crack on the CANDU pressure tube is performed. The normal operation conditions for ten years period of time are assumed to consider their influence on the material properties.*

Keywords: Key words: crack propagation velocity, stress intensity factor, hydride platelet, embrittlement, Zr-2.5% Nb alloy

1. Introduction

Zirconium alloys are used in the water reactors because of their low capture cross-section for thermal neutrons and good mechanical and corrosion properties. Unfortunately, hydrogen was identified as an embrittlement agent, as, on reasons of solubility in the alloy matrix, it precipitates as hydride platelets [1]. Many experimental results [2] pointed out that Zr-2.5% Nb alloys may also fracture by a time-dependent mechanism involving hydrogen, but the first practical confirmation of such a mechanism was the cracking of experimental fuel cladding made from Zr-2.5 % Nb. Hydrides were associated with the cracks and the process was called Delayed Hydride Cracking – abbreviated DHC [3].

In order to describe in a quantitative way this phenomenon it is necessary to evaluate the stress-strain field of the specimen which contain the crack susceptible to extent by DHC; this concern either initiation and propagation. Usually, this is done using finite element method and certain calculus programs/codes. In the case of the Institute of Nuclear Research from Pitesti (INR), for the fuel channel assembly, it was developed over the time a code, called CANTUP. The CANTUP

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