Stress-Relaxation Behavior of Inconel 718 in thermal and in-pile conditions

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ABSTRACT: Ni-base Superalloys are widely used in the manufacturing of spring materials

which are used in the fuel rod assemblies of PWR's, because they have very high tensile strength and

sufficient ductility. During their life in the reactor at a temperature of about 315°C, the pressure

exerted by these springs decreases by the effect of neutron irradiation, and might become insufficient

for long term applications. The aim of this paper is to study the stress-relaxation behavior of the

Inconel 718 in thermal and in-reactor conditions.

At first, we describe the experimental device allowing us to irradiate Inc 718 bending strips in

Metallurgical Test Reactors (Siloé and Osiris), and to measure the stress- and strain- relaxation ratio

after each irradiation period. The results of these experimental irradiations allow us to study the

evolution of this ratio with irradiation time (up to 3600 hours), initial stress level (300-900 N/mm²)

and metallurgical condition (Solution-Annealed and Aged or Cold-Worked and Aged). We deduce

two deformation stages from calculation of plastic deformation resulting of stress-relaxation.

Secondly, we use the results of out-of-pile relaxation tests to highlight the main differences induced

by irradiation. Finally, we will discuss the validity of thermal relaxation models with respect to the

relaxation under irradiation, and we will show the first results of examinations by transmission

electron microscopy which should reveal the microstructural origin of the irradiation-induced

behavior.

Superalloys 718, 625, 706 and Various Derivatives Edited by E.A. Loria

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