

HYDROGEN EFFECTS ON MECHANICAL PERFORMANCE OF NODULAR CAST IRON

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The ferritic nodular cast iron grade EN-GJS-400-15 intended for use as the load-bearing part of canisters for long-term disposal of spent nuclear fuel was studied in order to evaluate its sensitivity to the hydrogen-induced effects on mechanical performance. Hydrogen was introduced in the cast iron electrochemically from 1N H₂SO₄ solution under controlled cathodic potential. Hydrogen uptake in the course of tensile testing was measured using hydrogen thermal desorption method. It was found that plastic deformation of the specimens in the continuous hydrogen charging results in a remarkable increase of hydrogen uptake in the studied cast iron.

Constant extension rate tests (CERT) and constant load tests (CLT) performed under continuous electrochemical hydrogen charging showed a remarkable reduction of elongation to fracture in CERT and time to fracture in CLT as compared to the corresponding values obtained by testing in air and water environments. The most important finding is that hydrogen increases dramatically the creep rate of the cast iron in CLT already at applied load of about 0.5 x yield stress. The tensile tests were followed with SEM observations of the hydrogen-induced cracking appearance on the tensile specimen outer and fracture surfaces.

The obtained results are discussed in terms of the specific role of the graphite nodules as abundant sources of hydrogen and the nodule distribution in the cast iron matrix in the mechanisms of hydrogen-induced cracking.