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Abstract

The present study involves the estimation of ring tensile properties of Indian Pressurised Heavy Water Reactor (IPHWR) fuel cladding made of Zircaloy-4, subjected to experiments under a simulated loss-of-coolant-accident (LOCA) condition. Isothermal steam oxidation experiments were conducted on clad tube specimens at temperatures ranging from 900 to 1200^{o}C at an interval of 50^{o}C for different soaking periods with subsequent quenching in water at ambient temperature. The specimens, which survived quenching, were then subjected to ambient temperature ring tensile test (RTT). The microstructure was correlated with the mechanical properties. The yield strength (YS) and ultimate tensile strength (UTS) increased initially with rise in oxidation temperature and time duration but then decreased with further increase in oxidation. Ductility is adversely affected with rising oxidation temperature and longer holding time. A higher fraction of load bearing phase and lower oxygen content in it ensures higher residual ductility. Cladding shows almost zero ductility behavior in ring tensile test when load bearing phase fraction is less than 0.72 and its average oxygen concentration is greater than 0.58 wt%.

Keywords: Loss of coolant accident, steam oxidation, oxide growth, α-Zr(O) growth, oxidation kinetics, cladding embrittlement, ring tension test

1. Introduction

Fuel cladding plays a crucial role of transferring the nuclear heat produced in the fuel to the coolant as well as preventing the leakage of radioactive material into the coolant in the reactor. Hence the integrity of the clad is to be maintained under normal, off normal as well as accident