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Sodium compatibility of Recently-Developed Optimized Grade 92 and its Weldments for Advanced Fast Reactors

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This paper presents the results of sodium compatibility of the base metal and weldment of optimized Grade 92 steel recently developed in the United States for applications in advanced sodium-cooled fast reactors. Optimized Grade 92 (Fe-9Cr-0.5Mo-2W-V,Nb) is a variant of commercially available Grade 92 ferritic-martensitic steels with tighter control of chemistry and thermo-mechanical treatment to achieve improved high temperature performance. Several heats of optimized Grade 92 were investigated in liquid sodium environments to evaluate their long-term performance. The data are used to assess optimized Grade 92 for the American Society of Mechanical Engineers (ASME) code qualification and Nuclear Regulatory Commission (NRC) licensing. Sodium exposure experiments were conducted at 550, 600 and 650C in forced convection sodium loops at the Argonne National Laboratory (ANL). The oxygen content of sodium was controlled by the cold-trapping method to achieve ˜1 wppm oxygen level. Specimens were removed from the sodium loop after a pre-determined exposure time for post sodium-exposure examination, including weight and thickness measurements, cross-sectional examinations, microhardness measurements, microstructural characterization, and tensile tests at the sodium exposure temperature. Data of sodium-exposed specimens were compared with thermal aging data of the same heat of optimized Grade 92 to separate the effects of sodium exposures and thermal aging. Optimized Grade 92 showed an insignificant weight loss after exposures to sodium at 550-650C. Sodium exposures at 650℃ have a much stronger effect on the tensile strength than thermal exposures at 650℃, but not at 600 and 550C with available data. Microstructural characterization of optimized Grade 92 after sodium exposure at 650℃ showed drastic microstructural changes manifested by reduction in dislocation density, subgrain coarsening, M23C6 particle coarsening, MX dissolution, precipitation and coarsening of Laves phase. Weldment of optimized Grade 62 was also characterized after sodium exposures at 600C.

Country/Int. Organization

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