

Effect of Simulated Post Weld Heat Treatment on the Microstructure and Mechanical Properties of IN-RAFM Steel

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Indigenously developed India specific Reduced Activation Ferritic/Martensitic (IN-RAFM) steels are currently considered as a structural material for the Indian Lead Lithium cooled Ceramic Breeder Test Blanket Module (IN-LLCB TBM). Advanced ferritic/martensitic steels offer the opportunity for improvements in fusion reactor performance, operational lifetime and reliability, superior neutron radiation damage resistance, higher thermodynamic efficiency and reduced construction costs. Typically RAFM steels are normalized at high temperature i.e. 980oC for 30 minutes followed by low temperature tempering for longer duration i.e. 760oC for 90 minutes. The resulting microstructure determines the mechanical properties of the steel. These microstructures are designed to produce an optimum combination of strength and toughness at high temperature. However, situations may arise in practice, particularly during welding operations for example, whereby the RAFM steel may receive an additional heat treatment which briefly exceeds the Ac1 and possibly the Ac3 temperature before stabilizing at the tempering temperature. To restore the properties of the weld joints, post weld heat treatment (PWHT) is applied to the steel at 750oC for 2 hours followed by furnace cooling. During PWHT, the base or parent metal of the RAFM steel weld joints also undergo heat treatment process. In this present investigation, the consequence of PWHT effect on base metal of IN-RAFM steel is studied. Simulated post weld heat treatments (SPWHT) have been applied to IN-RAFM steel in a muffle furnace at 750oC and 770 oC for 2 hours followed by cooling inside the furnace. Hardness measurements were carried out on the heat treated sample and was found to be ~210 HVN which is comparable with base metal hardness properties. Advanced electron microscopy has been carried out to investigate the effect of the SPWHT excursions on subsequent microstructural evolution. Tensile tests have been carried out on SPWHT specimens at various temperatures from room temperature to 600 oC. Tensile properties of SPWHT specimen at room temperature is ~650 MPa and at 550 oC is ~320 MPa. Impact toughness upto -100 oC are also being evaluated in this present investigation. The results discuss the effect of SPWHT on mechanical properties of RAFM steel during high temperature service.

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