Choice of Welding Consumable and Procedure Qualification for Welding of 304HCu Austenitic Stainless Steel Boiler Tubes for Indian Advanced Ultra Super Critical Power Plant

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ABSTRACT

India has embarked on a mission program for setting-up a coal-fired 800 MWe Advanced Ultra Super Critical (AUSC) power plant with steam parameters of 710°C/ 720°C temperature 310 kg/cm^2 pressure. For the boiler tubes in the final stages of the superheater and reheater, the material chosen is 304HCu stainless steel (SS), a 18Cr-9Ni-3Cu-Nb-N austenitic SS (UNS S30432) as ASME code case 2328 and VdTÜV 510 specifications. The 304HCu SS is a variant of the conventional 18Cr-8Ni austenitic SS, containing ~3% copper, increased carbon and controlled amounts of niobium and nitrogen, for enhanced elevated temperature strength, especially creep. India-specific version of 304HCu SS boiler tubes, of 52 mm diameter with 9.5 mm wall thickness, produced in collaboration with Indian manufacturers has been used for welding procedure qualification trials.

The objective of the present study is to choose the appropriate gas tungsten arc (GTA) welding consumable, from among ER304HCu (matching chemistry) and ERNiCrMo-3 and ERNiCrCoMo-1 (both nickel-base) filler wires, for welding of 304HCu SS. This involved qualifying the welding consumables, development of welding procedures for 304HCu SS tubes, and producing weld coupons for evaluation of mechanical properties and microstructural characterisation. Mock-up tube weld joints, with single-V groove joint geometry, were prepared using all the three filler wires to optimize the welding parameters. Weld defects like root crack; hot crack and crater cracks were observed during the initial trials in weld joints made with the nickel-base filler metals due to the poor fluidity of the weld metal. These problems were overcome by suitably altering the weld joint design and optimisation of heat input. Subsequently, the weld joints were qualified, in the as-welded condition, by liquid penetrant and radiography examinations followed by tensile tests and bend tests as per ASME section IX requirements for preparing the Welding Procedure Qualification records. Based on detailed evaluation of mechanical properties, including creep, ER304HCu filler metal was chosen for welding of ER 304HCu SS.