Effect of Electron Beam Welding on Stress Corrosion Cracking Behaviour of Nickel Free High Nitrogen Austenitic Stainless Steel

Raffi Mohammed[1, *], *G Madhusudhan Reddy*[2], *K SrinivasaRao*[3]

[1] *Department of Metallurgical & Materials Engineering, National Institute of Technology Andhra Pradesh, Tadepalligudem, 534102, India.*
[2]*Defence Metallurgical Research Laboratory, Hyderabad, 500058, India.*
[3] *Department of Metallurgical Engineering, Andhra University, Visakhapatnam, 530003, India.*
Email of Corresponding Author: raffimohammed@nitandhra.ac.in

Nickel free high nitrogen stainless steel (HNS) having >0.4% N is becoming an important structural material and welding is the major fabrication technique used for joining structural components of high nitrogen steel. Conventional fusion welding leads to solidification cracking, liquation cracking, inferior mechanical properties and poor corrosion resistance. An attempt has been made to weld high nitrogen stainless steel using gas tungsten arc welding (GTAW) process made with PH13-8Mo filler and compared with autogenous electron beam welding (EBW) process. Welds were characterized for microstructural studies using optical microscopy and field emission scanning electron microscopy (FESEM). Vickers hardness, impact toughness and tensile testing were carried out to study the mechanical properties of welds. Potentio-dynamic polarization and double loop electrochemical potentiokinetic reactivation(DL-EPR) tests were performed in 3.5% NaCl aerated solution for evaluating the pitting corrosion resistance and to quantify the sensitization degree of welds. Stress corrosion cracking(SCC) testing was carried out in an aggressive environment of 45%$MgCl_2$ solution boiling at 155°C using a constant load type machine with an applied stress of 50% yield strength. Results of the present investigation established that GTA welds resulted in discontinuous network of delta ferrite in the austenite matrix and coarsening of grain are observed whereas electron beam welds resulted in narrow width of the weld zone along with fine dendritic grain morphology in the weld metal. SCC testing is determined by time to failure and for GTA welds is observed to be 41 hours and 55 hours for EB welds. Hence, it can be concluded that electron beam welds of nickel free high nitrogen stainless steel have achieved better localized and stress corrosion resistance when compared to GTA welds. It is attributed to the narrow width and fine grain morphology of the weld zone.

Keywords: Nickel Free High Nitrogen Stainless Steel (HNS), Gas Tungsten Arc Welding (GTAW), Electron Beam Welding (EBW), Double loop - Electrochemical Poteniokinetic Reactivation (DL-EPR), Stress Corrosion Cracking (SCC).