

Characterization of NiCr20Mn3Nb submerged arc strip cladding on a curved 20MnMoNi55 plate for Nuclear Pressure Vessel Applications

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Abstract

This study investigates the characterization and weldability of Inconel DIN NiCr20Mn3Nb cladding deposited on low alloy steel DIN 20MnMoNi55 using the submerged arc strip cladding (SASC) process. Unlike conventional practice, where SASC is restricted to flat plates, this work introduces a novel methodology for cladding on a three-dimensionally curved block simulating the crown portion of a dished end. Welding was performed over a 120° sector of the curved block having cladding length of 1800mm and width of 500mm in a critical position between flat and horizontal. Cladding deposition thickness is around 10mm. This novel process requires SASC process modifications including optimization of weld parameters, stick-out distance and modification of the welding head arrangement. After cladding deposition and machining, non-destructive examinations comprising penetrant testing (PT) and ultrasonic testing (UT) confirmed the absence of surface and subsurface defects. The clad blocks were subjected to post weld heat treatment (PWHT) at 600 °C for 40 h, after which repeat NDE revealed no deterioration in cladding integrity. Chemical composition was measured at successive 1 mm intervals across the thickness to evaluate dilution. Weldability was confirmed through cross bead and crack opening tests, which did not show any cracking or other issues. Bend testing also did not reveal any defects. Metallographic examination showed an austenitic microstructure in the cladding and tempered martensite in the base material. Hardness (HV-1) in the cladding ranged between 220–280, whereas in the heat-affected zone (HAZ) it ranged between 195–220. Overall, the study demonstrates that NiCr20Mn3Nb cladding can be reliably applied on complex curved geometries with excellent weldability, stable microstructure, and

favorable mechanical properties. The methodology established here provides a practical route for industry-scale application, offering significant advantages in terms of productivity and reliability in nuclear pressure vessel fabrication.

Keywords: Submerged arc strip cladding (SASC), NiCr20Mn3Nb, 20MnMoNi55, Power generation industry applications