Seminar

Institute for Plasma Research

Title : Investigations on Weldability of Aluminide Coated 9Cr steels

Speaker: Mr. Arunsinh B. Zala
Institute for Plasma Research, Gandhinagar

Date : 4th February 2021 (Thursday)

Time : 11:00 AM

Venue : Online - Join the talk: https://meet.ipr.res.in/Ph.D.VivaVoce_ZalaArunsinhB

Abstract :

9Cr-1Mo steels are structural steels extensively developed for power plant applications demanding higher creep resistance. Aluminide coating on 9Cr-1Mo steels is widely reported for enhancing service life conditions in numerous applications such as petrochemical plant, turbine-driven systems, automobile industry and especially for test blanket module of fusion reactors. One of the critical issues associated with such aluminide coatings (α-Al2O3 + FeAl) is the fabrication sequence. Considering the candidate aluminide coatings for different applications, it appears that fabrication followed by coating may not be a good option as diffusion heat treatment after the coating may induce distortions. Alternatively, the second option involving coating process followed by fabrication poses uncertainties of weldability of coated steels. Further, the weldability of aluminide coated P91 steel is scarcely reported. Weldability of aluminide coated structures is thus an area with lacunae and has been attempted to be addressed in this doctoral thesis work.

In this study, effects of aluminide coatings have been investigated by autogenous TIG welding through bead-on-plate trials. The weld microstructures were investigated using X-ray diffraction (XRD), scanning electron microscopy with energy dispersive x-rays (SEM-EDX) and microhardness tests. It was observed that the presence of alumina (Al2O3) on the top of coated samples resulted in an improved depth of penetration (DOP) due to arc constriction. The concentration of Al in the weld zone contaminated the weld metal and it supports the δ-ferrite formation which would deteriorate mechanical properties. Results with bead-on-plate trials show that the d-ferrite had an average volume fraction of ~5.09% in the weld metal with an average 192–198HV0.05 microhardness. This is approximately half of the reported microhardness martensitic laths (396–410HV0.05). To restrict the delta ferrite formation within the permissible limit, conventional TIG welding process had been attempted with Vgroove design in accordance to ASME standards. The resultant weld microstructure has been analyzed with respect to defects in microstructures (inclusions, delta ferrite) presence of δ-ferrite. The microscopic studies indicated the presence of alumina inclusion at the weld fusion line. Despite such inclusions, the observed tensile strength of the weld joint for coated steel is 648 MPa±16MPa which is in line with weld joint of un-coated steel (667±14 MPa) and substrate (643 MPa±18MPa). The impact toughness tests were carried out at 0°C,-25°C and room temperature indicate that there is no drastic effect of coating on weld joint and the observed toughness values are acceptable as per the reported data (45J). The present investigation would be helpful to understand the effect of aluminized coating on weldability for 9Cr-1Mo steels. Subsequently, the welding parameters deduced from this study can be utilized for the welding of aluminized 9Cr-1Mo steels for power plant, chemical processing industries and nuclear applications.