Seminar

Institute for Plasma Research

Title : Thermo-mechanical Analysis of GTA Welding of Mod. 9Cr-1Mo Steel considering the effects of Phase transformation, Pre heating and Post heating

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Venue : Committee Room 4, (New Building), IPR

Abstract :

Modified 9Cr-1Mo or Grade 91 steel is ferritic martensitic steel extensively used for high temperature applications in nuclear power plants and petrochemical industries. The as-welded martensitic microstructure of P91 steel also makes the weld highly prone to Hydrogen Assisted Cracking (HAC). In addition to a susceptible microstructure, high residual stress and presence of diffusible hydrogen in the weld are prerequisite for HAC to occur. Preheating (before welding) and post heating (after welding) are two techniques adopted to remove hydrogen from the weld and avoid cracking. Purpose of this work is to develop FEM based numerical model for predicting residual stresses and distortions in modified 9Cr-1Mo steel plate weld joints by considering phase transformation effects for autogenous and multi-pass GTA welding. The beneficial effects of pre heating and combined preheating and post heating on the residual stresses and distortion need to be quantified. Proposed numerical models is capable of predicting thermal cycles, residual stress and distortion in both Autogenous and multi-pass GTA welding of Grade 91 steel considering pre and post heating during welding using SYSWELD. Validation of the simulated results on the residual stresses and displacements employing suitable experimental tools such as XRD technique and height gauge respectively is envisaged. Two different thickness 3 and 6 mm of Grade 91 steel plates were welded using GTA welding process. Square butt joint thickness of 3 mm and V Groove butt joint of 6 mm thick plates were preheated at 200°C and after welding; the joint was post heated at 200°C for 30 minutes. Predicted and measured values are compared for the joints fabricated employing pre and post heating and with only pre heating and without pre heating. Longitudinal residual stresses were measured using X-ray diffraction technique at the centre of weld plate in transverse direction (perpendicular to weld line). Peak values of distortion at the corner of weld plate in longitudinal and transverse directions were measured using electronic height gauge. For all three cases, heat input and other working conditions were maintained constant. The developed models were able to successfully predict the effect of preheating and post heating on residual stress and distortion with reasonable accuracy. A disk shaped heat source with Gaussian distribution has been successfully used for simulating the effect of preheating for the first time. Results of both modeling and experiments show preheating alone has only marginal effect on reducing residual stress in the weld joints; but combination of preheating and post heating significantly brings down the residual stress and distortion in the weld joints.