Seminar

Institute for Plasma Research

Title : Development of Dissimilar Weld Joints of Ferritic and Austenitic Steel for Test Blanket Module (TBM)

Speaker: Dr. Gaurang Joshi
Institute for Plasma Research, Gandhinagar

Date : 06th December 2021 (Monday)

Time : 10.30 AM

Venue : Online - Join the talk: https://meet.google.com/eza-oygx-vpm

Abstract :

India-Specific Reduced Activation Ferritic-Martensitic (INRAFM) steel considered as structural material for both Lead Lithium Cooled Ceramic Breeder (LLCB) and Helium Cooled Ceramic Breeder (HCCB) of TBM. The efficient joining of INRAFM steel to 316L Stainless Steel (SS) is a structural requirement for joining TBM to other axillary components of International Thermo Nuclear Experimental Reactor's (ITER) vacuum vessel. It shows that the bimetallic joints inhale multiple properties within a single structural component. Hence, it gained the attention of modern industry and academia to generate enough informations on better joining reliability and structural integrity. However, the materials mentioned earlier,' amalgamation face heterogeneous physical and metallurgical properties across the joint line. In addition to that, doing experiments and failing to serve the INRAFM steel to 316L SS joint's desirable quality is costly. It is due to the high cost and limited availability of INRAFM steel, Grade-91 steel is considered as surrogate material because of its identical mechanical and metallurgical properties compared to INRAFM steel. The first phase of investigation is to identify the favourable weld conditions for Grade-91 steel to 316L SS, which further exploited for joining INRAFM steel to 316L SS. Moreover, it is necessary to establish sustainable weld conditions for the materials mentioned above, referring to their critical future applications.

Thus, attempts were made to join Grade-91 steel to 316L SS. The work is categorize into three sets of studies, i.e. (1) exploitation of activated flux assisted GTAW (A-TIG, FB-TIG and FZ-TIG) to get a full penetration across the 8 mm thickness while butt joint configuration in single pass, (2) bead on plate trials for 316L SS to know the weld conditions aiming full penetration and (3) manual GTAW to know the joint behaviour of Grade-91 steel to 316L SS bimetallic joints. In the first set of study, Co3O4, TiO2 and Fe2O3 are utilized as flux material. The results show the lack of penetration i.e. due to arc deviation towards the Grade-91 steel. It represents the influence of the magnetic nature of the ferritic steel on the weld arc. The high i.e. 5.3 mm and low weld penetration i.e. 3.6 mm are obtained in case of FZ-TIG (flux at centre and side region are Co3O4 and TiO2 respectively) and A-TIG (Co3O4 used as flux) respectively. At the end of the same weld trials, low i.e. 0.3 mm and high i.e. 2.7 mm arc deviation are measured. It suggests the necessity to identify the type of activated flux, its application methods and offsetting the heat source towards the 316L SS base material for enhancing the heat penetration to the level of through thickness complete fusion. Moreover, heat density at the striking arc point needs to increase to achieve full penetration in a single-pass configuration. It is possible by avoiding deviation of heat source, increasing weld current or reducing weld speed and arc constriction through appropriate utilization of assisted flux.

Furthermore, the 250 to 300 A welding current were selected for future weld experiments, referring to bead on plates experiments (using GTAW autogenously) on 316L SS. In fact, the full penetration of 8 mm is observed

visually at 300 A. The same work concludes that the low pulse frequency ranges from 5 Hz to 50 Hz and torch oscillation reduces the heat-affected zone. However, the subject of study should be to identify better weld pulsing and torch oscillation conditions for full weld penetration in conjunction with less heat-affected zone. Flux assistance during the above-selected range of weld current is better to reduce the size of the heat-affected zone than pulsing and torch oscillation while GTAW. Additionally, manual groove welding to join Grade-91 steel to 316L SS is performed. In this study set, the effect of pre and post weld heat treatment of Grade-91 steel (buttered by 316L SS) was examined on the scale of tensile testing and compared with sample welded without heat treatment. The results show that the pre weld heat treatment obtained better weld tensile strength. The scientific claims for the same are appropriate after microstructural examinations. The highest tensile strength i.e. 602 MPa observed. All the samples, failed from either of the base materials confirmed the soundness of the joints. Moreover, present work is in the constructive direction to obtain the desired outputs in the best way possible.