MS Research PROJECTS GUIDED BY DR S KUMANAN

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	Project Title	Scholar	Year
1	**Investigations on angular distortion In combined butt and fillet joints**	Vaghela Sanket Johnbhai	2016
2	**Investigations on repairability of Grade 91 steel tube welds**	R Silamabarasan	2016
3	**Analysis of nondestructive evaluation methods for cladding in pressure vessels**	JAGADEESH S	2019

1. **Investigations on angular distortion In combined butt and fillet joints** Welding is considered as the most widely used metal joining process in manufacturing industries. The application of welding process includes ship building, construction, aviation and automotive industries because of the high efficiency of joint, low fabrication cost and easiness to join intricate shapes. Gas Metal Arc Welding (GMAW) is widely used due to its high productivity. Distortion occurred as a result of rapid heating and cooling in welding affects its dimensional accuracy and aesthetic value. Remedial work done to control the distortion increases the overall fabrication cost and time. To control weld distortion it is important to understand the effect of process parameters. In cases which involve costly materials or costly processes, Numerical Methods (such as Finite Element Method) have found to be a useful tool to reduce the number of trials. This present investigation is focused on estimating angular weld distortion of combined butt and fillet weld joint of low carbon steel. The effect of different weld sequences on weld distortion is analysed. Weld sequences are selected based on weld direction and heat flux deposition along neutral axis. GMAW process is used to join workpiece. The pilot experiment is carried out to collect data for model creation. The SYSWELD software is used to create three dimensional model. The double ellipsoidal heat source model has been used to simulate the transient thermal load with moving heat source. The temperature dependent material properties and suitable boundary conditions are applied. The time variant temperature fields obtained from thermal analysis have been applied as thermal load into the mechanical analysis to predict weld distortion. Selected weld sequences are analysed using FE model. The sequence with least distortion is validated with experimental results. Finally, a summary and contributions of the research study are highlighted. The possible extensions for future research are also suggested. [GO TO LIST]

2. **Investigations on repairability of Grade 91 steel tube welds** Thermal power plants are constructed based on once through super critical technology with the aim of improving thermal efficiency and reducing carbon dioxide emission. Once through super critical boilers are operated at higher temperatures and pressures to achieve these benefits. Development of materials for high temperature and high pressure applications needs attention. Modified 9Cr-1Mo-V steel (Grade 91) is widely used for building super critical boilers. A review is conducted on welding and post weld heat treatment of Grade 91 material and also the difficulties faced by the manufacturers and power plants on failures and repair are highlighted. The boiler components fabricated using Grade 91 steel are subjected to multiple PWHT cycles in due course of fabrication and servicing to fix the desired physical and mechanical properties. Welding and Post weld heat treatment (PWHT) of this modified 9Cr-1MoV steel need attention in order to avoid any premature failures during its service. The impact on mechanical properties of Grade 91 steel due to repeated tube welding and PWHT while servicing is important to avoid premature failures. This present investigation is focused on analyzing the reparability of grade 91 steel weldments using multiple post weld heat treatment. Grade 91 tubes (T91) are welded by GMAW (root pass) and SMAW (filler pass) processes. Welded test pieces are subjected to multiple PWHT cycles after each imposed repair welding. Mechanical properties such as Tensile strength, Hardness at parent material, HAZ and weldment, Impact toughness, Macro and microstructures are investigated and reported. The impact of repeated PWHT while repairing Grade 91 tube welds is assessed by estimating the physical and mechanical properties. It is concluded that there is no significant degradation in mechanical properties of Grade 91 steel welds after repeated repairs and PWHTs. The condition stipulated for Grade 91 tube welding and subsequent PWHT are established through mechanical and microstructural investigations. [GO TO LIST]

3. Analysis of non destructive evaluation methods for cladding in pressure vessels

Pressure vessels are designed to handle gases and liquids under high pressure and temperature. These are exposed to solvents and other chemicals. Long years of service in industrial environments result in corrosion. A coating of high alloy overlay called cladding is deposited over low alloy material to safeguard the base metal. Flaws are present in the cladded component and on operation, these flaws could propagate due to high working temperatures and pressures resulting in shortened service life of the product. Non-destructive evaluation (NDE) on cladding becomes essential. Dye penetrant examination and conventional Ultrasonic Testing are being employed to ascertain the integrity of the cladding before and after heat treatment of the component. Dye penetrant examination can detect flaws open to surface only. Conventional Ultrasonic Testing (UT) is widely preferred method as it can detect flaws in the volume of the cladded metal. However, UT is found to be limited in its application. Flaws of different shapes and orientations are not detected by conventional UT. Phased Array Ultrasonic Testing (PAUT) is an advanced NDE technique which has been successfully employed to detect flaws in forgings and welds. Application of PAUT in evaluation and testing of cladded components needs attention. This investigation focusses on establishing PAUT as a suitable method to non-destructively evaluate cladding. PAUT is capable of detecting flaws of different configurations and orientations. A cladded block with induced flaws serves as a reference specimen for establishing the capabilities of PAUT. Manual metal arc welding is carried out to create the reference specimen. PAUT uses a beam simulation software to help fix the testing parameters. Reference specimen is tested with the testing parameters by scanning the cladded surface using ultrasound generated by a PAUT transducer. PAUT provides a visual representation of flaw in the form of encoded scan images which are interpreted to identify flaws. The number of flaws detected by UT and PAUT is compared to establish the prediction accuracy of PAUT. Digital radiography has been employed as a supplementary NDE technique to provide a two dimensional representation of cladding flaws. [GO TO LIST]