View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by International Journal of Innovative Technology and Research (IJITR)

(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.5, August – September 2016, 3523 – 3525.

Structural And Thermal Analysis Of Varied Metal Welding Of 1020 Mild Metal And 304 Stainless Steel

BADAVATH SURESH
M.tech
AVN Institute of Engineering and Technology
Koheda road, Ibrahimpatanam, Rangareddy, Telangana

MR. B.RAVIKIRAN
Associate Professor, Department of Mechanical Engineering
AVN Institute of Engineering and Technology
Koheda road, Ibrahimpatanam, Rangareddy, Telangana

Abstract: **Joining of distinct metals has observed its use broadly in energy new release, electronic, nuclear reactors,petrochemical and chemical industries mostly to get tailor-made homes in a factor and reduction in weight. However efficient welding of distinctive metals has posed a major challenge due to difference in thermo-mechanical and chemical residences of the materials to be joined underneath a common welding situation. This factors a steep gradient of the thermo-mechanical houses alongside the weld. A kind of issues come up in distinctive welding like cracking, massive weld residual stresses, migration of atoms throughout welding causing stress awareness on one facet of the weld, compressive and tensile thermal stresses, stress corrosion cracking, and so forth. Weld residual stress and thermal stress had been analyzed for assorted steel welding of 304 stainless-steel to 1020 mild steel taking 302 stainless steel because the filler metallic. Similarly taking pressure developed as an index the susceptibility of the welded joint to stress corrosion cracking had been studied. It is found that once the filler steel is replaced by Inconel 625 significant growth is obtained within the welded joint in terms of discount in stress developed and stress corrosion cracking. Also the concern of carbon migration is eliminated by way of Inconel 625 as a weld filler metal because of the resistance of nickel-founded alloys to any carbon diffusion through them.**

I. INTRODUCTION

Welding is a producing system of making a permanent joint received by the fusion of the outside of the ingredients to be joined collectively, with or without the applying of stress and a filler material. The substances to be joined could also be identical or varied to each other. The warmth required for the fusion of the material could also be received by using burning of fuel or via an electrical arc. The latter method is more extensively used due to the fact that of larger welding speed. Welding is largely utilized in fabrication as a substitute procedure for casting or forging and as a replacement for bolted and riveted joints. It can also be used as a restore medium e.G. To reunite a steel at a crack or to construct up a small part that has damaged off equivalent to a equipment enamel or to repair a worn floor reminiscent of a bearing surface.

A. Goal

The aim of this assignment work is to simulate a welding joint between 304 stainless-steel and 1020 slight steel making use of 302 stainless steel as the weld metal and analyze the joint for thermal and residual stresses developed in them. Then the weld joint is to be analyzed for residual stresses superimposed on thermal stresses. After the outcomes are bought the purpose is to propose improvement within the joint by minimizing the stresses and lowering probabilities of stress corrosion cracking by a metamorphosis in the weld metal.

II. RELATED WORK

The aim of this challenge has been to gain knowledge of assorted steel joint making use of a filler metallic. Numerous welding is used to fabricate the stress vessels and piping in power plant however disasters arise more often than not as a result of:

- Thermal Stress which is generated as a result of change in co-effective of thermal enlargement.
- change in mechanical homes, the nearby heating and subsequent cooling outcome in colossal residual stress.

This thermal stress superimposed on weld residual stress and running tensile stress promotes brittle fracture, broaden susceptibility to fatigue and stress corrosion cracking in the course of its carrier existence. The domain of this study covers rationale, outcomes and elimination of issues induced as a result of stresses, carbon migration and stress corrosion cracking. The metals to be welded are 304 stainless steel and 1020 undeniable carbon metal\ and the filler metallic used is 302 stainless steel whose properties has been taken just like 304 stainless-steel for the intent of evaluation. The welding process has been simulated making use of finite detail analysis. The application used for this evaluation is ANSYS thirteen. Zero utilising its Workbench module. It's considering that Workbench is an awfully strong device to simulate a welding joint and infer the outcome. Also it has a popularity of coming up with outcome very nearly the useful values. The enter parameters are conveniently fed and boundary conditions, simulation programmers and geometrical modeling is very convenient due to its user-friendly graphic interface.

 @ 2013-2016 http://www.ijitr.com All rights Reserved.

(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.5, August – September 2016, 3523 – 3525.

III. REVIEW

Over the years a lot of research has been done in the area of dissimilar welding and many interesting results have been brought up with regards to the problems encountered in dissimilar welding. With dissimilar welding finding its use in nuclear, petrochemical, electronics and several other industrial domains, this section brings into account the work of the predecessors in this field.

IV. RESEARCH

Chengwu et al. [1] in their work on weld interface microstructure and mechanical properties of copper-steel dissimilar welding, the microstructure near the interface between Cu plate and the intermixing zone was investigated. Experimental results showed that for the welded joint with high dilution ratio of copper, there was a transition zone with numerous filler particles near the interface.

However, if the dilution ratio of copper is low, the transition zone is only generated near the upper side of the interface. [1] At the lower side of the interface, the turbulent bursting behaviour in the welding pool led to the penetration of liquid metal into Cu. The welded joint with lower dilution ratio of copper in the fusion zone exhibited higher tensile strength.

Jiang and Guan [2] studied the thermal stress and residual stress in dissimilar steels. They suggested that large residual stresses are induced by welding in the weld metal and heat affected zone (HAZ), which superimpose and increase the thermal stress.

Gyun Na, Kim and Lim [3] studied the residual stress and its prediction for dissimilar welds at nuclear plants using Fuzzy Neural network models. The factors that have an impact upon fatigue strength are residual stress, stress concentration, the mechanical properties of the material, and its micro and macro structure.

Gyun Na et al. [3] stated that residual stress is one of the most important factors but its effect on high-cycle fatigue is of more concern than the other factors. Residual stress is a tension or compression that exists in a material without any external load being applied, and the residual stresses in a component or structure are caused by incompatible internal permanent strains of welded joints must be ensured against fatigue or corrosion during their long use in welded components or structures.

On stress corrosion cracking Gyun Na et al. [3] stated that stress-corrosion cracking usually occurs when the following three factors exist at the same time: susceptible material, corrosive environment, and tensile stress including residual stress. Thus, residual stress becomes very critical for stress-corrosion cracking when it is difficult to improve the material corrosiveness of the components and their environment under operating conditions.

Khan et al. [4] studied laser beam welding of dissimilar stainless steels in a fillet joint configuration and during the study metallurgical analysis of the weld interface was done. Fusion zone microstructures contained a variety of complex austenite ferrite structures. Local micro-hardness of fusion zone was greater than that of both base metals.

The welding fusion zone microstructure consists of mostly primary ferrite dendrites with an inter-dendritic layer of austenite. [4] This austenite forms through a peritectic–eutectic reaction and exists at the ferrite solidification boundaries at the end of solidification. Some lathy ferrite morphology is also observed in this zone. This is due to restricted diffusion during ferrite–austenite transformation that results in a residual ferrite pattern.

Khan et al. [4] came to the conclusion that formation of ferrite along the austenite grain boundary in the heat affected zone on austenite side is observed. At the same time, microstructures are composed of two-phase ferrite and martensite with intra-granular carbide on ferrite side. Also the variation in local micro-hardness observed across the weld depends on the fraction intermix of each base metal and the redistribution of austenite- and ferrite-promoting elements in the weld.

Itoh et al. [5] got a patent on the joined structure on the dissimilar metallic materials. This invention relates generally to a joined structure of dissimilar metallic materials having different characteristics. More specifically, the invention relates to a joined structure of a current carrying contact or arching contact which are used for, e.g., a power breaker, or a coating end structure of a metal base and a coating material for improving conductivity and heat resistance.

Delphin, Sattari-Far and Brickstad [6] studied the effect of thermal and weld residual stresses on CTOD (Crack Tip Opening Displacement) in elastic-plastic fracture analysis. They stated that structures may fail because of crack growth both in welds and in the heat affected zone (HAZ). The welding process itself induces residual stresses in the weld and HAZ, which contribute to crack growth.

Delphin et al. [6] used a non-linear thermoplastic finite element model to simulate the circumferential weld in a relatively thin-walled stainless steel pipe. After the pipe had cooled down after welding a circumferential surface crack was introduced. The crack, located in the centre of the weld, was subjected to two types of

Welding, which is one of the most significant causes of residual stress, typically produces large tensile stresses, the maximum value of which is approximately equal to the yield strength of materials that are joined by lower compressive residual stresses in a component. [3] The residual stress of welding can significantly impair the

 @ 2013-2016 http://www.ijitr.com All rights Reserved.

performance and reliability of welded structures. The integrity loads. Firstly, the welded pipe was subjected to a primary tensile load, and then to a secondary thermal load.

Delphin et al. [6] stated that the choice of hardening model is important. It is believed that kinematic hardening is a better choice than isotropic hardening in low cycle simulations i.e. in a few-pass welding process, as in the present study.

For the case of weld residual stresses in combination with high thermal stresses, it is found that the plasticity induced by the thermal stresses is not sufficient to suppress the influence of weld residual stresses on CTOD, even for very high thermal loads. The residual stresses can be relaxed by unloading from a primary tensile load.

V. CONCLUSIONS

This research presents a study of thermal stress in a dissimilar welding joint between 1020 mild steel and 304 stainless steel, and the effect of weld residual stress on the thermal stress has been discussed. From the results above we arrive at the following conclusions:

1. Welding which is a significant cause of residual stress generates a large amount of residual stress in the weld metal and HAZ of the parent metals, which increases the final thermal stress and should be considered while determining the strength of the joint.

2. If the residual stresses are not considered, due to lower co-efficient of thermal expansion, 1020 mild steel develops tensile thermal stress while compressive thermal stress is generated in 304 stainless steel during operating conditions.

3. The peak of the stress is reached in the weld interface of 1020 mild steel and weld metal near the mild steel side, which becomes the highest risk zone.

4. If A302 steel is replaced by Inconel 625 then the developed peak stress falls by 15-30%, and hence the welded joint becomes safer.

5. Inconel 625 is recommended to be used as the weld metal, because it also reduces strain which is an index of stress corrosion cracking as result of which the chances of stress corrosion cracking are reduced by 17%.

6. Also by introducing a weld metal which is a nickel-based alloy decreases the carbon activity gradient due to its low carbon diffusivity. Thus there is no abrupt change in material composition and hence a steep stress gradient is avoided.

A future work that can be undertaken from this research can be:

1. Superimposing fatigue loads on welded parts.

2. Introduction of a new weld metal that can still improve the results than Inconel 625 for dissimilar steels.

VI. REFERENCES

[1] Chengwu Yao, Binshi Xu, Xiancheng Zhang, Jian, Huang, Jun Fu and Yixiong Wu "Interface microstructure and mechanical properties of laser welding copper-steel dissimilar joint" *Optics and Lasers in Engineering,* Vol. 47, 2009, PP 807–814.

[2] Wen-chun Jiang and Xue-wei Guan "A study of the residual stress and deformation in the welding between half-pipe jacket and shell" *Materials and Design,* Vol. 43, 2013, PP 213-219.

[3] Man Gyun Na, Jin Weon Kim and Dong Hyuk Lim "Prediction of Residual Stress for dissimilar metals welding at nuclear plants using Fuzzy Neural Network Models" *Nuclear Engineering and Technology,* Vol. 39, 2007, PP 337-348.

[4] M.M.A. Khan, L. Romoli, M. Fiaschi, G. Dini and F. Sarri "Laser beam welding of dissimilar stainless steels in a fillet joint configuration" *Journal of Materials Processing Technology,* Vol. 212, 2012, PP 856-867.

[5] Yoshiyasu Itoh and Kabushiki Kaisha Toshiba "Joined structure of dissimilar metallic materials" *Patent Publication Number*, EP0923145A2, 1999.

[6] P. Delphin, I. Sattari-Far and B. Brickstad "Effect of thermal and weld induced residual stresses on the j-integral and ctod in elastic-plastic fracture analyses" *Final Report* Vol. SINTAP/SAQ/03, 1998, PP 1-47.

[7] T.A. Mai and A.C. Spowage "Characterization of dissimilar joints in laser welding of steel-kovar, copper-steel and copper-aluminium" *Materials Science and Engineering,* Vol. 374, 2004, PP 224-233.

[8] Paul Colegrove, Chukwugozie Ikeagu, Adam Thistlethwaite, Stewart Williams, Tamas Nagy, Wojciech Suder, Axel Steuwer and Thilo Pirling " The welding process impact on residual stress and distortion" *Science and Technology of Welding and Joining,* Vol. 14, 2009, PP 717-725.

[9] N. Arunkumar, P. Duraisamy and S. Veeramanikandan "Evaluation Of Mechanical Properties Of Dissimilar Metal Tube Welded Joints Using Inert Gas Welding" *International Journal of Engineering Research and Applications,* Vol. 2, Issue 5, 2012, PP 1709-1717.

 @ 2013-2016 http://www.ijitr.com All rights Reserved.