ABSTRACT

With increasing demand for large welded structures using thicker plates, assurance of high quality welded joints has been an inevitable subject. For this end, "Narrow gap welding" has been widely applied to various kinds of large welded structures. Narrow gap welding, enables considerable reduction of cross section of the groove leading to more efficient welding without excess heat input, cost saving and good productivity of high quality welded joints with minimum distortion. Narrow Gap Gas Metal Arc Welding (NG-GMAW) technique offers higher production rate because of the lower volume of the weld metal needed for given plate thickness.

Narrow gap welding technique involves square butt joint, with joint gap ranging from 9-12 mm. Even in case of 'V' or double 'U' preparation, groove angle remains very small. Narrow gap created by two square butt faces can be filled by any suitable welding process such as SAW, GMAW and SMAW etc. It is a technique and not a process and should be specified along with the process. It is multipass technique, where several runs are to be made to fill the joint gap. It has been reported that plates as thick as 300 mm can be welded using this technique.

The most important challenge in narrow groove welding is to maintain uniform and sufficient penetration at both the groove faces commonly referred as sidewall fusion. One major problem addressed by all research workers has been to ensure adequate sidewall fusion. In order to achieve reasonable fusion at the side walls of the joint, several approaches, such as wire bending technique, wire rotating method, torch oscillation, twisted electrodes wire and tandem electrode have been adopted. Residual magnetism may also restrict sidewall fusion. There are many other problems such as slag inclusion, porosity, undercut formation which needs to be overcome before successful NGW can be created. Also repair of defective welds is very complex in NGW.

Very little acceptance of the NGW technique by the Indian welding and fabrication industry has triggered the present work. This technique is so much to offer by way of cost reduction, it should be made available to Indian industry in such a way that it can be readily adopted by the industry. Dimension of the problem shall be thoroughly understood, technique shall be simplified enough and equipment should be made cost effective by getting it manufactured locally. Therefore during this work all systems including torch, traversing mechanism, oscillation device were manufactured locally. NG-GMAW process was selected for intensive study for the nature of challenge it offered and also because it is an automatic process.

In the present work NG-GMAW torches were designed and fabricated for a minimum joint gap of 10 mm. Performance of these torches were studied by bead on plate as well as inside the joint gap. Results were recorded through photographs. All throughout, experiments were conducted for 300 mm x 100 mm x 50 mm and 150 mm x 100 mm x 50 mm of mild steel plates with metallic backing strip. NG-GWAW set up and torches permits welding for higher thickness than 50 mm and longer length than 300 mm.
Torch oscillation device has been developed and the effect of oscillation on the sidewall fusion was studied. 50 mm thick welded joints were subjected to mechanical testing such as Side bend test, Tensile test and Sidewall Fusion measurement. Contribution due to residual magnetism was found to be much more important than cited in the literature and have been studied in greater detail. Investigation of weld microstructure was also part of the studies.

AIM OF THE INVESTIGATION

The aim of the present investigation was “To Develop Narrow Gap Gas Metal Arc Welding Systems and Study the Effect of Magnetic Field and Torch Oscillation Parameters on Sidewall Fusion”. It includes

1) Design and development of Narrow gap gas metal arc welding (NG-GMAW) torch suitable for joint gap as narrow as 10 mm. Initial bead on plate trials for adjusting parameters and for development of torch.

2) Design and development of torch traversing mechanism for movement of NG-GMAW torch in X & Y axis.

3) Design and development of torch oscillation system for transverse movement of NG-GMAW torch in joint gap.

4) Selection of welding variables for welding of 50 mm thick mild steel plate. (Part I & II)

5) Study the effect of oscillation parameters on depth of sidewall fusion of 50 mm thick mild steel plate.

6) Measurement of residual magnetism for different combination of welding direction and effect of magnetism on sidewall fusion.

7) Study of microstructure in fusion zone