Experimental investigation and analysis of different joint design and parameters affecting welding distortion

R.M.Master¹, Dr.P.S.Jain² and Prof.H.V.Naik³
¹,²,³SNPIT&RC, Vidhyabharti Campus, Umra, Bardoli

Abstract—This study contains experimental investigation and analysis of different joint design and parameters affecting welding distortion observed in gtaw process. Distortion is a major problem and it has different types. The extent of distortion depends on some important parameters related to welding. The important parameters chosen for given study are arc welding current, thickness, gas flow rate and joint design. The experiments are conducted based on four factor three level designs with taguchi technique. Analysis of variance (ANOVA) has been used for determining most significant parameters affecting the welding distortion.

Index Terms—Welding, TIG, Distortion, Doe, welding parameters

I. INTRODUCTION

Gas tungsten arc welding process, consist of non-consumable tungsten electrode which is used to provide the arc for welding. Tungsten inert gas welding (TIG) is also known as Gas tungsten arc welding (GTAW) in USA and Wolfram inert gas (WIG) in Germany. This welding process is widely used for producing high welding quality of a variety of materials, specially for stainless steel, aluminum and titanium. Gas tungsten arc welding process welding set utilized suitable power source, a cylinder of argon gas, welding torch having connection of cable for current supply, tube for gas supply.

In fabrication of metallic structures, fundamental dimensional changes that occur during welding are often found. It is known as welding distortion. Distortion in a weldment is the result of non-uniform expansion and contraction of the weld and surrounding base material caused by heating and cooling cycle of the welding process. Distortion causes many problems during the manufacturing stage and during service. In manufacturing, welding distortion can cause assembly related problems by adversely affecting the dimensional tolerances.

II. PRINCIPLE

Tungsten electrodes are commonly available from 0.5 mm to 6.4 mm diameter and 150 - 200 mm length. The current carrying capacity of each size of electrode depends on whether it is connected to negative or positive terminal of DC power source. The power source required to maintain the TIG arc has a drooping or constant current characteristic which provides an essentially constant current output when the arc length is varied over several millimeters. Hence, the natural variations in the arc length which occur in manual welding have little effect on welding current. The capacity to limit the current to the set value is equally crucial when the electrode is short circuited to the work piece, otherwise excessively high current will flow, damaging the electrode. Open circuit voltage of power source ranges from 60 to 80 V.

III. LITERATURE REVIEW

Balaram Naik and Chennakesava Reddy, [1] Angular distortion was minimum when root gap was minimum and it was maximum when welding current was maximum, electrode diameter was minimum.

Deepak Malik, Sachin Kumar, Mandeep Saini, [2] Within the design range of parameters, the highest effect on angular distortion is found of diameter of the
electrode. Within the design range of parameters, the least effect on angular distortion is found of time between successive passes.

S.M.Ahir,N.B.Patel,K.A.Patel,[11]from experimental result Parameter Angle has major effect of weld distortion. This procedure can be effectively used to reduce angular distortion in the design of structures. Weld distortion analysis for optimum TIG process parameters control with lowest number of experiments.

Hardik Naik, G.D.Karhadkar, [3] It is suggested to clamp the welding plates to reduce the welding distortion. Second significant factor is thickness of the welding joint and third effective parameter is heat input given to welding joint to reduce the welding distortion.

Imran A. Shaikh, M. Veerabhadra Rao, [4] In this taguchi method and grey relational method both were used to find the optimal process parameter for max tensile strength and min angular distortion. ANOVA is used to find the % contribution of each parameter for TIG process. S/N ratio is used to find the optimal parameter.

M.S.Harne, S.S.Sathe, [5] From various literature surveys it is observed that most of the welding parameters like welding current, welding speed, flux, depth to width ratio are usually used in research work. Also TIG welding is carried out on various materials like mild steel, stainless steel, titanium alloy, brass, bronze etc. Also the welding of dissimilar material is possible by the use of TIG welding.

R. Sudhakaran, V. vel murugan, P.S.Sivasakthivel, [9] To optimize the welding parameters and minimize the angular distortion.

B N Sathyarayana Reddy, G Mahendramani, Vishwanath M M, [17] Angular distortion in single v-groove butt welded joints decreases with increase in included angle, Angular distortion in bevel-groove butt welded joints decreases with increase in bevel angle similar to the single v- groove butt joints.

Yanhong ye, jianpeng cai, xiaohua jiang, deping dai, dean deng, [16] Both the measured data and the simulated results indicate that the angular distortion of the butt joint is significantly affected by groove type. The numerical results show that the total sensitization region on the top surface in v-groove joint is significantly larger than those in k-groove and x-groove joints. The simulation results suggest that x-groove and k-groove are superior to v-groove.

Ravindra Burkul, Prof. Vijay Bhamre, Prof. Babasaheb Londhe, Mrs. Deepali Sanap, [18] In future while making the butt weld joint prepare the single J-groove butt weld joint instead of V-groove, so it will increase the strength of weld and it also reduce the cost of welding by reducing the requirement of weld metal.

B. N. Sathyanarayana Reddy and N. Lakshmana Swamy, [19] The transverse shrinkage increases with increase in the included angle in case of single V-groove butt joints and also double v-groove butt joint.

P. vasantharaja,M. vasudevan, p. palanichamy, [15] Double side tig welding joints exhibited lower angular distortion values while y groove joint exhibited maximum angular distortion values due to non-uniform distribution of residual stresses in top and bottom side.

IV. CONCLUSION

From various literature surveys it is observed that in the weld Angular distortion increases as welding current increase and it is not always possible to keep distortion within acceptable limits and also from graphical representation and main effects plot for distortion, the current is the most significant parameter. Welding speed and groove angle also has an effect on distortion but not as current. Both the measured data and the simulated results indicate that the angular distortion of the butt joint is significantly affected by groove type

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