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Experimental Study For Dissimilar Joints Using CO_2 Laser Welded Butt Joints

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Abstract: Inconel and Stainless-steel weldments are widely in structural industries. In this study the dissimilar joints of SS316L to IN625 are made with CO_2 Laser beam welding processes. Radiography is measured for the weldment to assess the quality of the welds. Distortion is measured using the vernier height gauge. The lower the better-quality characteristics is chosen for distortion. The weld bead geometry is evaluated by microscope. The results show the fully penetration for dissimilar weldment. The welds are free from flaws. The distortion in the weldment shows industrial accepted results and hence chosen parameters are believed for dissimilar joints.

IndexTerms - Dissimilar plates, CO_2 Laser beam, weld bead geometry, Distortion.

1. INTRODUCTION

Austenitic treated steels are generally utilized in the manufacture of basic parts in the combination reactors because of their unrivalled mechanical properties at raised temperatures, opposition against corrosion and better wet blanket break properties. Laser beam welding drawn in nuclear division applications like fusion and combination reactor segments creation(buddu-2015, Nakajima-2007, Mazaev-2010, Zhang-2014, Kujanpaa-2011). Because of the points of interest like low heat input, low damage and limited warmth influenced zone in the welded structures, laser beam welding has increased as one of the potentials joining process for requesting applications. Also, inferable from the powerful thickness and low heat input genius with laser pillar, low mutilations are created in the welded structure and can address the basic manufacture difficulties in combination reactor parts. The mechanical advances in the laser pillar conveyance frameworks with high power CO2 and diode lasers have opened up the likelihood of considering the high thickness recolor less steel plates welding with laser shaft process. The choice of laser welding process parameters like laser control, weld speed, protecting gas stream rate and so forth is critical to accomplish the ideal laser weld globule quality without imperfections.

A.T. Egbewande et al. (2009) Inconel738 plate is utilized to comprehend weldability, microstructure advertisement hardness of the laser pillar welded plate of 6.5mm thick. Inconel 625 material is welded with Direct Diode with Laser welding power 2.0kW, central lenth82mm. The outcomes are acquired in Inconel625 is microstructure, microhardness, fractographs. S.H. Baghjari (2014) Nd:YAG laser welding is utilized with heartbeat voltage for joining of 2mm plate, Focused bar 0.7mm, beat length 6m/s welding speed 1.4,0.7,2mm/sec, beat recurrence 6Hz. The outcomes are closed base metal microstructure, SEM micrograph, XRD designs, ED's investigation of weld metal development rate.

S.Williams and R.M. Miranda (2011) had given an account of NiTi foils of 0.34mm thick and AISI 316L of 0.47mm thick plate were utilized contemplated. The procedure parameters of the above materials is streak light voltage190-400V, wavelength1.06μm, greatest heart beat energy 80J, most extreme heartbeat top power 6.0kW, beat length 0.5-50 ms, interfacing power 1.7kw, pillar spot measurement 1mm in utilizing disparate laser welding of NiTi to hardened steel the Sem investigation is done at different zones in the weldment.

Vemanaboina et al (2018) conducted experiments with L_4 orthogonal array was chosen to minimize the distortion in the multipass dissimilar joints of SS316L to Inconel 625 using ERNiCrMo-3 filler using the Gas Tungsten Arc Welding. The pulsed current GTAW process shows the superior results compared with constant current GTAW process. Akshansh Mishra et al. (2018) had reported the depth of penetration of weld joint and examination is carried out to understand the micro structure and mechanical properties of the weldment. In his report the tensile sample had failure at the fusion zone and observed the dendrites in Inconel side.

The objective of this work is to study the Non-Destructive testing methods are used for understanding the quality of the weld structure. The understand the weld bead geometry of the weldment to assess the penetration of the joints. The CO_2 Laser Beam welding process is used for joining the plates. Vernier height gauge is used to measure the distortion in the weldment.

2. EXPERIMENTATION

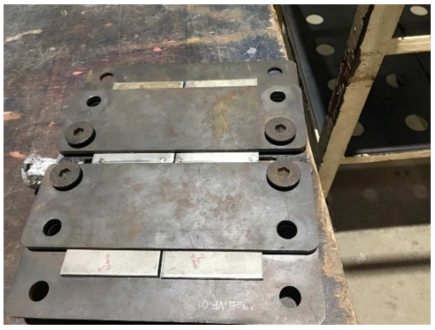
The experiments are conducted by using TRUMPF make continuous wave CO_2 laser welding system with ~4 kW maximum power and operating in TEM*01mode. The optimization of the welding process parameters like laser beam power, weld speed, Helium shield gas flow rate, beam focus distance, beam spot size and frequency have been carried out by using bead on plate experiments to decide the final process parameters for 5 mm thick plates welding. The

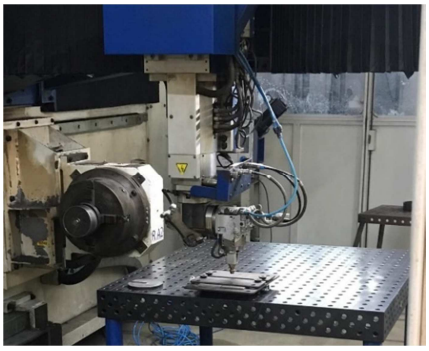
optimization of process parameters is a challenging task, which can cause weld defects like lack of penetration, gas porosity, craters formation and undercuts if proper parameters are not used. The plates are maintained typically zero gap and aligned in parallel for the welding process. The CO_2laser system used for the experiments is shown in Fig. 1 for reference. The fig.1 a shows the clamping of the sample tightly to gap between the samples. The final dissimilar welded sample are shown in fig.1c with a dimension of 220mm*80mm*5.

Stainless steel plate of 5mm thick plate is used for the study. CO_2 Laser Beam Welding process is used for the joining. The samples prepared such way that welding edges are well finished with CNC milling to avoid burrs. The samples are prepared with zero gap between the butting edges. The dimensions of the plate are 80mm*110mm*5mm and the joining is carried out in the with 80mm side. The details dimensions of the plate are shown in fig.2. The controlled process parameters are laser power(W), welding speed (m/min) and shielding gas (LPM). The process parameters with combinations are show in table -1. The shielding at the samples is provided with helium.

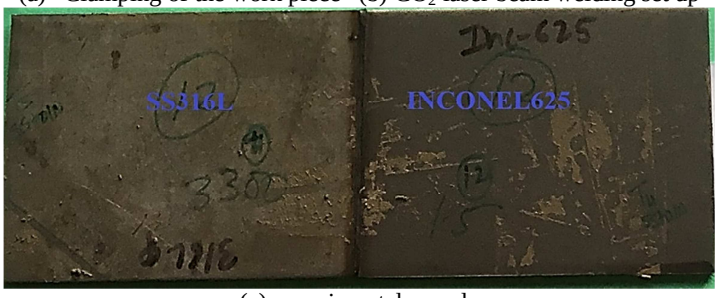
Table-1. CO_2 laser beam welding process parameters used for experimentation

CO_2 process parameters	Value
Laser power	3.0 kW
Welding speed	1.0 m/min
Shielding gas	10 l/min





(a) Clamping of the work piece (b) CO_2 laser beam welding set up



(c) experimental sample
Fig:1. Experimental samples

The heat input calculation for each bead on plate is given in equation-1. The heat input supplied by the LBW to the base material is calculated by the formula mentioned below. where W is the laser power in kW and V is the travel speed in m min−1. The calculation of heat input for the trails are table-

$$HI = \frac{60W}{V} \quad (1)$$

3. RESULTS AND DISCUSSIONS

3.1 Distortion

The distortion in the weldment is caused by rapid heat and cooling process during the welding process. The distortion in the weldment causes in accuracy and affect the in assemblies of the structure. The quality characteristic for Distortion is ‘Smaller the Better’. The shapes of distortion can cause in weldment are the longitudinal and transverse direction which was shown in Fig.2. The calculation of the angular distortion for the weldments is carried with Equation

3. The angular distortion of the weldment is expressed in degrees.

$$a = \sin^{-1}\left[\frac{h_1 - h_2}{b}\right] \quad (2)$$

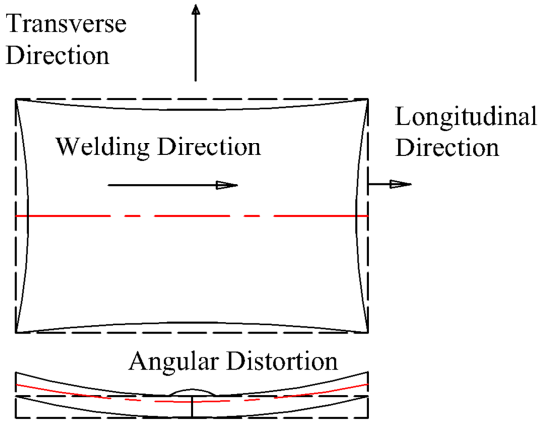


Fig. 2. Distortion caused by welding

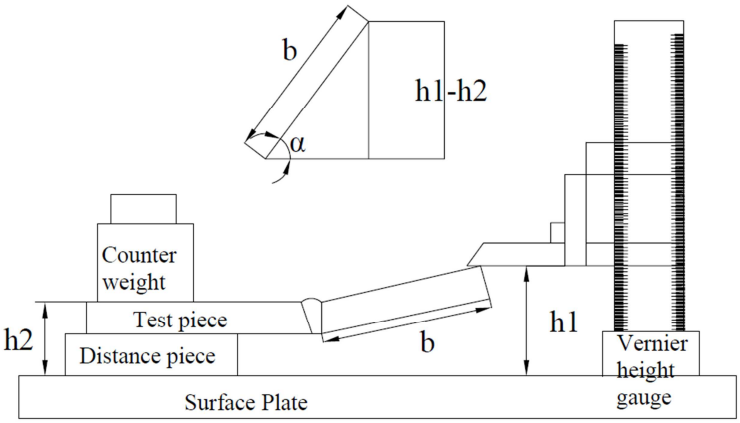


Fig 3(a). Measurement of distortion using Vernier height gauge

Fig 3(b). Measurement of distortion for weldments

From the radiography measurement the weldment is free from defects and accepted for the further examination. The heat input is calculated for the sample using equation as shown in equation-1. 120 J/min heat is generated during the welding process throughout the experimentation. The distortion was about 0.1mm which very less and can be accepted for industrial standards.

Table -2. Process parameters and responses of the experimentation

Laser power	Welding speed	Shielding flow rate	Heat input	Radiography	Distortion
kW	m/min	LPM	j/min	-	mm
3000	1.5	15	120	Acceptable	0.1

The figure-4 shows the weld bead geometry of the welded. It is evident from experimentation the weldment was full penetrated and both the plates are solvable and has full penetrated. The laser beam was contacted with both the plates and welding takes place. The weld bead was formed with 1.80mm on the top side of the plate and middle of the plate it was about 1.09mm and depth of penetration was about 5mm

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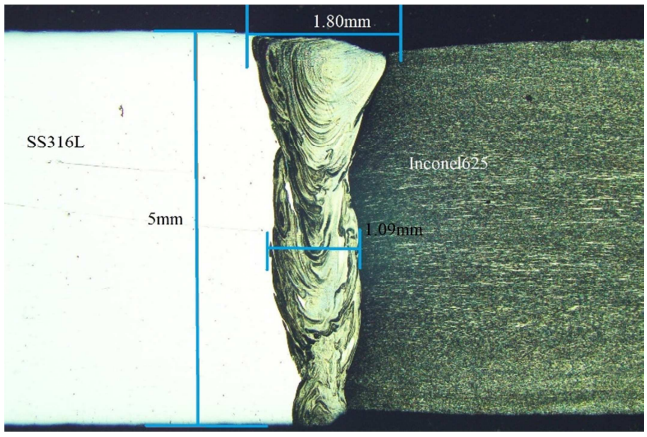

Fig.4 weld bead geometry of the weldment

4. CONCLUSIONS

The study of CO_2 laser beam butt welded joints is made for dissimilar joints of SS316L to Inconel625. The joint shows deep penetration. The weldments are free from defect through visual inspection and verified through radiography analysis. Distortion was observed in the weldment and results are accepted for industrial standards.

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