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Effects Of Process Parameters In Tungsten Inert Gas (TIG)Welding Process On IS: 2062 Mild Steel Plate.

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ABSTRACT

It is of great significance to select appropriate welding process parameters and their limits for quality weld in any welding process.The weld quality mainly depends on mechanical properties and important physical characteristics of the weldment,which is directly related to the type of welding and its process parameters i.e. heat input. In this study, we analysed the effects of most influencing process parameters namely welding current (I), welding speed(S) and constant voltage on bead geometry viz.depth of penetration, bead width, and depth of haz; and hardness in the IS:2062 mild steel welded plate (bead on plate) using Tungsten Inert Gas (TIG) Welding process with Tungsten electrode of 2.5 mm diameter. For the experimentations the sixteen numbers of optimal parameter has been constructed based on the design of experiment (DOE) of Taguchi's L16 orthogonal array. And it has been observed that the depth of penetration, bead width, and depth of haz are proportional and hardness are inversely proportional to the heat input in TIG welding process.

Keywords: TIG Welding, DOE, Process Parameters, Heat Input, Bead Geometry, Mechanical Properties.

1. INTRODUCTION

Structure without steel is impossible and structure without joint cannot be survive. The advancement of the manufacturing world the quality of joint becomes a challenge for the Engineers and which cannot be possible without welding. The quality welding joint mainly influence by heat input,which is dependent on the parameters of welding viz. welding current, welding voltage, welding speed, nature of the shielding gas and rate, stick out, arc length,fluxes etc. Tungsten Inert Gas (TIG) welding was used for the process of welding because of its high reliability, all position capability, ease of use, low cost and high productivity.

Shanben, Wu Lin, Wang Qilong & Liu Yuchi et al. Using artificial neural networks for modeling the process, the design of the fuzzy control system is simulated so that the difficulties of modeling and control of the pulse TIG welding in classic control methods are avoided[1]. J S Smith & J Lucas et al reported In the automation of the TIG (tungsten inert gas) welding process, robots and dedicated machines have been used to place the welding torch at the correct orientation above the seam to be welded [2]. Indira Rani M & R N Marpu et al Studied that the rate at which automation is being introduced into welding process is astonishing and it may be expected that by the end of this century more automated machines than men inwelding fabrication units will be found[3]. WANG Jian-jun, LIN Tao,CHEN Shan-ben &HU Jun-chuan et al In this paper the specialties of the TIG welding process for aluminum alloy are analyzed, introduced stochastic system theory into the welding process[4].Zhao Jiarui, Sun Dong ,Hu ShengSun &Zhang Xuanming et al reported that The distribution of high frequency pulse TIG welding arc anode average current density and the dynamic process of the said arc anode are determined in this paper[5]. ZHANG Rui-hua, FAN Ding, YIN Yan et al investigate that An efficient activating flux made of Sio2,TiO2,Cr2O3 , halogenide, etc for TIG welding of low carbon steel is developed[6]. LIU Feng-yao, LIN San-bao, YANG Chun-li & WU Lin et al studied that Conventional TIG welding is known as its low productivity and limited weld depth in a single pass causes an enhancement in weld penetration and the enhancement increases with increasing coating quantity when the later is small[7]. HUANG Youg, FAN Ding & FAN Qing-hua et al in this report the activating of tungsten inert-gas (A-TIG) welding with direct current straight polarity (DCSP) on aluminum alloy found that welding penetration varied with fluxes and was consistent with welding voltage[8]. J.L. Song, S.B. Lin ,, C.L. Yan & C.L. Fan et al studied that filler metal with Si additions on Dissimilar metals of 5A06 aluminum alloy and AISI 321 stainless steel have great effects in preventing the growth of the IMC layer, and minimizing its thickness[9]. Q. Wang, D.L. Sun, Y. Na, Y. Zhou, X.L. Han & J. Wanget al studied that the influences of parameters of tungsten inert gas arc welding on the morphology, microstructure, tensile property and fracture of welded joints of Ni-base super alloy have been studied. Results show that the increase of welding current and the decrease of welding speed bring about the large amount of heat input in the welding pool and the enlargement of width and deepness of the welding pool[10]. Ahmed Khalid Hussain, Abdul Lateef, Mohd Javed, Pramesh.T et al This paper deals with the investigation of effect of welding speed on the tensile strength of the welded joint. The material selected for preparing the test specimen is Aluminium AA6351 Alloy[11].

The aim of this study is to investigate the important effect of the bead geometry viz. depth of penetration, bead width, and depth of haz; and hardness of weldment on the input heat, which is influenced by welding current(I),voltage(V) and traverse speed(S).

2. MATERIAL

Material used for experimentation: The experiment viz. bead on plate welding by TIG welding process has been carried out on mild steel plate having size (150mm×50mm×5mm) and designation as IS 2062 made by SAIL makes.

Table 2.1 : Composition of MS IS 2062

Grade	C%	Mn	P	S	Si	C.E
	Max	Max	Max	Max	Max	Max
B	0.22	1.5	0.045	0.046	0.04	0.41

Electrode: Tungsten electrode with 2.5 mm dia.

3. DESIGN OF EXPERIENT (DOE)

In full factorial design, the number of experimental runs exponentially increases as the number of factors as well as their level increases. This results huge experimentation cost and considerable time. So, in order to compromise these two adverse factors and to search the optimal process condition through a limited number of experimental runs, the present study has been planned to use three conventional process parameters viz. current, traverse speed, gas flow rate varied at four different levels. Taguchi's L16 orthogonal array has been selected to restrict the number of experimental runs. Experiments have been conducted with these process parameters to obtain bead-on-plate weldment on IS 2062 mild steel plates (150 mm×50 mm×5 mm) by Tungsten Inert gas welding. Process parameters during this experiment with their notations, unit and values at different levels are listed in Table-3.1.

Table-3.1: Process parameters and their limits

Parameter	Notation	Unit	Level of factors			
			1	2	3	4
Current	I	Amp	160	180	200	220
Welding Speed	S	m/min	0.30	0.36	0.42	0.48
Gas flow	G_f	Ltr./min	10	15	20	25
Voltage	V	volt	25 Volt (constant)			
Efficiency	70% (consider)					

Table 3.2 Taguchi's L16 orthogonal array design for TIG welding

Sl.no	I	S	G_f
1	1	1	1
2	1	2	2
3	1	3	3
4	1	4	4
5	2	1	2
6	2	2	1
7	2	3	4
8	2	4	3
9	3	1	3
10	3	2	4
11	3	3	1
12	3	4	2
13	4	1	4
14	4	2	3
15	4	3	2
16	4	4	1

4. EXPERIMENTATION

Tungsten Inert gas welding is a multi-factor metal fabrication technique. Various process parameters influencing bead geometry, bead quality as well as mechanical-metallurgical characteristics of the weldment include welding current, voltage, traverse speed, size and material of electrode, filler metal, inert gases type and flow rate etc. For the experimentation 16 identical samples of size (150mm x 50mm x 5mm dimension)has been prepared collecting from a single plate and sharp edges are prepared by the use of file and by the emery paper clean the surface (rust, grease, oil particles etc.) for better conductivity as well as welding. The work pieces are prepared with first 80 then 150 grade emery paper to remove the rust or any kind of impurities which may present in the plates previously. The machine used for there is no attachment for automatic movement of the torch, so we used a special type fixture joined with the submerge arc welding machine carriage as shown in figure.

After welding at room atmospheric temperature i.e. about 30^oC and the weld samples have been cooled in the same atmospheric condition. The cross sections of the samples of about 5mm of thickness have been cut by power hydraulic saw with normal water as coolant. The section faces of each sample have been machined by shaper to get parallel plane as well as semi-finished surface. Then samples have been filed with smooth flat file followed by finishing with the emery paper of grade 120, 150, 220, 400, 600, 1000,1200,1500 and 2000 consequently getting almost mirror finish. The mirror finished surfaces have been etched with natal solution i.e. 10% nitric acid solution in 90% distilled water in room atmospheric condition. The weld bead geometry descriptors such as depth of penetration, bead width, reinforcement and depth of HAZ have been measured with Digital Venire Caliper and hardness are defined by the Micro Hardness Testing Machine. Data related to bead geometry and hardness have been furnished in Table-4.1.

Fig: 2.1 TIG welding machine with special fixture.

4.1.<u>EXPERIMENTAL DATA</u>

Table-4.1.Data related to bead geometry and hardness of weldment.

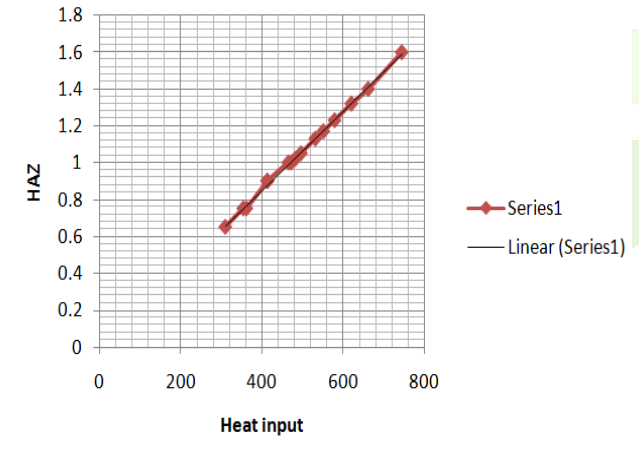
Sample No	Depth of Penetration (mm)	Depth of HAZ (mm)	Bead Width (mm)	Hardness in HAZ (BHN)	Hardness in welding zone (BHN)
1	**2.40**	**1.05**	**3.98**	**330.95**	**383.25**
2	**2.05**	**0.90**	**3.35**	**364.03**	**396.12**
3	**1.71**	**0.75**	**2.66**	**383.25**	**301.25**
4	**1.50**	**0.65**	**1.23**	**396.12**	**335.55**
5	**2.90**	**1.23**	**5.05**	**301.25**	**363.85**
6	**2.33**	**1.02**	**3.90**	**335.55**	**375.18**
7	**2.10**	**0.87**	**3.20**	**363.85**	**273.14**
8	**1.80**	**0.76**	**3.00**	**375.18**	**318.41**
9	**3.30**	**1.40**	**5.60**	**273.14**	**342.18**
10	**2.75**	**1.19**	**4.50**	**318.41**	**363.10**
11	**2.28**	**1.00**	**3.90**	**342.18**	**257.65**
12	**2.15**	**0.88**	**3.60**	**363.10**	**283.55**
13	**3.60**	**1.60**	**6.00**	**257.65**	**318.75**
14	**3.00**	**1.32**	**5.10**	**283.55**	**354.15**
15	**2.55**	**1.13**	**4.15**	**318.75**	**383.25**
16	**2.30**	**1.00**	**3.80**	**354.15**	**396.12**

5. RESULTS

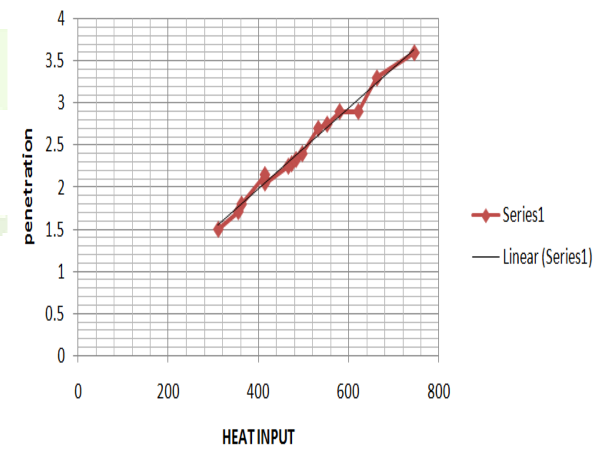
5.1. Heat Input (Maximum to Minimum) vs weldment characteristics (mechanical & physical)

Serial number	Heat Input J/mm	Depth of Penetration (mm)	Depth of HAZ (mm)	Bead Width (mm)	Hardness of HAZ (BHN)	Hardness of welding zone (BHN)
1	**770.00**	**3.60**	**1.60**	**6.00**	**257.65**	**195.70**
2	**700.00**	**3.30**	**1.40**	**5.60**	**273.14**	**217.57**
3	**641.90**	**2.90**	**1.32**	**5.10**	**283.55**	**220.95**
4	**630.00**	**2.90**	**1.23**	**5.05**	**301.25**	**240.56**
5	**583.10**	**2.75**	**1.19**	**4.50**	**318.41**	**247.68**
6	**560.00**	**2.70**	**1.13**	**4.15**	**318.65**	**253.47**
7	**549.50**	**2.40**	**1.05**	**3.98**	**330.95**	**264.74**
8	**525.00**	**2.33**	**1.02**	**3.90**	**335.55**	**266.10**
9	**498.80**	**2.28**	**1.01**	**3.90**	**342.18**	**269.25**
10	**467.60**	**2.25**	**1.00**	**3.80**	**351.15**	**275.91**
11	**466.66**	**2.05**	**0.90**	**3.35**	**363.10**	**285.53**
12	**450.10**	**2.10**	**0.88**	**3.20**	**363.85**	**285.48**
13	**437.50**	**2.15**	**0.87**	**3.60**	**364.03**	**285.42**
14	**399.70**	**1.80**	**0.76**	**3.00**	**375.18**	**296.18**
15	**394.10**	**1.71**	**0.75**	**2.66**	**383.25**	**299.61**
16	**387.00**	**1.50**	**0.65**	**1.23**	**396.12**	**308.27**

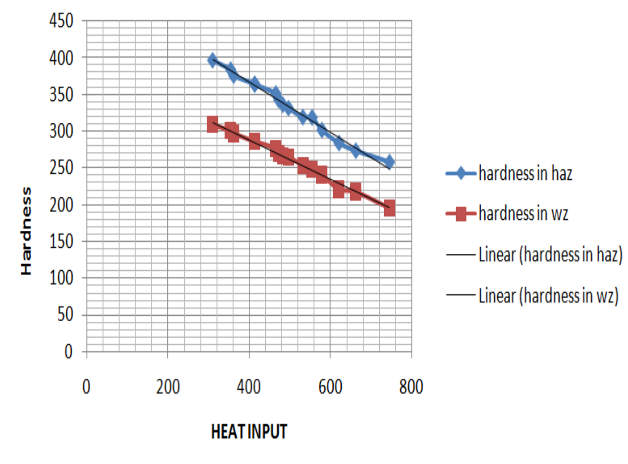
5.2. Graphical Representation of results:



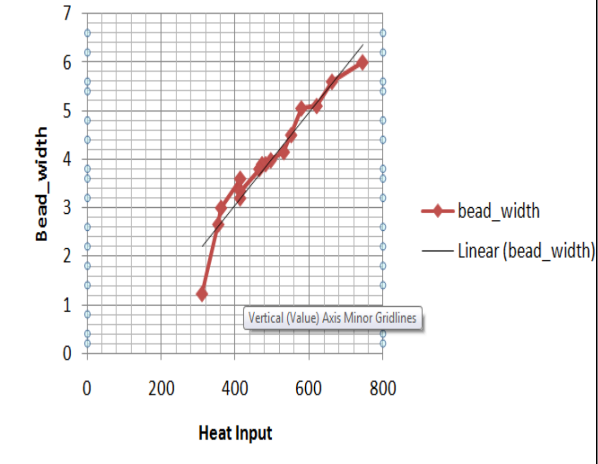
Graph 5.2(a): Relation showing depth of HAZ with heat input.



Graph 5.2(b):Relation showing depth of Penetration with heat input.

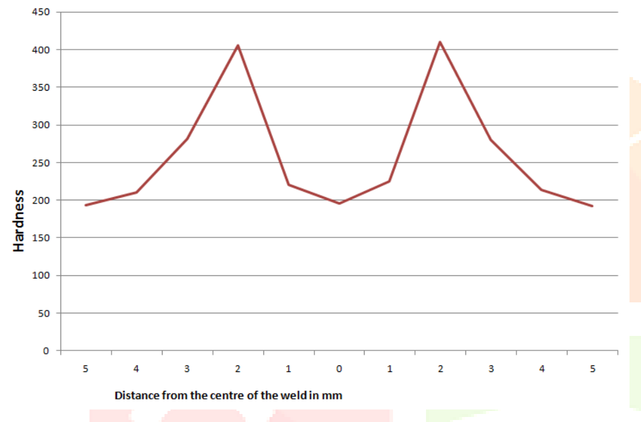


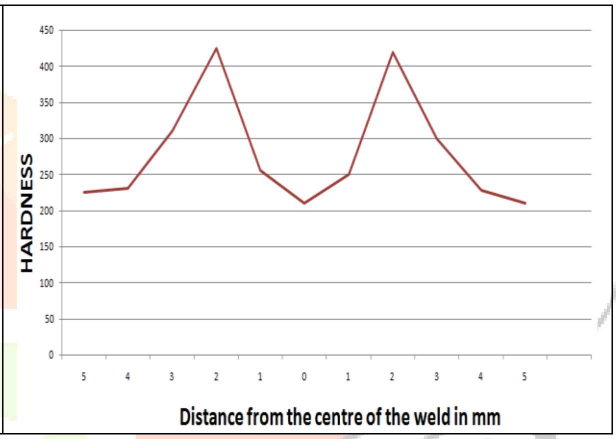
Graph 5.2(c) Relation showing Hardness of Haz and Weld zone with Heat input.



Graph5.4(d): Relation showing Bead width with relation to Heat input.

5.3.Graphical representation of Hardness of weldment in varoius region left and right from the middle of weld zone (maximum heat input and minimum heat input sample**).**





6. <u>CONCLUSION</u>

The present study mainly focuses on the influenced of mechanical properties and physical characteristics of the weldment by welding process parameters in the tungsten inert gas welding process on IS:2062 mild steel plate-

I. The major attributes such as depth of penetration, weld bead width, depth of HAZ having the general tendency of increase with the increase of heat input, which is influenced by the variation of process parameters viz. welding current, traverse speed and welding voltage.

II. Hardness of different sections are also measured and it has been found that the hardness of weld zone and haz are inversely proportional to the heat input.

7. REFERENCES

1. Shanben, Wu Lin, Wang Qilong & Liu Yuchi et al A Fuzzy Inference-neural Network Control of Dynamic Process of Weld Bead Width in Pulse TIG Welding(1997-03)
2. J S Smith & J Lucas et al “A vision-based seam tracker for butt-plate TIG welding” IOPscience Volume 22 ,Year of publication 1989.
3. Indira Rani M & R N Marpu et al Effect of Pulsed Current Tig Welding Parameters on Mechanical Properties of J-Joint Strength of Aa6351 ISSN: 2319–1813 ISBN: 2319–1805 Publication date 5, Nov, 2012.
4. WANG Jian-jun,LIN Tao,CHEN Shan-ben &HU Jun-chuan et al Adaptive control based on vision technology for aluminium alloy TIG welding, Transactions of The China Welding Institution-2003
5. Zhao Jiarui, Sun Dong ,Hu ShengSun &Zhang Xuanming et al Anode behaviour of high frequency pulse TIG welding arc (1992-01)
6. ZHANG Rui-hua, FAN Ding, YIN Yan et al Development of efficient activating flux for TIG welding of lowcarbon steel (2001-04)
7. LIU Feng-yao, LIN San-bao, YANG Chun-li & WU Lin et al Effect of coating quantity of fluxes on weld penetration depth in A - TIG welding (2002-03)
8. HUANG Youg, FAN Ding & FAN Qing-hua et al Effect of surface activating flux on welding penetration of A-TIG welding with DCSP mode of aluminum alloy (2004-05)
9. J.L. Song, S.B. Lin ,, C.L. Yan & C.L. Fan et al Effects of Si additions on intermetallic compound layer of aluminum–steel TIG welding–brazing joint (20 November 2009)
10. Q. Wang, D.L. Sun, Y. Na, Y. Zhou, X.L. Han & J. Wanget al Effects of TIG Welding Parameters on Morphology and Mechanical Properties of Welded Joint of Ni-base Super alloy (2011)
11. Ahmed Khalid Hussain, Abdul Lateef, Mohd Javed, Pramesh.T et al Influence of Welding Speed on Tensile Strength of Welded Joint in TIG Welding Process (2010).
12. A Text Book of Welding Technology-O.P.Kkanna,Dhanpat Rai Publications.
13. Manufacturing Technology – P.N. Rao Publiation- Tata MC Graw Hill
14. Production Technology – R.K. Jain Khanna Publication
15. Production Engineering– P.C. Sharma Publication S Chand.