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Experimental Analysis of TIG Welding and Comparison between Activated-TIG and TIG on Duplex Stainless Steel (2205)

A.Balaram Naik, A.Chennakesava Reddy

Abstract— In this study the welding process was conducted using the TIG (Tungsten Inert Gas) welding technique. TIG is used very commonly in areas, such as rail car manufacturing, automotive and chemical industries.Duplex Stainless steel (2205) is extensively used in industries as an important material, because of its excellent corrosion resistance, higher yield strength and hardness. In the present paper an attempt is made to understand the effect of tungsten inert gas welding by varying input process parameters such as gas flow rate , welding speed and welding current, that are influences on mechanical properties such as strength of weld joint, microstructure and hardness by using taguchi technique (L9 orthogonal array). The experimental analysis has been studied to produce better weld quality and higher productivity and comparison of Activated TIG welding with TIG welding.Activated TIG welding can increase the joint penetration. SiO_2 is used as a flux in this work and comparing weld joint penetration and weld depth to-width ratio. By using best clamping method, the angular distortion of weld plates has been avoided.

Index Terms— Welding, Duplex Stainless Steel, microstructure, Taguchi technique, hardness, Tungsten Inert Gas Welding, Tensilestrength.

1 Introduction

TheTungsten inert gas welding (GTAW) is an electric arc welding process, in which the fusion energy is produced by an electric arc burning between the work piece and the tungsten electrode. During the welding process the electrode, the arc and the weld pool are protected against the damaging effects of the atmospheric air by an inert shielding gas. By means of a gas nozzle, the shielding gas is lead to the welding zone where it replaces the atmospheric air. Background of TIG welding was, like MIG/MAG developed during 1940 at the start of the Second World War. TIG's development came about to help in the welding of difficult types of material, example aluminum and magnesium. The use of TIG today has spread to a variety of metals like stainless mild and high tensile steels. Arc welding is a technique to melt and join different materials that is widely used in the industry. The gas tungsten arc welding (GTAW) process is sometimes referred to as TIG, or heliarc. Under the correct welding conditions, the tungsten electrode does not melt and is considered non-consumable. To make a weld, either the edges of the metal must melt and flow together by themselves or filler metal must be added directly into the molten pool. Filler metal is added by dipping the end of a filler rod into the leading edge of the molten weld pool. Most metals oxidize rapidly in their molten state. To prevent oxidation from occurring, an inert gas flows out of the welding torch, surrounding the hot tungsten and molten weld metal shielding it from atmospheric oxygen. GTA welding is efficient for welding metals ranging from sheet metal up to 1/4 in.

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The eye-hand coordination required to make TIG welds is very similar to the coordination required for oxy- fuel gas welding. Although most other welding processes are faster and less expensive, the clean, neat, slag-free welds GTAW produces are used because of their appearance and ease of finishing. The TIG welding process is so good that it is widely used in the high-tech industry applications such as, nuclear industry, aircraft, food industry, maintenance and repair work and some manufacturing areas [1, 2].TIG welding is a process that uses a power source, a shielding gas and a TIG hand piece. An electric arc is then created between the tungsten electrode and the work piece. The tungsten and the welding zone are protected from the surrounding air by a gas shield (Inert gas). The electric arc can produce temperatures of up to $19,400^0$C and this heat can be much focused local heat.

Mukesh, Sanjeev Sharma [1] investigated on mechanical properties of austenitic stainless steel 202 during tungsten inert gas welding. Three input parameters varied at three levels and nine experiments were performed based on L9 orthogonal array.The specimen size was 100x50x6 mm with square edge butt joint. Tensile strength is calculated experimentally, microhardness is found by diagonals of indent formed by pyramid shaped diamond indenter on the specimen. They found that highest tensile strength is 0.595 KN/mm^2 at a welding current 210 Amps,gas flow rate 14 L/min and welding speed of 190 mm/sec .The specimen is rubbing with emery paper of size 400, 600, 1000 and 2000 and then cleaned with acetone solution. The maximum micro hardness is 80.473 HV at welding current of 210 Amps, gas flow rate of 12 L/min and welding speed of 180 mm/sec. ANOVA analysis was performed for analysis purpose that shows current is significant parameters that mostly influence tensile strength and micro hardness.

Vijay Gautam [2] studies process parameters for tungsten arc welding of aluminum alloy AA1100 using AC wave using argon as inert gas. Tensile properties of parent metal and weld part

were determined as per ASTM-E8M. Taguchi approach was applied to find parameters which will yield better tensile strength.It hasfound that tensile strength was maximum at 65 Amps, on further increase of current would cause oxidation of tungsten and causing its contamination. Maximum strength as found at 10 L/hr, if there is excess flow could cause cooling and turbulence in weld pool.The welding speed (2.5 mm/s) is optimal for proper fusion and strength. After conducting a confirmation test to verify strength by using optimal conditions, and found that strength is 85.78 MPa, it is within the limit compared to calculated value 91.35 MPa.
N. Arunkumar, P. Duraisamy and S. Veeramanikandan [3] evaluated the tensile, bend and hardness properties of austenitic stainless steel SS347H, T91 and T22 by metal inert gas welding and tungsten inert gas welding.The tube weld of 54mm outer and 50mm of inner diameter and compared metal inert gas and tungsten inert gas welding. In tensile test he found that tungsten inert gas welding exhibited more strength than metal inert gas welding, approximately 21%. For hardness test vicker hardness testing machine was used and found that GTAW produced weld is harder than GMAW(gas metal arc welding), hardness are 270 VHN and 245 VHN for T22 and T91, 293VHN and 197 VHN for T91 and SS .The bend test was performed to evaluate ductility and goodness of weld joint. He found that by selecting proper wire feed, current can remedy wire stub, porosity can be decreased by low hydrogen welding, increasing gas flow and heat input and cleaning joint faces. Undercut can be rectified by low travel speed, correct voltage and clean weld surface. Excessive penetration can be rectified by proper alignment of tubes of weld joint.

Kundan kumar and Somnath chttopadhyaya [4] has investigated on input variables (current, voltage, travel speed) and output parameters (reinforcement height, weld bead width, metal deposition rate) of tungsten inert gas welding on stainless steel 304L material of size 150x50x4.8 mm and observed that the error between the experimental result and mathematical values are at acceptable levels. Input parameters are travel speed (1.195 mm/sec), current (265 Amp) and result they got is reinforcement height (2.83mm), bead width (8.16mm). Mathematical result is 3.477 mm was reinforcement and 5.2mm was bead width.The error is 22.9 % for reinforcement and 36.7 in bead width.
Ahmid Khalid hussain and Abdul lateef [5] has investigated on influence of welding speed on tensile strength of weld joint of aluminum AA6351 alloy in tungsten inert gas welding.The filler material was aluminum 6063,shielding gas M21 (18%of CO_2 and 82% of argon).The dimension of the plate was 4x50x200 mm.They found that with increase of bevel height of V-butt joint, penetration of weld bead decrease, tensile strength is higher with lower weld speed, at weld speed of 6 mm /sec maximum tensile strength of 230 Mpa was observed for 40^0 bevel and 1.5 bevel height, tensile strength of the weldment has effect of bevel angle, for maximum strength 30^0 to 45^0 bevel angle is suitable and strength increase with decrease in heat input rate.
Y.S.Tarng, S.S.Yen, S.C.Juang [6] has studied on weld quality of aluminum in tungsten inert gas welding by using a fuzzy pattern recognition technique. Fuzzy pattern recognition is basic characteristic of human intelligence; it became an important branch in artificial intelligence.
Fuzzy c-mean algorithm is used to calculate the cluster center and membership grindings. Components for pattern recognition are the front width, the front height, the back height.Basically the front width, back height, front height of weld has a smaller the better quality characteristic. By evaluating the back height, front height, front width they found quality of weld (good, fair and poor). In study they study, they found weld quality of thin aluminum plate is fair. By this approach, we can find the influence of process parameters in weld quality.

A.kumar, S.Sunderrajan [7] has investigated on the process parameter of pulsed tungsten inert gas welding on dilution and mechanical properties of AL-Mg-Si alloy of 250x150x3.15 mm size. Tensile test is done on both planes, notched specimen, specimen for impact test was made as per ASTMA370 standard, and test was conducted on a charpy impact test machine. It is mechanically polished and etched before microstructure test and microstructure as observed and recorded using an optical microscope. Weld metal dilution was evaluated in terms of area fraction. They found that maximum notch tensile strength was observed at pulse frequency and pulse current are on the higher side, hardness is highest in the partially melted zone because this zone has fine grain compared to the weld center, in soft zone the hardness is 60% less than base metal. The effect of the pulsed TIG is observed that microstructure consist of dendrites, dendrites arm spacing equal to the grain size, fine grain is found at 200A current, base current of 60A, welding speed of 150mm/min and pulsed frequency of 6Hz.
P.K.Giridharan, N.Murgan[8] has investigated on pulsed tungsten inert gas welding process parameters was carried out to obtain optimum weld bead geometry in welding of austenite stainless steel sheet (304L) . They used quasi-Newton numerical optimization technique. They found that with increase in pulse current, all heat input, penetration, bead width and bead area increased, further increase in pulsed current there is no significant change in heat input, penetration and slight decrease in bead area. With increase in duration of pulsed current increase in penetration, bead width and further increase in duration of pulsed current slight change in penetration and significantly increase in width area, aspect ratio decreases first as penetration increases. With increase of welding speed aspect ratio increases as penetration decreases. Welding speed is the most important and pulsed current is next most important influence on bead parameters and pulsed current duration as no significant effect on bead parameters.
Pawan Kumar, Kishor Purushottamrao, Sashikant Janarda [9] has studied the effect of process parameters of pulsed current tungsten inert gas welding on aluminum alloy6061 using sinusoidal AC wave with argon and helium gas mixture. From the study they have found that pulse current pulse duty cycle, frequency, percentage of helium in argon plays an important role on microstructure, and hardness of weld, Pulsed current plays major role in all of them. Lower micro hardness was observed in the weld zone because of using filler rod, dendrites solidified microstructure and segregated phase. It is also observed that the pulsed parameters play an important role in

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development of fine microstructure.

Ratnesh K Shukla, Pravin K Shahhas[10] has done investigation on micro structure, hardness distribution, tensile properties and fracture surface morphology on tungsten inert gas welding and friction stir welding of weld butt joint of 6061 T6 aluminum alloy. They used $AlSi_5$ as filler material, argon as shielding gas, 6061 T6 of 150x60x4 mm size, for friction stir welding rotating tool assembly at 1000-rpm rotation, CNC milling with motor of 11KW is used. They used optical microscope for microstructure and Vickers hardness for hardness of weld material. They found that very fine, equiaxed grain in FSW; this may be due to dynamic recrystallisation. TIGS welding contain dendritic structure this may be due to fast heating of base metal and fast cooling of molten metal. The percentage of elongation of TIG joint is lower than FSW, FSW exhibited higher ductility compare to TIG, FSW joint has higher strength value of 51% of base metal and TIG of 44.5%. Microhardness in FSW is more than TIG and different at four different points of FSW joint.

Nanda naik korra, M Vasudevan, KR Balasubramanian [11] has studied the effect on weld bead geometry of duplex stainless steel alloy 2205 of activated tungsten inert gas welding process parameters. The current, torch speed and arc gap as input process parameters. The output parameters are depth of penetration, bead width, bead height and aspect ratio. ANOVA analysis was used for development of mathematical models and found that higher current, lower torch speed and lower arc gap gives maximum depth of penetration, higher current, higher arc gap and lower torch speed increases bead width. Higher current, low torch speed and low arc gap gives higher aspect ratio.

Hsuan-Liang Lin and Tong-Min Wu [12] have done experiment on effect of flux and process parameters of Inconel 718 alloy in tig welding. The work piece of 50x100x6.5 mm dimension and flux materials are $Sio_{2,}$ NiO, MoO_3, Cr_2O_3, TiO_2, MnO_2, ZnO and MoS_2 and flux is mixed with methanol to make paint like consistency. It was found that the depth to width ratio of weld precoated with mixed component flux.It increase with single component flux, with the oxide 50% SiO_2 + 50% MoO_3 being more significant, the fluxes SiO_2, 50%SiO_2 +50%MoO_3 and 50% SiO_2 + 50% MnS_2 have more effect on the voltage, hot cracking was tested by spot varestraint test and found that hot cracking resistance is more in activated TIG compair to conventional TIG.

The most significant parameter for depth to width ratio of weld are welding current, speed, electrode angle, in addition a mixed component flux has most effect on penetration and hot cracking of inconel178 alloy.The present work deals with to find best influence of process paramenters on mechinal properties and microstrutues of weld metal on Duplex stainless steel (2205) material using L9 Orthogonal array desing of experiments.

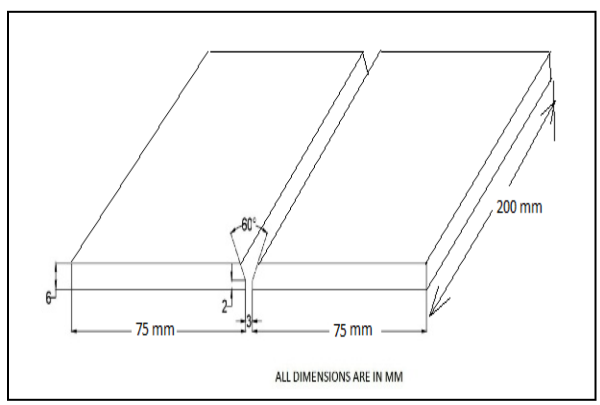
2 Methodology and Material.

In this work, Duplex Stainless Steel (2205) alloy of dimension plates 200x75x6mm was taken and the number of pieces was 18. TIG was performed, the number of experiments were nine. The process parameters are root gap, current, electrode and gas flow rate. The DSS2205 (18) metal pieces of plates 200x75x6mm and cleaned the surface of the plates and all the four edges of rectangular shaped metal plates are properly finished. Chamfering is done for the better penetration of depth and 2 to 4 mm of chamfering was taken. The Welding is performed with a TIG apparatus on the metal plates by using filler rod ER 316 according to given parameters. L9 orthogonal array is used to perform design of experiments via Taguchi method. The work pieces are wired cut into required shape on EDM wire cut machine for conducting Tensile strength test, hardness test, microstructure test and penetration. For Activated TIG procedure is same as conventional TIG but here we coat the base plates with fluxes. The flux used is SiO_2 and number of experiments performed is three. DSS 2205 six metal pieces are taken and welding is performed.The chemical composition of the base metal and filler rods are given in table 1.

Table 1.Chemical composition of Base Matel DSS (2205).

C	Cr	Mn	Ni	Mo	Si	Cu	Fe
0.024	22.82	1.72	5.75	3.22	0.46	0.73	Rem

The weld joint design is shown in figure 1. The experiments Were conducted using arc gap 2 mm, V-groove angle of 60^0, and root gap of 3 mm. The direct current electrode negative DCEN (Straight polarity) was employed during TIG welding process to provide deeper weld penetration and optimal angular distortion.



2.1 Taguchi Method:

Dr. Taguchi of Nippon Telephones and Telegraph Company, Japan has developed a method based on “orthogonal array " experiments, which gives much reduced variance for the experiment with optimum settings of control parameters.The Design of Experiments with optimization of control parameters to obtain best results by Taguchi Method. Orthogonal Arrays provide a set of well balanced (minimum) experiments and Dr. Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as objective functions for optimization, help in data analysis and prediction of optimum results.

2.2 Design of Experiments

A well-planned set of experiments, in which all parameters of interest are varied over a specified range, is a much better approach to obtain systematic data. Mathematically speaking, such a complete set of experiments ought to give desired results. Usually the number of experiments and resources (materials and time) required are prohibitively large. Often the experimenter decides to perform a subset of the complete set of experiments to save on time and money.However; it does not easily lend itself to understanding of science behind the phenomenon. The analysis is not very easy, (though it may be easy for the mathematician/statistician) and thus effects of various parameters on the observed data are not readily apparent. In many cases, particularly those in which some optimization is required, the method does not point to the best settings of parameters. A classic example illustrating the drawback of design of experiments is found in the planning of a world cup event, say football. While all matches are well arranged with respect to the different teams and different venues on different dates and yet the planning does not care about the result of any match (win or lose). Obviously, such a strategy is not desirable for conducting scientific experiments (except for co-ordinating various institutions, committees, people, equipment, materialsetc). The choice and the selection of the parameter were decided by considering the objective of present study. Before selecting a particular othogonal array to be used as a matrix for conducting the experiments.The number of parameters and interactions of interest.The numbers of levels of the parameter of interest. The non-linear behavior, if exists, among the process parameters can only be studied if more than two levels of the parameters are used [16]. Therefore, each parameter was analyzed at three-levels.The Chemical composition of filler matel ER316L is given in the table2. The selected numbers of the process parameters are four and their three levels are given in Table3. For the sake of simplification, the second order interaction among the parameters is not considered.

Table 2.Chemical composition of Fiiler Matel ER 316L.

C	Cr	Si	Mn	P	S	Mo	Ni	Fe	Cu
0.03	18.5	0.45	1.75	0.03	0.03	2.8	11.5	Rem	0.75

Table 3. L9 Orthogonal Array:

Experiment Numbers	Electrode dia (mm)	Time (sec)	Current (Amp)	Gas flow (l/min)
1	2	100	150	5
2	2	150	200	6
3	2	180	250	7
4	2.4	100	200	7
5	2.4	150	250	5
6	2.4	180	150	6
7	3	100	250	6
8	3	150	150	7
9	3	180	200	5

2.3 Activated TIG (A-TIG)

Activated TIG is the process of welding in flux power is coated or painted over the part where welding takes place. In TIG welding depth of penetration may not exceed 3mm in a single pass where as in Activated TIG welding depth of penetration goes up to 6mm and more in single pass, depth to width ratio increases, hot crack resistance is higher in Activated TIG.

2.4 **Experimental Setup**:

The work pieces of DSS plates are taken and parallel to each other on a base plate, fixed to the base plate by using clamps shown in figure 2 such that there will be no angle of distortion in weld plates and base plate is placed on a supporter such that clamps does not touch the ground and welding is done by using manual welding apparatus. For Activated set up is same as the conventional TIG but here before welding and after clamping to the base plate flux is coated on work pieces where welding is going to be done.

Fig. 2 Duplex stainless steel plates with clamping for Flat welding position.

3. Microstructure Analysis of Weld zone.

The specimen size was 45x10 x 6 mm with rectangular edge butt joint.In an attmpt to investigate the microstructural variation with welding process parameters.The microstructure of the weld zone is finer and typical α-phase dentritic grains are observed in the center of the weld.

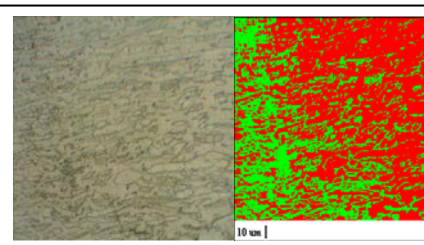


Fig 3. Experiment No.1; It contains 34.09% of ferrite, 63.56% of austenite and 2.35% of others.

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The percentage content of ferrite and austenite in weld metal were observed and investigate the phase, volume of phase and grain size at the weld zone. The given samples have tested according to ASTM E112 for grain size and size of specimen tested for phase and volume is 10 micro meters.

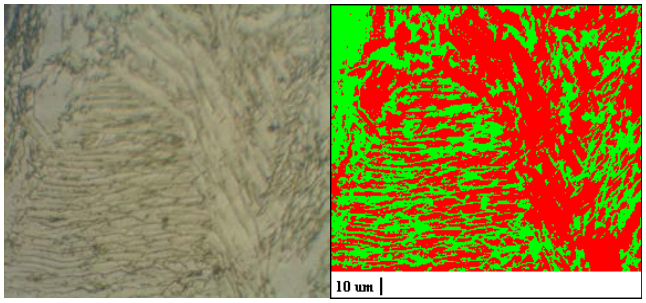

Fig 4. Experiment No 2; it contains 38.99% of ferrite, 58.33% of austenite and 2.68% of others.

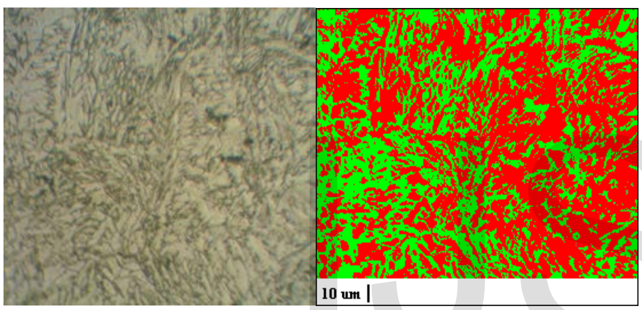

Fig 5. Experiment No.3; It contains 35.84% of ferrite, 61.96% of austenite and 2.2% of others.

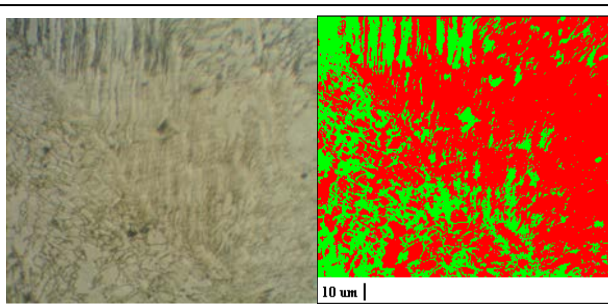

Fig 6. Experiment No.4; It contains 30.66% of ferrite, 67.32% of austenite and 2.02% of others.

The percentage content of austenite and ferrite in weld zone of nine experiments has shown in the Fig.3 to Fig 11.The maximum percentage of austenite content (70.07%) was found in experiment number 6, where welding time in maximum (180 sec/200 mm), current is 150 Amp and gas flow rate is 6 l/min.The maximum percent ferrite content is 38.99% in experiment number 2, where current is 200 Amp, welding time is 150 sec / 200mm and gas flow rate is 6 l/m. The summury of percent of austenite, ferrite content and grain size of microstructure of weld metal are given in table 4.

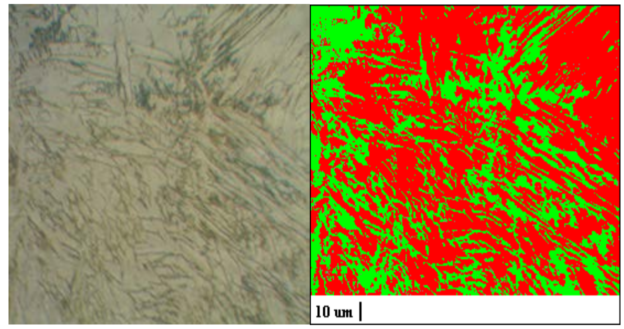

Fig.7. Experiment No. 5; It contains 34.35% of ferrite, 63.39% of austenite and 2.25% of others.

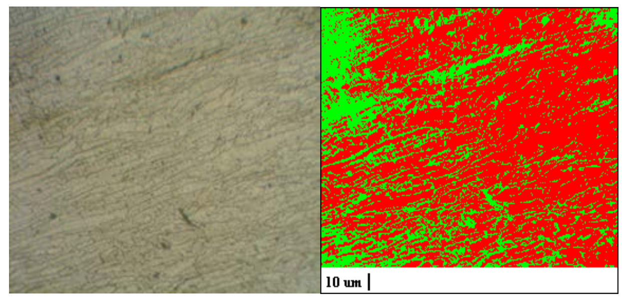

Fig 8. Experiment No.6; It contains 27.26% of ferrite, 70.07% of austenite and 2.66% of others.

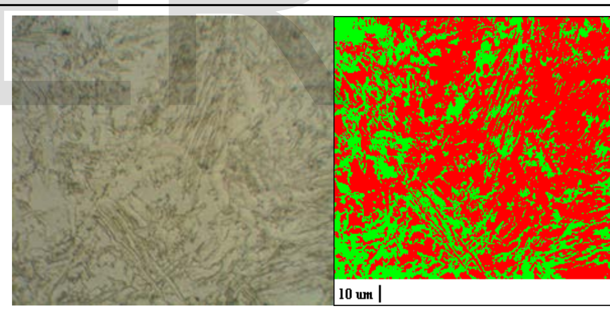

Fig 9. Experiment No.7 ; It contains 34.33% of ferrite, 63.33% of austenite and 2.34% of others.

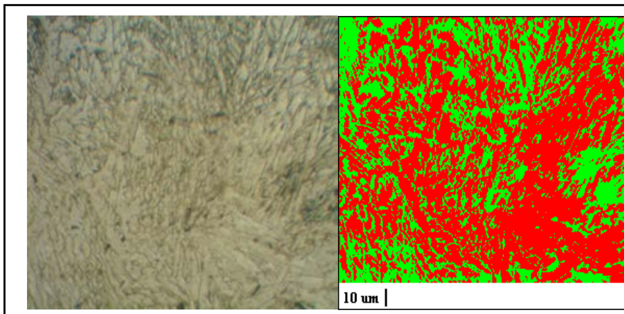

Fig10. Experiment No. 8; It contains 35.84% of ferrite, 61.96% of austenite and 2.2% of others.

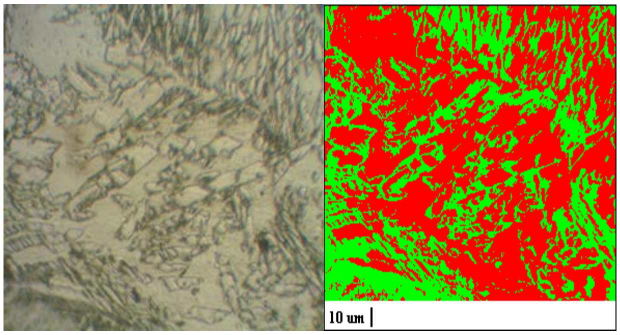

Fig11.Experiment No. 9 ; It contains 33.26% of ferrite, 64.26% of austenite and 2.53% of others.

Table 4. Ferrite and Austenite Percentage of Weld Zones.

Experiment No	Ferrite %	Austenite %	Others %	Grain size
1	34.09	63.56	2.35	5
2	38.99	58.33	2.68	5
3	35.84	61.96	2.2	5.5
4	30.66	67.32	2.02	5.5
5	34.35	63.39	2.25	5.5
6	27.26	70.07	2.66	5.5
7	34.33	63.33	2.34	5.5
8	35.84	61.96	2.2	5.5
9	33.26	64.21	2.53	5.5

4. Results and Discussion

The specimens shown in the figure12 were prepared by EDM wire cut machine from each nine experiments welded paltes and tested for tensile strength of weld metal on universal testing machine 40 (UTM-40), length of the specimen is 51mm, specimen width is 18-19mm and specimen thickness is 2.5-3.5mm (at weld joint).

Fig 12.Tensile test specimens

The time taken for one tensile test specimen of weld joint was 2 hours on EDM wire cut machine.

Table 5.Results of Tensile Strenght (N/mm^2).

Experiment No.	Electrode Dia(mm)	Time(sec)	Current (AMP)	Gas Flow rate (l/m)	Tensile Strenght. (N/mm^2)
1	2	100	150	5	569
2	2	150	200	6	610
3	2	180	250	7	687
4	2.4	100	200	7	677
5	2.4	150	250	5	723
6	2.4	180	150	6	719
7	3	100	250	6	672
8	3	150	150	7	657
9	3	180	200	5	744

The tensile properties of GTAW welded joints were evaluated for each parameters and results are shown in table 5.The maximum tensile strength was found in the experiment number nine where welding time is maximum 180 sec / 200 mm.

Fig 13. Hardness test and Microstructure specimens

Table 6 Results of Rockwell Hardness Test.

Experiment No.	Electrode Dia (mm)	Time (sec)	Current (Amp)	Gas flow rate (l/m)	Hardness(HRB)
1	2	100	150	5	91
2	2	150	200	6	95
3	2	180	250	7	92
4	2.4	100	200	7	93
5	2.4	150	250	5	98
6	2.4	180	150	6	92
7	3	100	250	6	96
8	3	150	150	7	92
9	3	180	200	5	91

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After the experiment was conducted, the specimens shown in the figure 13 were tested for hardness in both the weld zone and base metal. It was observed that the heat affected zone had more hardness than weld zone .Rock well hardness test was done indenter was diamond and the load was 100 kg. Out of all the three zones heat affected zone had the highest hardness. in some cases, hardness of heat affected zone was equal to base metal hardness but hardness of weld zone was always less than heat affected zone.The Rockwell hardness values of weld zone are given in the table 6.

4.1. Signal-to-Noise Ratio for Tensile strength

S/N Ratio $\eta = -10 \, Log_{10} \, (1/n \;\; \Sigma 1/ Y_i^2)$

(larger the better)

4.2 Signal-to-Noise Ratio for Hardness

S/N Ratio $\eta = -10 \, Log_{10} \, (1/n \;\; \Sigma \, 1/Y_i^2)$

(larger thebetter)

Where n is the number of observations and Y is the observed data. Taguchi Signal-to- Noise ratio for tensile Strength and hardness was given in the table 7.The maximun S/N ratio for tensile strength was found in the experiment number 9,and maximum S/N ratio for hardness was found in the experiment number 2.

Table 7. S/N Ratio For Tsensile Strength And Hardness

Experiment No.	$(Hardness)^2$	$(Tensile\ Strength)^2$	S/N Ratio Hardness	S/N Ratio Tensile Strength
1	8649	323761	39.367	55.102
2	9604	372100	39.824	55.706
3	8649	471969	39.369	56.739
4	8281	458329	39.18	56.611
5	9025	522729	39.554	57.182
6	8464	516961	39.275	5.134
7	9216	451584	39.645	56.547
8	8486	431649	39.276	56.351
9	8281	553536	39.18	57.431

The main effect plots for tensile strength of weld metal are shown in the figure 13.The tensile strength of weld metal is maximumun at minimum welding speed i.e 180 sec/200 mm. Tensile strength value decrease at minimum diameter of filler rod and welding current is directly propositional to strength of weld metal.The main effect plot of Rockwell hardness value of weld zone are shown in the figure 14.Hardness value is maximum at lower diameter of filler rod.it also found that as current increase Rockwell hardness also increases.From the experimental analysis it is proved tha at 6 L/min gas flow rate the harness of weld zone is maximum.

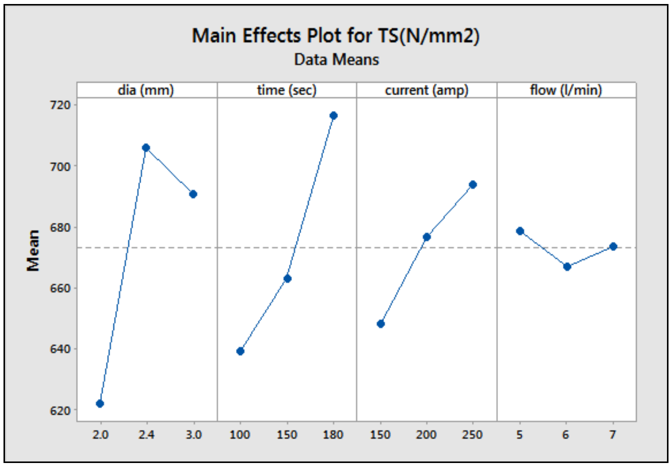

Fig 13: Main effects plot for tensile strength of weld zone.

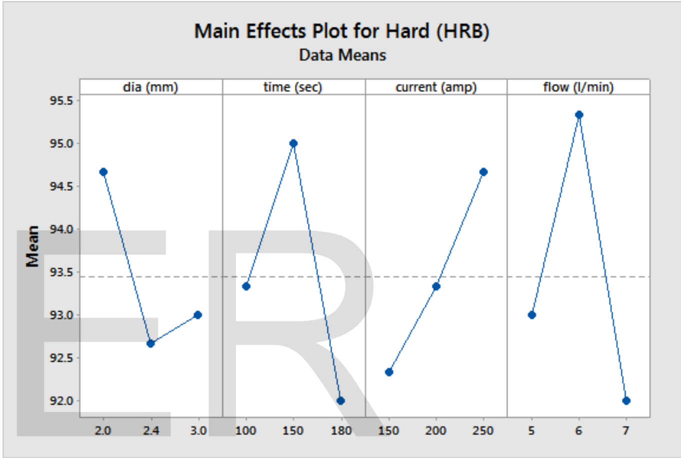

Fig 14. Mian effect plot for Rockwell hardness of weld zone.

Table 8. Comparison of TIG Welding with Activated TIG Weld.

Depth of penetration (mm)		Depth to Width Ratio	
TIG	A-TIG	TIG	A-TIG
2.6	5.2	0.4	0.65
2.9	5.6	0.414	0.67
3.8	5.9	0.447	0.737

Results of depth of penetration and depth of width ratio of three experiments in Activated TIG welding process by using SiO_2 as flux for the same parameters used for TIG welding are given in the table 8.The depth of penetration and width to depth ratio is high in Activated TIG welding when compared to conventional TIG welding. This is because the heat input increase when we coat flux on the work piece and that increases the penetration depth of weld.

5. Conclusion

The present work is aimed at experimental analysis of TIG welding by considering the effect of various input parameters on certain performance measures using Taguchi's orthogonal array experimental design on DSS 2205.The comparison of Activated TIG welding with TIG welding has been investigated.

- Time and current has the major effect on the tensile strength, tensile strength is maximum at 180 sec and 250 amps, but at low gas flow rate.
- Hardness is mainly effected by current and hardness is maximum at 250 amps, 150 sec and 6 L/min.
- From experimental number 5 it was observation the optimum process parameters are time 150 sec, current 250 amps, gas flow 5 L/min and 2.4mm electrode diameter where tensile strength (723 N/mm^2) and Rockwell hardness number is 98.
- In Activated TIG welding depth of penetration (91.6%) and depth to width ratio is high compared to TIG welding.

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