EXPERIMENTAL INVESTIGATION TO DETERMINE OPTIMUM WELDING PARAMETERS FOR MIG WELDING

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Abstract--

Metal Inert Gas welding is one of the most widely used processes in industry. The input parameters play a very significant role in determining the quality of a welded joint. In fact, weld geometry directly affects the complexity of weld schedules and thereby the construction and manufacturing costs of steel structures and mechanical devices. Therefore, these parameters affecting the arc and welding should be estimated and their changing conditions during process must be known before in order to obtain optimum results; in fact a perfect arc can be achieved when all the parameters are in conformity.

In this thesis, MIG welding is performed on the mild steel pieces. Different mild steel pieces are welded by varying the currents, 150amp, 200amp and 250amps and weld speeds 3.2mm/sec, 3.7mm/sec and 4.2mm/sec. The hardness and tensile tests are performed to determine the optimal welding currents and weld speeds.

Regression analysis is used to determine the optimal process parameters for high tensile strength and hardness.
Thermal analysis and structural analysis is performed to determine the heat transfer rates and the strength of the pieces at the applied load respectively. Modeling is done in Pro/Engineer and analysis is done in Ansys.

Key words — Welding Electrode,

I. INTRODUCTION

Metal Inert Gas welding is one of the most widely used processes in industry. The input parameters play a very significant role in determining the quality of a welded joint. In fact, weld geometry directly affects the complexity of weld schedules and thereby the construction and manufacturing costs of steel structures and mechanical devices. Therefore, these parameters affecting the arc and welding should be estimated and their changing conditions during process must be known before in order to obtain optimum results; in fact a perfect arc can be achieved when all the parameters are in conformity. These are combined in two groups as first order adjustable and second order adjustable parameters defined before welding process. Former are welding current, arc voltage and welding speed. These parameters will affect the weld characteristics to a great extent. Because these factors can be varied over a large range, they are considered the primary adjustments in any welding operation. Their values should be recorded for every different type of weld to permit reproducibility.

LITERATURE REVIEW

The work done by K. Abbasi[1], aimed at the evaluation of depth of penetration and weld width by employing different MIG welding parameters. The weld bead and shape factor characteristic of bright drawn mild steel specimen of dimensions 144 x 31 x 10 mm has been investigated.

The work done by S. R. Patil [2], presents the influence of welding parameters like welding current, welding voltage, welding speed on ultimate tensile strength (UTS) of AISI 1030 mild steel material during welding. A plan of experiments based on Taguchi technique has been used. An Orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are employed to study the welding characteristics of material & optimize the welding parameters. From this study, it is observed that welding current and welding speed are major parameters which influence on the tensile strength of welded joint.

In the work done by Biswajit Das[3], The effect of various welding process parameters on the weldability of Mild Steel specimens of grade EN-3A having dimensions 150mm× 100mm× 6 mm, welded by metal inert gas welding were investigated. The welding current, arc voltage, welding speed, are chosen as welding parameters. The depth of penetrations were measured for each specimen after the welding operation is done on closed butt joint and the effects of welding speed, current, voltage parameters on depth of penetration were investigated.

In the work done by Vikas Chauhan [4], dissimilar metals, stainless steel (SS-304) and low carbon steel plates are joined by MIG welding successfully. Three parameters of MIG welding viz. current, voltage and travel speed are taken for the analysis. A plan of experiments based on Taguchi technique has been used to acquire the data. The analysis for signal to noise ratio was done using MINITAB 13 software for higher the better quality characteristics. The significance of each parameter was studied by using the ANOVA (Analysis of variance). Finally the confirmation tests were performed to compare the predicted values with the experimental values which confirm its effectiveness in the analysis of tensile strength of the joint.

In the work done by Vineeta Kanwal[5], Parametric optimization of MIG welding for Hardness has been performed by using Taguchi method. Welding Speed, Welding Current and Welding Voltage were chosen as welding parameters. The materials used for this purpose were aluminium alloys of grades 6061 and 5083 having dimensions (75x60x6) mm. Argon was used as a shielding gas. Filler wire 4043 of diameter 1.2 mm was used.

The work done by 6.Syed Askari Raza Baqar[6], research describes the measurement and study of temperature in welded components using a microcontroller based temperature measurement system with Type-K thermocouple sensor. The experimentation was conducted on low carbon steel plates on a semi-automatic MIG welding machine using bead on plate welding technique by varying welding parameters like wire feed rate and welding speed. The temperature response was recorded for different distances from the weld bead and time-temperature graphs were plotted.

In the work done by H.R. Ghazvinloo[7], The effect of processing variables on fatigue life, impact energy and bead penetration of AA6061 joints produced by MIG robotic welding process was analyzed in the present study. Different samples were obtained by employing arc voltages of 20, 23 and 26 V, welding currents of 110, 130 and 150 A, welding speeds of 50, 60 and 70 cm/min. Results were clearly illustrated that when heat input increases, fatigue life of weld metal decreases whereas impact energy of weld metal increases in first and then drops significantly. A linear increase in depth of penetration with increasing welding current and arc voltage was also observed. The biggest penetration in this investigation was observed for 60 cm/min welding speed.

The work done by Hakan Ates[8], studied Design of Experiments for this work and by use of the experimental data have performed ANN (Artificial Neural Network) prediction and make comparison with experimental data. Where inputs parameters for MAG-CO_2 welding are welding current, wire diameter and wire feed rate and for TIG welding are welding current, wire diameter output parameter is weld strength for both MAG-CO_2 welding and TIG welding techniques.

II. Proposed Work

Experimental investigation is done to verify the mechanical properties of MIG welding of mild steel. The properties investigated are tensile strength and hardness compared before and after welding.
The welding is done on Conventional MIG welding machine.

MIG WELDING MACHINE

MODEL	MIG-180	MIG-250	MIG-350	MIG-400
Input Supply! V)	U220/230	3x380/415	3x380/415	3x380/415/440
Frequency (Hz)	50	50	50	50
Off-Load Voltage(VDC)	15-34	17-36	17-38	18-50
Max. Welding Current	120	200	230	315
Load 100%				
Load 60%	140	250	275	400
Load 40%	180	-	350	-
Welding Current (A)	30-180	50 - 250	50 - 350	60 - 400
(Min. lo Max.)				
Power Consumption(KVA)	6.2	9	13.5	20
Voltage Level	9	10	20	36
Inductance Tapping	2	2	2	3
Insulation (Class)	H	H	H	H
Cooling	Fan	Fan	Fan	Fan
IS Cum forms to	7931	7931	7931	7931
Fuse Rating (A)	DP 16/25	TP 16	TP 16/25	TP 25/32
Cross section of input	2x4	3x2.5	3x4	3x4
cable (mm2)				
Rectifier Bridge	SIL Diodes.	SIL Diodes.	SIL Diodes.	SIL Diodes.
Cross section of Weld	16/25	25/35	35/50	50
Cable (mm2)				
Dimension (LXBXH) cm	50x35x59	58x40x59	63x45x59	83x52x75
Weight	60	80	95	140

Machine Specifications

SAMPLES	CURRENT (amps)	WIREFEED RATE (mm/sec)
Sample 1	150	3.2
Sample 2	200	3.7
Sample 3	250	4.2

Parameters taken for experimentation

Welding Process is being done

Welding on pieces

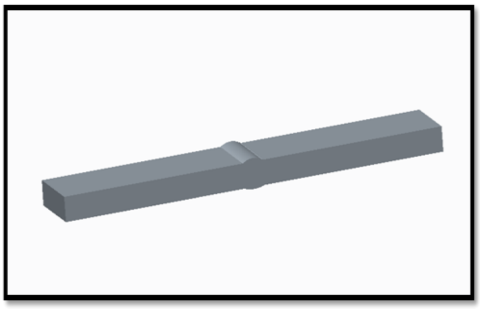
Welding on pieces

Final Welded Pieces

Final Welded Pieces

RESULT & DISCUSSION

3D model of the welded pieces is done in Creo 2.0.

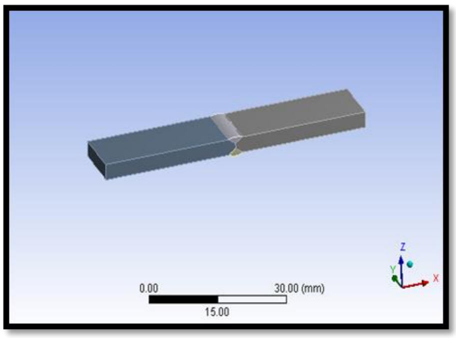


3D model of welded pieces

THERMAL ANALYSIS OF MIG WELDING

CASE 1: 150 Amps (1502^{0}C)

Open work bench 14.5>select **steady state thermal** in analysis systems>select geometry>right click on the geometry>import geometry>select **IGES** file>open



Imported Model from Creo 2.0

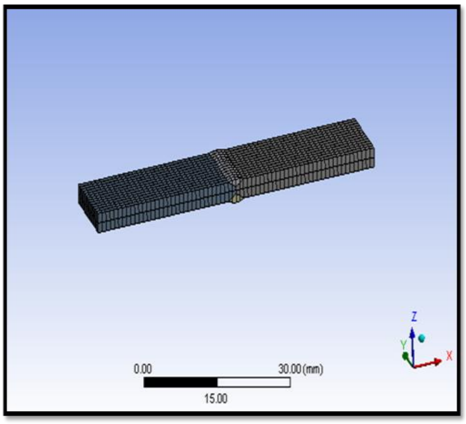
MATERIAL PROPERTIES OF MILD STEEL

Thermal conductivity of aluminum = 60.5W/mK

Specific heat =380 J/Kg K

Density = 0.00000785Kg/mm^3

Model >right click>edit>select generate mesh



Meshed model

Boundary conditions

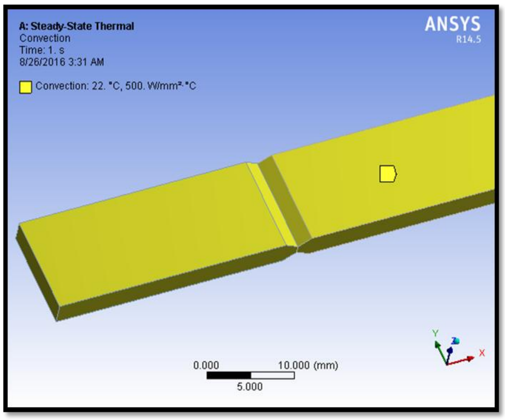
T_1 =1502^{0}C

Select steady state thermal >right click>insert>select convection

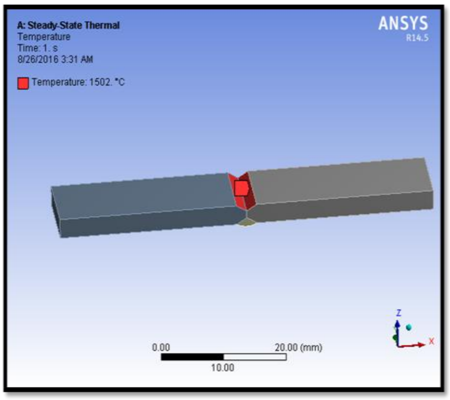
Select steady state thermal >right click>insert>select heat flux

Select steady state thermal >right click>solve

Solution>right click on solution>insert>select temperature



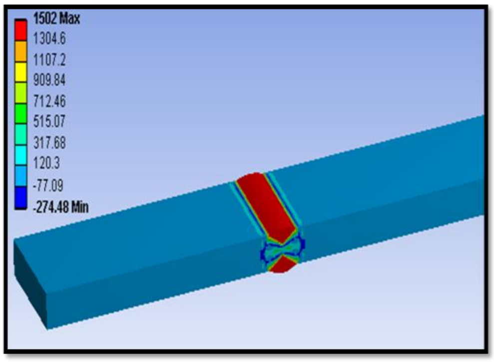
Applying of convection



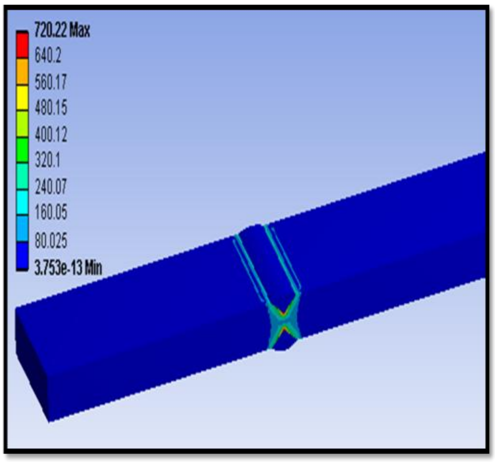
Temperature is applied at the welded region

Solution - Select Temperature and Heat Flux

Evaluate all Results



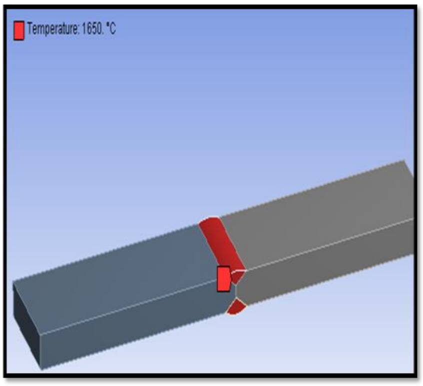
Temperature distribution on the welded pieces



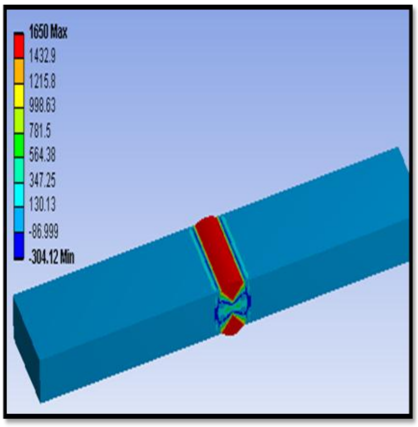
Heat Flux on the welded pieces

Case 2: 200 Amps (1650^{0}C)

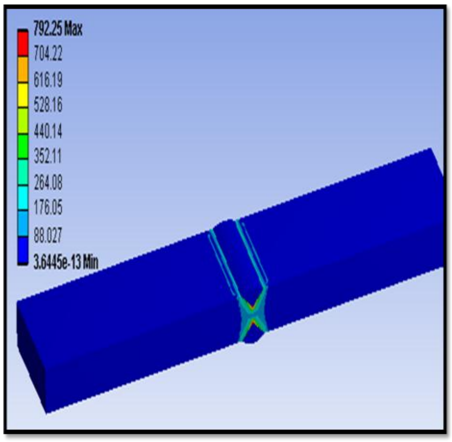
Temperature



Applied Temperature at the welded region



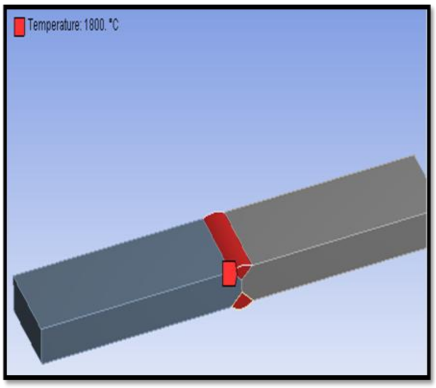
Temperature distribution on the welded pieces



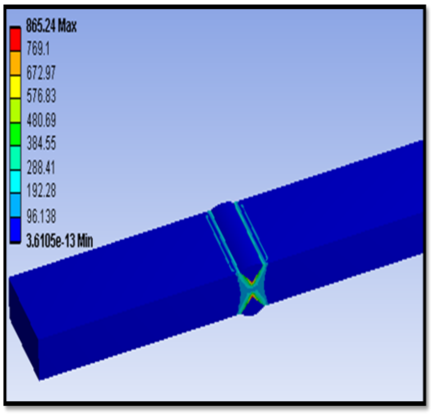
Heat Flux on the welded pieces

Case 3: 250 Amps (1800^{0}C)

Temperature



Temperature is applied at the welded region

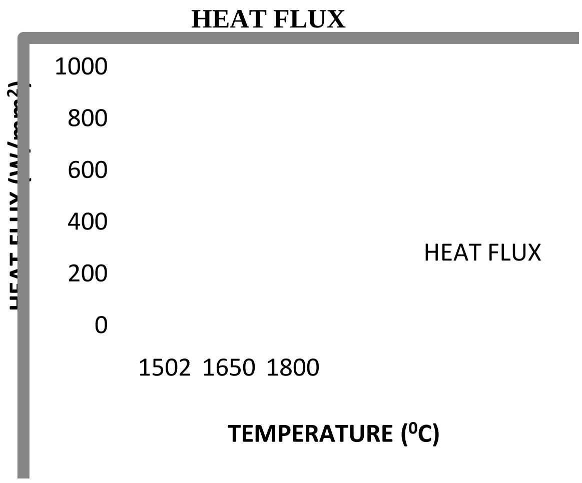


Heat Flux on the welded pieces

RESULTS TABLE

Thermal analysis

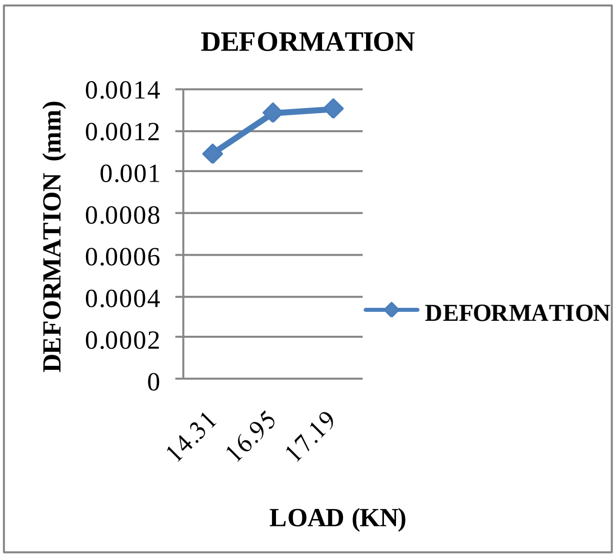
Cases	Temperature (^{0}C)	Heat flux (W/mm^2)
Case1	1502	720.22
Case2	1650	792.25
Case3	1800	865.24

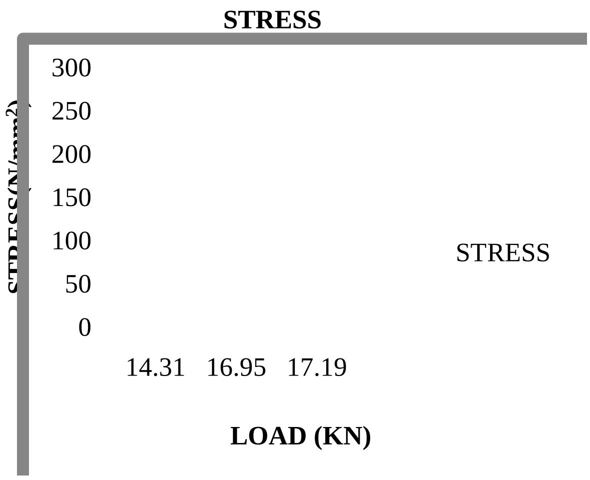


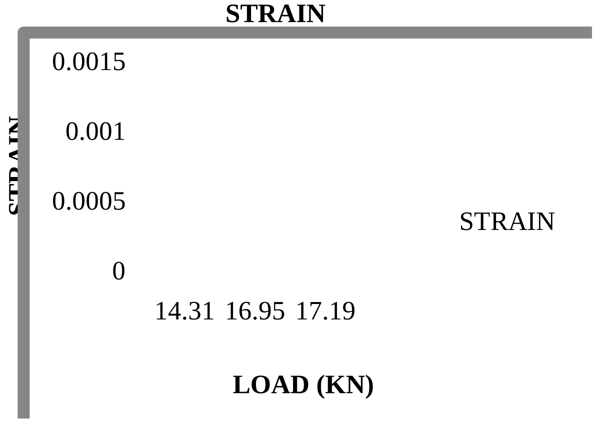
Structural analysis

Load(KN)	Deformation (mm)	Stress (N/mm^2)	Strain
14.31	0.0010905	237.13	0.0011864
16.95	0.0012899	280.48	0.0014032

17.19	0.00131	284.85	0.0014251







CONCLUSION

In this thesis MIG welding is performed on the Mild steel pieces by varying the welding current at weld speeds of 3.2mm/sec, 3.7mm/sec and 4.2mm/sec. The welding currents are 150amps, 200amps and 250 amps. Hardness and tensile tests are performed on the pieces.

The brinell hardness of mild steel is 120HRB. By observing the hardness test results, the hardness is decreased after welding. By increasing the welding current the hardness is increased from 150amp to 250amp.

From the tensile test results, the strength of the welded pieces is increasing by increasing the current.

By observing the Regression Analysis, results show that among main input welding parameters the effect of the current is significant. Increasing the current and increasing the weld speed increases the ultimate tensile strength and hardness of welded joint. So, to maximize tensile strength and hardness, the Current should be set at 250Amps and Wire Feed Rate at 4.2mm/sec.

Thermal analysis is done. By observing the results, the heat flux is increasing by increasing the welding current.

Structural analysis is also done. By observing the result, the stress values obtained are less than that of the experimental tensile strength values.

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