“Evaluate the effect of process parameters on mechanical properties of 6mm thickness SS317L weld joint for receiver application GTAW welding”

Submitted By

PRASHANT R. PANDYA

(180044003)

Supervised by

Dr. G. D. Acharya

Principal

Atmiya University, Rajkot

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Mechanical department,

Faculty of Engineering &Technology,

ATMIYA University,

Yogidham Gurukul, Kalawad Road, Rajkot-360005

CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled **"EVALUATE THE EFFECT OF PROCESS PARAMETERS ON MECHANICAL PROPERTIES OF 6MM THICKNESS SS317L WELD JOINT FOR RECEIVER APPLICATION GTAW WELDING"** submitted by **Mr. PANDYA PRASHANT R.(180044003)** studying at Mechanical Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech Mechanical-Production engineering is absolutely based on his own work carried out under my supervision and this thesis has not been submitted elsewhere for any degree.

Date –

Place -

Dr. G. D. Acharya
Principal,
Atmiya University Rajkot

Mr. Manojkumar V. Sheladiya
Head of Mechanical
Engineering Department

Seal of University

INDUSTRY CERTIFICATE

Mobile : 98796 05756
Phone : 0260-2426111

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Shed No. C1B-5501/7, 4th Phase, G.I.D.C., VAPI - 396 195.
E-mail : sairatnaeng6@yahoo.in Website : www.sairatnaengg6.com

DATE: 13/03/2020

INDUSTRY CERTIFICATE

To whomever it may concern,

This is to Certify that **Mr. PRASHANT. R. PANDYA** form Faculty of Engineering & Technology, Atmiya University, Rajkot has Satisfactorily Completed his Work on the Project Title" **Evaluate the effect of Process Parameters on Mechanical Properties of 6mm Thickness SS317 L Weld joint for receiver application GTAW welding**" in time duration form [May 2019] to [March 2020].

During the span of his project we found him law abinding, honest and hard working in his work.

Thank you.

With Best Regards,

For SAI RATNA ENGG. & FABRICATORS

PROPRIETOR
(Jitendra .C. Davada)

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It is certified that the work contained in this dissertation thesis entitled "**EVALUATE THE EFFECT OF PROCESS PARAMETERS ON MECHANICAL PROPERTIES OF 6MM THICKNESS SS317L WELD JOINT FOR RECEIVER APPLICATION GTAW WELDING"** submitted by **Mr. PANDYA PRASHANT R.(180044003)** studying at Mechanical Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University. He has complied the comments of the Dissertation Progress Review-I, Dissertation Part-I as well as Dissertation Progress Review-II with my satisfaction.

Date:

Place:

Prashant R. Pandya
(180044003)

Dr. G. D. Acharya
Principal
Atmiya University, Rajkot

PAPER PUBLICATION CERTIFICATE

This is to certify that research work embodied in this dissertation titled **"EVALUATE THE EFFECT OF PROCESS PARAMETERS ON MECHANICAL PROPERTIES OF 6MM THICKNESS SS317L WELD JOINT FOR RECEIVER APPLICATION GTAW WELDING"** was carried out by **Pandya Prashant R. (En. No. 180044003)** at **Faculty of Engineering & Technology, Rajkot (051)** for partial fulfillment of Master of Technology degree to be awarded by Atmiya University has published review article **"A REVIEW ON EVALUATE THE EFFECT OF PROCESS PARAMETERS ON MECHANICAL PROPERTIES OF 6MM THICKNESS SS317L WELD JOINT FOR RECEIVER APPLICATION GTAW WELDING"** for publication in the **"Trends in Mechanical Engineering & Technology, Volume 10 Issue 3, 2020."**

Date:

Place: Rajkot

Prashant Pandya
180044003
Atmiya University, Rajkot

DR. G. D. Acharya,
Principal,
Atmiya University, Rajkot.

Seal of University

THESIS APPROVAL CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled "**EVALUATE THE EFFECT OF PROCESS PARAMETER ON MECHANICAL PROPERTIES 6MM THICKNESS SS317L WELD JOINT FOR RECEIVER APPLICATION GTAW WELDING"** submitted by **Mr. PANDYA PRASHANT R.(180044003)** studying at Mechanical Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University.

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Enrollment No:_____________________	**Institute Code: 051**

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PRASHANT R. PANDYA
(180044003)
Atmiya University, Rajkot.

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NOMENCLATURE

GTAW	Gas tungsten arc welding
HAZ	Heat effected zone
ASME	American society of mechanical engineers
AWS	American welding society
TIG	Tungsten inert gas
DCEN	Direct current electrode negative
DCEP	Direct current electrode positive
AC	Alternative current
DC	Direct current
DPT	Dye penetrant testing
DPI	Dye penetrant inspection
WPS	Welding procedure specification
BM	Base Metal
WM	Weld Metal
HRB	Rockwell Hardness Measured on the B scale

“Evaluate the effect of process parameters on mechanical properties of 6mm thickness SS317L weld joint for receiver application GTAW welding ’’

(180044003)

Prashant R. Pandya

FOET, Department of Mechanical Engineering, Atmiya University, RAJKOT

prashantpandya65@gmail.com

ABSTRACT

GTAW welding is most important especially welding of stainless steel and aluminum are more difficult to do. Nowadays SS317L materiel is used in top production receiver application in chemical and Pharma Company. That’s why this must have contain good mechanical properties and also resistance to corrosion. For achieving the good mechanical properties of weld ment, the optimal selection of process parameters is very important. For the GTAW welding the most influence input parameter are selected form the ASME section IX. In this work, the effect of different welding parameters like gas flow rate, current and included angle is selected for the project work. The filler wire which is used for the project work that is ER317L for similar welding of SS317L 6mm thickness plate joint. Tensile test and hardness test is done for check the mechanical properties of weld joint respectively. ANOVA is used for finding out the most influencing input parameter on output result. Optimization of selected parameter done by response surface optimizer. After the optimization validate the result obtain. Taguchi L9 orthogonal array in DOE is used for the optimization with MINITAB 17 version is used.

Keywords: Austenitic stainless steel 317 L , TIG welding, WPS

CHAPTER – 1

Introduction

1.1 Background:

Nowadays manufacturing industries performs very important role in the growth of the any country to be develop. The economic strength of any developing country dependent on the performances of manufacturing company. And also the growth of manufacturing sector can develop the employment for the people and by doing this any country can go towards to the progress.

In manufacturing industries joining is also the one of the most important phenomenon. In other words Joining can be defined as the “metal or non-metal metal can be join to serve some desired purpose” that purpose can be anything dependent upon application. Joining have many process like welding, soldering and brazing also whatever may be used according to application.

Welding can be defined as “a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and a filler metal may or may not be used if required particularly for the application”.

The G.T.A.W welding process is most preferable welding process for the manufacture for the household appliance product. This process is most widely used in industries because it is cheap, easy to use and it can be automated with the ease.

For manufacturing the chemical plant receiver, at first nozzle orientation is mark on top dish then tacking the nozzle and nozzle welded with the top dish. The shell and both dish end are welding with the help of the GTAW welding process. This welding process is more preferable for manufacturing stainless steel vessel.

The below fig 1.1 show the project boundary condition for the project work.

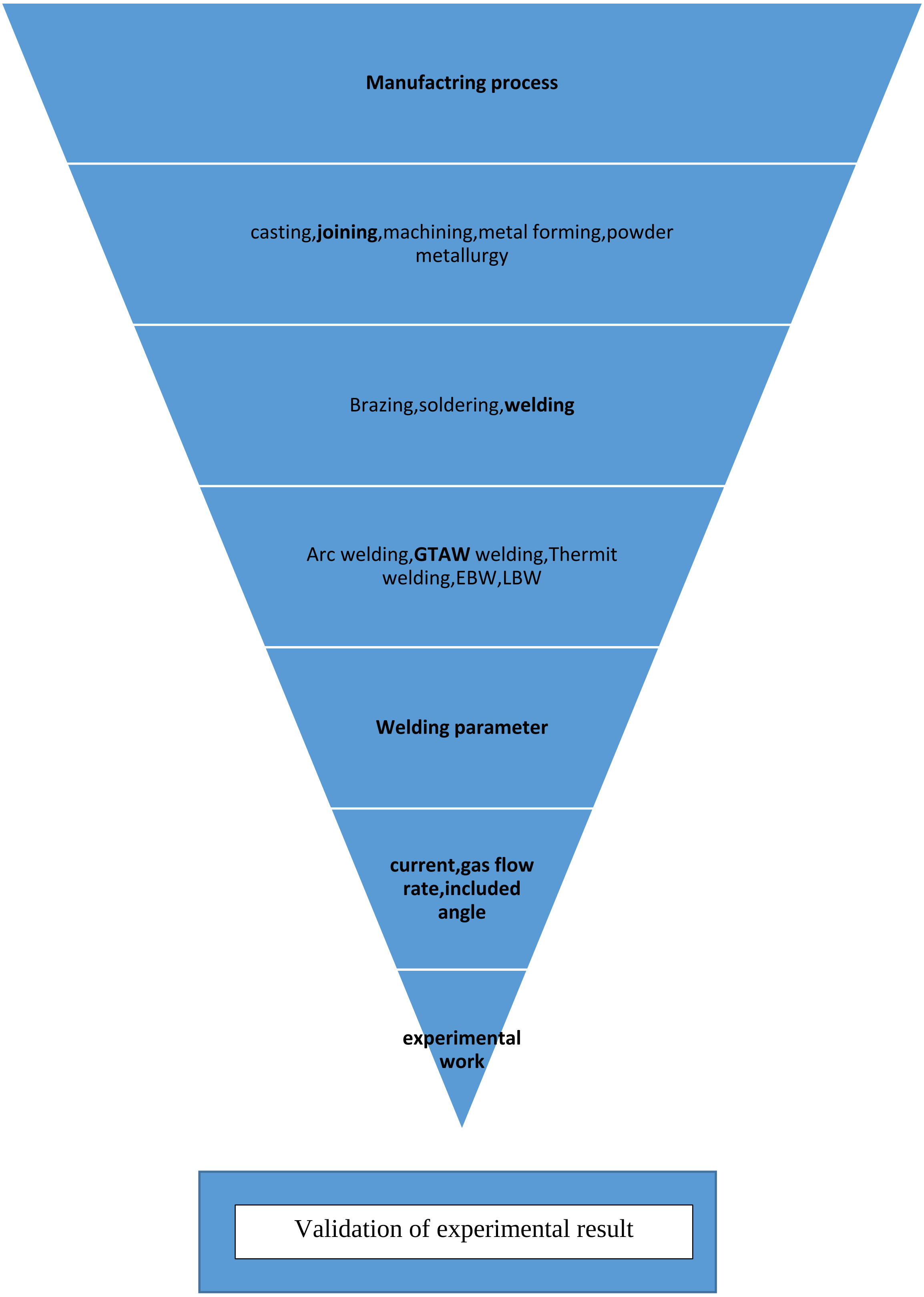


Fig 1.1-Project boundary condition

1.2 Tungsten inert gas welding process:

Manual GTAW welding is very difficult amongst all the welding processes commonly used in industrial application because it is totally dependent on craft man experience respectively. To prevent the electrode great care and skill are required and the welders must maintain a short arc length during the welding so for doing the welding of pressure vessel WPQ is essential for the welder. Welder manually feed a filler metal into the weld area with only one hand and at the other hand manipulating the welding torch in the form of weave bead respectively.

The GTAW welding process comes under the fusion welding process categorised shown in below fig 1.2. In this type of welding process the joining operation of two similar or dis-similar metal done with the metaling the parent metal.

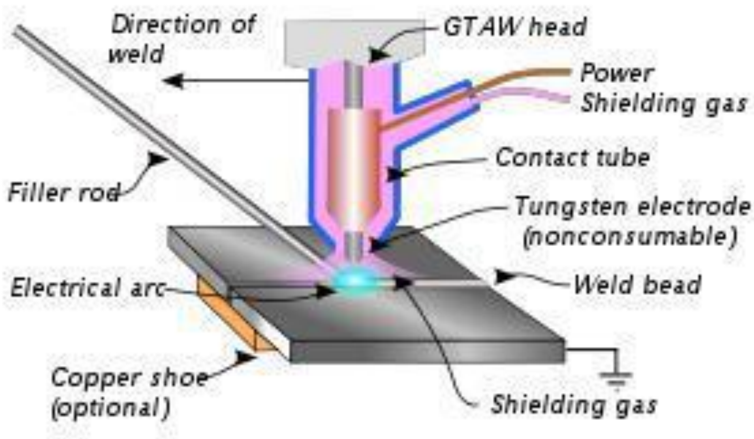


Fig 1.2 Tungsten inert gas welding process [31]

Gas tungsten arc welding (GTAW) process is most commonly and widely used in fabrication industry for manufacturing the different products. Non consumable tungsten electrode used in GTAW welding process for welding the parts. The different shielding gas used like argon, helium or the mixture of it. The shielding gas used for the preventation form other atmosphere contamination and form oxidation also. Generally argon as the shielding gas is used in fabrication industry because the cost parameter consideration compare to helium. At the other side helium is also use but when they required deeper penetration compare to other. While doing the GTAW welding the filler wire may or may not be used is dependent upon the application.

This welding process is mostly used in fabrication industry, chemical plant, and food processing industry, manufacturing vessel, storage tank, and nuclear plant, Pharma company plant for joining the similar or dis-similar material which are ferrous or non-ferrous.

1.3 GTAW welding parameter-

Form the ASME Section IX [33] there are mainly three types of welding variables form QW- 250(welding variables):

1. QW-251.2 Essential variables
2. QW-251.3 Non- Essential variables

Essential variables are those that any change in the value of variable that directly effects the mechanical properties of the weld joint respectively. And also the WPS requalification is required [33].

The requirement of supplementary essential variable for the notch toughness test and charpy V notch test [33].

Non-Essential variable are those that any change in the value of variable that does not effects the mechanical properties of weld joint. And also the WPS requalification is not required [33].

1.3.1 Welding Current:

Generally higher current in GTAW welding process can lead to splatter and undercut defect at the joint side and also work piece become defective. And also again lower current setting in GTAW welding process lead to sticking of the torch to base metal and also the base metal and filler wire does not melt properly and not good aesthetic appearance. Generally the fixed current mode will vary the voltage in order to maintain a constant arc current during the welding of the ferrous or nonferrous material respectively.

1.3.2 Welding Speed:

The speed of the welding is also one of the most important influence on the mechanical properties of weld joint. The heat input per unit length is decrease while the speed is increased due to this the penetration of welding and also the reinforcement is deceased. Due to the high welding speed, increases undercut, porosity in the weld ment and uneven bead shapes appear at the other side with slower welding speed reduces porosity defects and lack of fusion in the weld joint.

1.3.3 Gas Flow Rate:

Gas flow rate is also the most effective influence parameter in TIG welding process because the gas flow rate of inert gas whatever it may use protect the weld bead from atmospheric contamination and also form the oxidation preventation. If the rate of gas flow is high then the welding bead should be weaving while doing the welding and if the gas flow rate is low then the pin hole and porosity defects arise. Mostly in the fabrication industries pure argon gas is mostly used. And other gas are used relatively like helium, carbon dioxide, hydrogen.

1.3.4 Welding Voltage:

Welding Voltage can be fixed or adjustable depending on the GTAW welding Machine and also the thickness of the plate to be joint. A high initial voltage allows for easy arc initiation and rod does not stick to the base metal and the plate doesn't damage. Too high voltage, can lead to large variable in welding quality and not good aesthetic appearance and also not achieved good mechanical properties compare to other.

1.3.5 Welding polarity:

Mainly three types of polarity used in GTAW welding process there are-

1. DCEN
2. DCEP
3. AC

Generally the direction of the flows of electron is referred to as the polarity of the welding machine. The Electron are generally flows from a (-) charged body to a (+) charged body in the circuit. If the electrode is connected to negative terminal and earthing is connected to positive terminal then it called DCEN (direct current electrode negative). By using this deep penetration and narrow melted area is achieve and also approximately 30% heat in electrode and 70% heat to work piece.

If the electrode is connected to positive terminal and earthing is connected to negative terminal then it called DCEP (direct current electrode positive). By using this polarity shallow penetration and wide melted area is achieve as shown in below fig 1.3 respectively.

AC polarity provides good penetration and also the proper oxide cleaning. By using this polarity 50% heat to work piece and 50% heat to electrode. Fig 1.3 shows the bead geometry of different polarities.

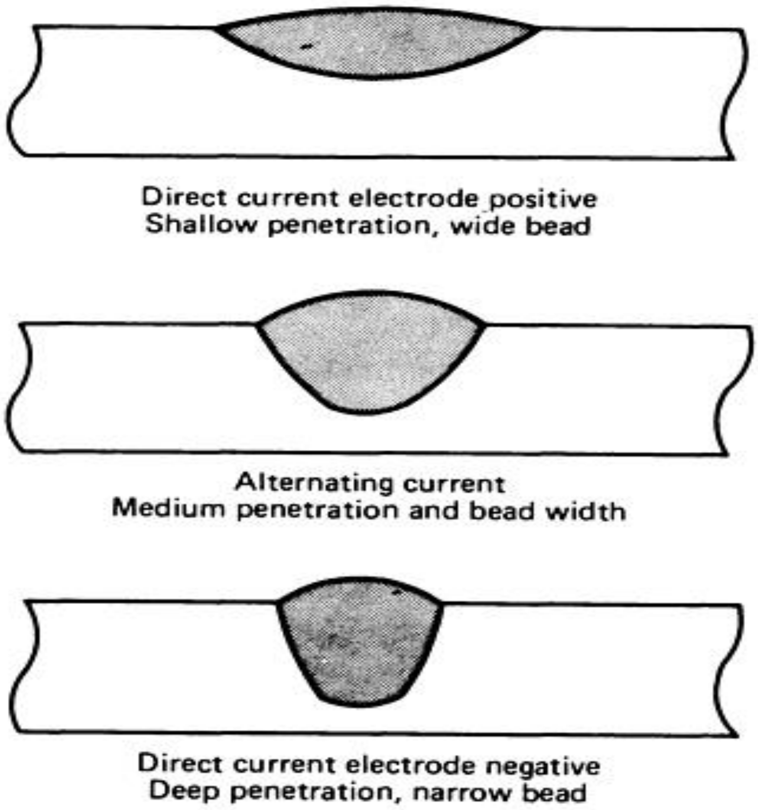


Fig 1.3 Bead geometry of different polarities [35]

1.4 Industry Profile:

Industry in which I was allowed to work in Sai ratna engineering &fabricators. Industry is situated in VAPI GIDC 4th phase near to Aarti industry Ltd.

Industry has gain expertise in making of any kind of fabrication work related to chemical and Pharma Company. Industry was stated in the year 2007 in VAPI GIDC, 3rd phase.

The annual turnover of the company is round about 4 to 5 cr.

Product being manufactured in plant listed below-

1] Reactor

2] Storage tank

3] Pressure vessel

4] Condenser &heat exchanger

5] Reboiler

6] Column etc

Machinery available in company-

1] TIG welding machine set up

2] MIG welding machine

3] DC rectifier welding machine

4] Lathe machine 20foot and 14foot

5] Overhead crane-10tone and 6tone

Fig 1.4- Sai Ratna Engineering and Fabricators, Vapi

1.5 Product detail-

A Receiver is made with a one cylindrical shell and both side 10% torisperical dish end provided.

The main application of receiver is to receive the chemical or liquid from the distillation column and transfer to the storage tank with the help of vacuum pump. This receiver used as the top production receiver in the chemical plant that’s why this material corrosion resistance properties is high compare to other material used.

(A) (B)

Fig 1.5 –(A),(B) Image of the top production receiver

The above fig 1.5 (A),(B) shows the image of the top production receiver.

1.5.1 Product specification:

The below table 1.1 gives the specification of top production receiver.

Table 1.1 Receiver specification

Receiver specification	
Inside Diameter(mm)	800
Shell height(mm)	970
Thickness (mm)	6 mm
Limpet coil	80%
pressure	0.8 N/mm^2
Density of material	8 gram/cm^3
Joint efficiency	0.75
Nozzle pipe	Shedual 40

1.5.2 Manufacturing step for Receiver :

Mainly eleven steps are followed by the industry for making the top production receiver and this step listed in the below fig 1.6.

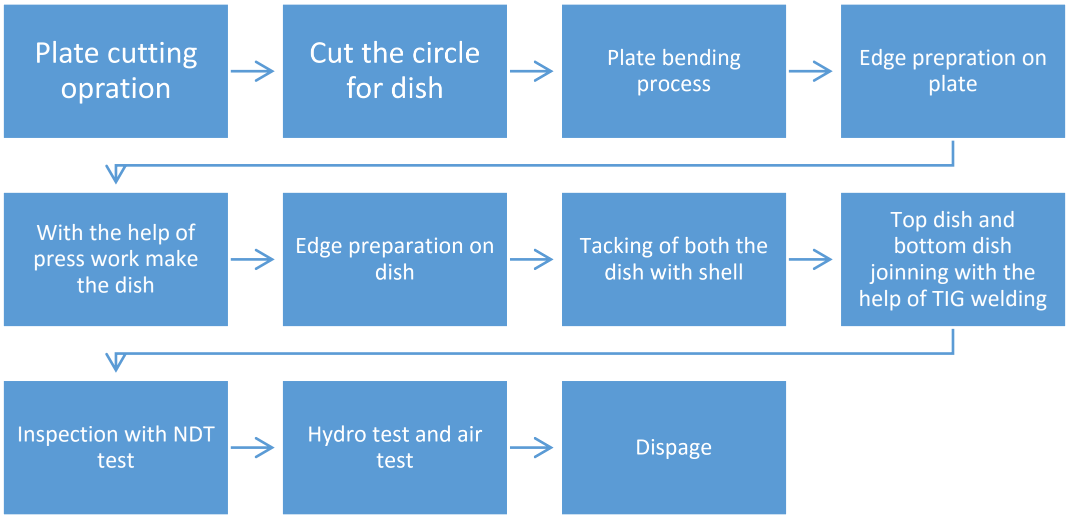


Fig 1.6-Manufacturing steps for making receiver

1.5.3 Material selection:

AISI SS317L material is used for manufacturing the top production receiver because compare to other material it has high resistance to corrosion and also have some good mechanical properties to other material. It comes under the ASME specification SA-240.

It has also the good percentage of Cr, Ni ,Mo compare to other material that why it is mostly used in the food processing industry, chemical plant, and also processing equipment of Pharmaceutical company ,textile company etc. this material also used at high elevated temperature and also the good fabricability.

The AISI SS317L content Carbon (C), Manganese(Mn), Phosphorus(P), Sulphur(S), Silicon(Si), Chromium (Cr), Nickel(Ni), Molybdenum(Mo), Nitrogen(N). The SS317L denoted by UNS number- S31703 Unified number system.

The mechanical test requirement of SS317L According to ASME SECTION-II-A (SA-240) listed in the below table 1.2 respectively.

Table 1.2- Mechanical properties of SS317L material [32]

Tensile strength;(min)		515 MPa
Yield strength; (min)		205 MPa
Elongation ; (min)		40%
Hardness (max)	Brinell	217
	Rockwell B	95

Chemical composition of SS317L 6 mm thickness plate material according to ASME section 2(A) listed in the below table 1.3.

Table 1.3–Chemical composition of SS317L plate material [32]

Element	Content (%)
Carbon (C)	0.03
Manganese(Mn)	2
Phosphorus(P)	0.045
Sulphur(S)	0.03
Silicon(Si)	0.75
Chromium (Cr)	18-20
Nickel(Ni)	11-15
Molybdenum(Mo)	3-4
Nitrogen(N)	0.10

The mechanical test requirement of ER-317L filler wire according to ASME section II (C) shown in below table 1.4.

Table 1.4-Mechanical properties of ER-SS317L filler wire [36]

Tensile strength;(min)	Ksi	83
	MPa	572
Elongation (min)		39
Heat treatment		none

Chemical composition of ER-SS317L according to ASME section 2 (C) listed in the below table 1.5.

Table 1.5- Chemical composition of ER-SS317L Filler wire [36]

Element	Content (%)
Carbon (C)	0.03
Chromium (Cr)	18.5-20.5
Nickel(Ni)	13-15
Molybdenum(Mo)	3-4
Manganese(Mn)	1-2.5
Silicon(Si)	0.30-0.65
Phosphorus(P)	0.03
Sulphur(S)	0.03

CHAPTER – 2

Literature Review

2.1 Problem Identification:

GTAW welding process is mostly used for join the similar and dissimilar welding in fabrication and chemical &Parma plant respectively. This welding process is need of the current fabrication industry market for economical fabrication with improve mechanical property of joint and quality of welding, good aesthetic appearance of welding joint.

Just suggesting correct parameter range ,which has given in standard but does not do the job totally in fabrication industry but industry need justification and also follow standard like ASME section IX,ASME section X etc. It comes with the experiment and testing particularly for specimen of joint .And also quality that industry want like aesthetic appearance and required mechanical property of joint in accordance with the TPI requirement.

The main aim of this research project has been study similar metal joining using the filler metal ER SS 317L. The higher current in TIG welding may be lead to spatter and due to the lower current the tungsten rod must be stick with the work piece and work piece become damage. Finally due to the improper amount of gas flow rate the weld puddle get tabulated and pinhole generated on the weld joint and due to the high current rang undercut is clearly visible that why not good aesthetic appearance. This joint not pass in RT test according to the TPI requirement and it's dependent on the joint efficiency (e) of the job.

To improve the mechanical property of weld joint by changing the rang of input parameter.

2.2 Literature Review:

Ramazan yilmaz et.al [1] investigated that the AISI 304L end AISI 316L types of austenitic steel welded by the GMAW using only ER316LSi filler wire and GTAW using ER 308L and ER 316L filler wire respectively step by step to perform the experiment. They do some DT test for to test the Mechanical properties of 304L and 316 austenitic stainless steel weldments such as tensile strength, hardness and impact properties were investigated by them respectively. Higher tensile strength was achieved for the weldment of both 304L and 316L austenitic stainless steel GTAW comparing with the weldment by GMAW in accordance with the DT test.At the other side, higher toughness value obtains from the weldment by GTAW process in compare with GMAW process respectively.

Nabendu Ghosh et.al [2] they have researched that Welding of dissimilar joints between AISI 409 ferrite stainless steel and AISI 316L austenitic stainless steel, is made by GMAW (Gas metal arc welding) using SS 316L as filler metal and then perform some DT and NDT test respectively. Welding has been conducted as per the design of experiments TAGUCHI methodology L9 orthogonal array is used to optimize the parameter.

Then after the three levels of the input parameters: welding current, gas flow rate and nozzle to plate distance, have been selected for the performing the experiment. After the DT test has been done among the nine different samples, the best result was obtained from Sample number 3 Corresponding to current 100A, gas flow rate 20 l/min and Nozzle to plate distance 15 mm respectively. Particularly for this sample the DT test result will be ultimate tensile strength = 468.7 MPa and Yield strength= 335.9 MPa respectively. The worst result in tensile testing has been obtained for sample Number 8 corresponding to current 124A, gas flow rate 15 l/min and nozzle to plate distance 9 mm for this sample the DT test result will be yield strength 233.4 MPa and Ultimate tensile strength 366.6 MPa of the weld joint respectively.

P.Bharath et.al [3] they had explains the effect of different input welding parameter on the pool geometry of the SS316 weld joint with follow some ASME standard. He do the different experimental tests to determine the proper input range of current, speed, and root gap respectively for getting good mechanical properties. Then after an ANNOVA technique is used to determine the most effective parameter current and speed, mathematical model is created by Minitab 17 software and optimization is done by this software respectively. Some DT test is done named by Band test and the tensile test for getting the mechanical properties of joint. At the end of the experiment with the help of ANOVA it is found that welding speed (46.51% commitment) has a more noteworthy impact on twist quality of the joint and current (96.75%) has a most elevated impact on rigidity quality of the weld joint respectively.

Subodh Kumar et.al [4] he investigated that the influence of different input welding parameter on stainless steel and do the microstructural development test and do the tensile strength test to check the mechanical performance of the joint respectively. Gas tungsten arc welding (GTAW) process was used to weld 6mm thick AISI 304L stainless steel using three levels of heat inputs and do the experimental work. The result of the experiment conclude that the weld metal under low welding heat input condition gives relatively fine columnar dendritic microstructure which resulted in high micro hardness result and good impact toughness of this zone particularly. Form the below fig 2.1 micrographs weld cross section it was clear seen that with the increase in the heat input the reinforcement was increased.

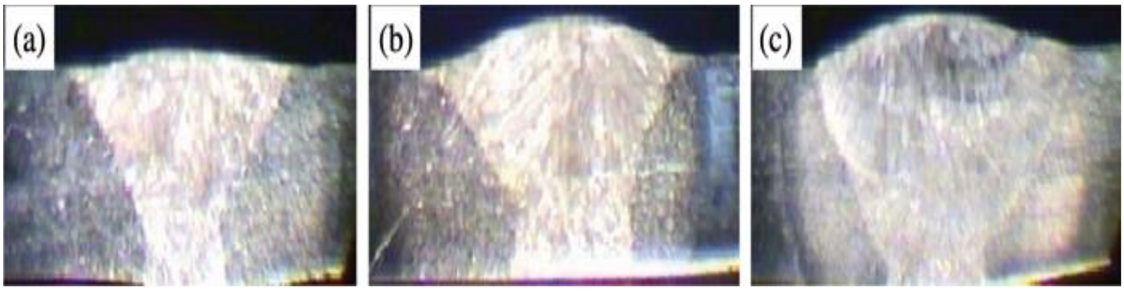


Fig 2.1 micrographs image at different heat input respectively-(0.88 KJ/mm),(1.154 KJ/mm),(1.474 KJ/mm)[4]

A.R.Khalifeh et.al [5] In this present experiment work was done by welding an austenitic stainless steel (AISI 304L) and a ferrite carbon steel (St37) welded by GTAW welding process using four different austenitic filler wire, name by ER308L, ER309L, ER316L and ER310 respectively. It was found from the experiment that the increase in the amount of delta ferrite content in the microstructure of the weld metals, causes in the decrease of the impact toughness energy of the weldments respectively from the experiment.

A.Moteshakker et.al [6] they had done the experiment to find out the good mechanical properties of dissimilar weld joints between SAF 2205 and AISI 316L welding joint respectively. For this experiment different types of welding filler wire like AWS ER

347, AWS ER 316L and AWS ER 309L wear used respectively. After that Micro hardness test and tensile tests were done to evaluate the hardness of the weld metal toward both sides of the weld joint and to determine the tensile strength of the weld joints and achieve the desired mechanical properties. After that the results of the NDT test shows no internal discontinuity, especially cracks, and lake of fusion present in the weld joint. The weld metals of all samples exhibited higher hardness values compare with the AISI 316L base metal and lower values compare with the SAF 2205 base metal respectively.

Ahmet Durgutlu et.al [7] In this present study, the effect of hydrogen with argon as shielding gas with different propagation was investigated by GTAW welding of AISI316L stainless steel respectively. They examined the microstructure of the weld joint, penetration and perform DT test for mechanical properties of the weld joint. Then after Pure argon, 1.5%H2–Ar and 5%H2–Ar different propagation were used as shielding gas respectively to perform the test. The best result of DT test was obtained from the sample which was welded under the given condition shielding gas of 1.5%H2–Ar respectively. The DT test result shown-the ultimate tensile strength was 695 N/mm2 and yield strength is 415 N/mm2, and elongation 42% during his experimental work perform in UTM machine.

Mehdi Safari et.al [8] In this research paper dissimilar welding of Incoloy alloy 825 and AISI 316 stainless steel tubes is welded by GMAW welding process respectively. For this experiment work different filler wire such as ER308L, ER309L, ER316L and Inconel 82 filler wire are employed for joining of Incoloy alloy 825 and AISI 316 tubes respectively for doing the experiment. Then after the results of tensile tests showed that dissimilar welding which has been produced by ER309L filler wire gives the maximum tensile strength 566MPa compare with other welding specimen. At the other and the Inconel 82 filler metal has the lowest tensile strength 429MPa compare with the other welding specimen. With the filler wire ER309L and filler wire Inconel 82 had maximum and minimum Vickers hardness 192 and 150 respectively form the experiment.

Subodh Kumar et.al [9] In this research paper the Influence of heat input on the microstructure and mechanical properties of GTAW welding of 304 stainless steel joints was studied for this experiment with different input parameter rang selected for it. After that the three heat input combinations was used as low heat 2.563 kJ/mm, medium heat 2.784 kJ/mm and high heat 3.017 kJ/mm were selected for the experimental work by using GTAW welding process and weld joints made using these combinations were subjected to microstructural study and also the tensile strength to analyze the mechanical properties of the weld joint under study respectively. Fig 2.2 shows the Vickers hardness (HV) vs. distance from the weld center.

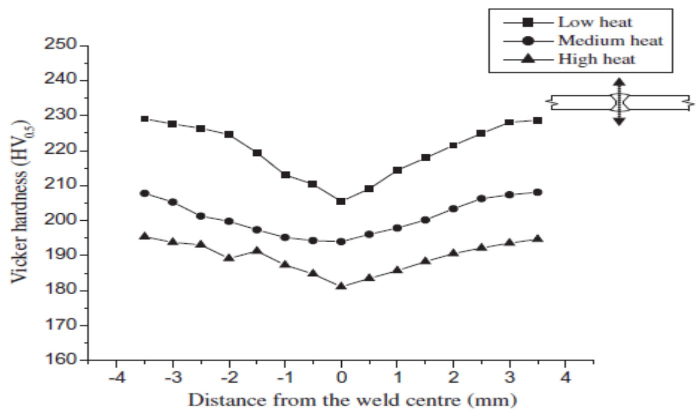


Fig 2.2 –Vickers hardness (HV) vs. distance form weld Centre [9]

K. V. Satheesh Kumar et.al [10] In this present experimental work the influence of different shielding gas composition on the mechanical properties of AISI 316L was investigated form the different combination of input parameter. Then after the selection of the input parameter shielding gases and current both are the most influencing parameter to achieve the good mechanical properties of the weld metal joint. In this experimental work the influence of four various shielding gas composition used for getting the good mechanical properties compare to other. It was carried out for the both GMAW and GTAW welding for 3 and 6mm thick plates respectively for doing the experiment. Form the experimental work this combination gives the best result Ar 92% and CO2 8% for the tensile test and hardness test.

M. Ahmadi et.al [11] In this experimental work, the microstructure study and mechanical properties of the weld metal and also the corrosion resistance properties of AISI 316L austenitic stainless steel to ASTM A335P11 low alloy steel dissimilar welding joints under the investigation. Then after for this purpose, these two filler wire

ER309L and ERNiCrMo-3 were selected to be used with the GTAW welding process to do the experiment on this dissimilar joint. After that the maximum impact fracture energy and micro hardness values were obtained from using this filler wire named by ERNiCrMo-3 while performing the experiment. At finally the corrosion resistance test shows that the maximum result achieved using the ERNiCrMo-3 filler wire compare to ER309 filler wire the corrosion result is best for the first one.

R. Prabhu et.al [12] By read this research paper knowing the effect of process parameters on ferrite number during AISI317L cladding by the Pulsed MIG welding process respectively. Then after the ferrite number was measured with the help of the Fisher's ferrite scope particularly for this experimental work.

RSM methodology was used to predict and develop the mathematical model for the identification of most influences process parameters such as welding current, welding speed and contact tip to work distance effects on ferrite number identification respectively from the experimental work. Fig 2.3 and fig 2.4 shows the 3-D surface plot and interaction effect.

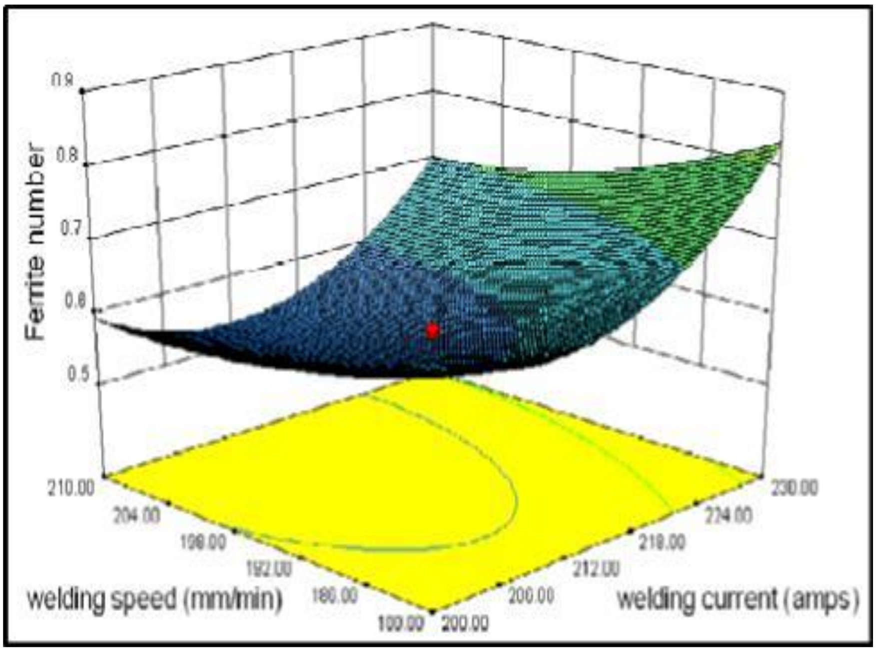


Fig 2.3 -3D surface plot showing the interaction effect of current and speed on ferrite number [12]

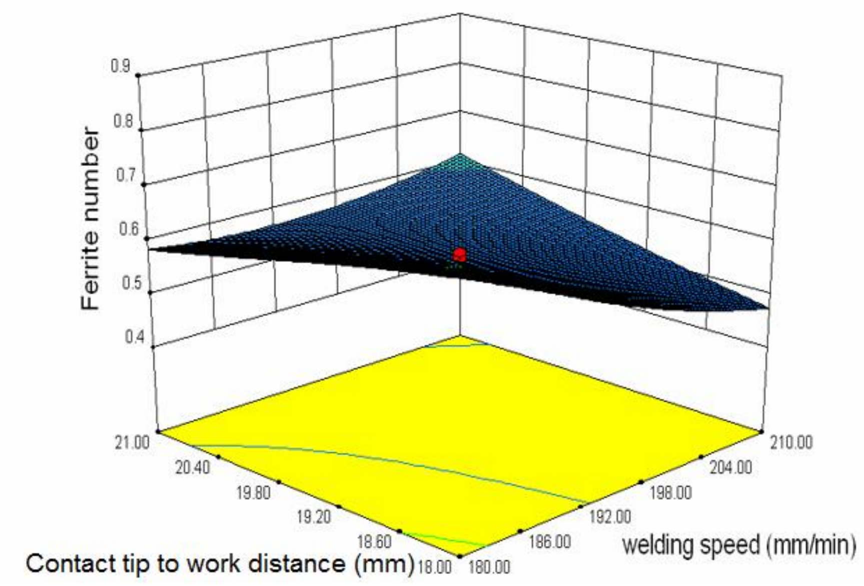


Fig 2.4 -3D surface plot showing the interaction effect of speed and contact tip to work piece distance on ferrite number [12]

Nabendu Ghosh et.al [13] he gives the review to study and also analyze the effects of input welding parameters such as welding current, gas flow rate and nozzle to plate distance on mechanical properties of AISI409 ferrite stainless steel to AISI 316L Austenitic Stainless Steel by using the welding process metal inert gas welding process respectively. L9 orthogonal array is used for the experimental work. The sample Number 1 Corresponding to current 100 A, flow rate 10 L/min and Nozzle to plate distance 9 mm and for this sample DT test result shown- ultimate tensile strength = 421.742 MPa and Yield strength = 266.322 MP gives the best result among all respectively .

Ramesh Kumar Buddu et.al [14] In this research work multi-pass GTAW welding process is used for joining the AISI SS316L material round about 40 to 60 mm thick plate for vessel application .Then after the NDT test has been done for measure the sub surface discontinuities like RT test and UT test respectively. The DT test is done named by tensile test, bend tests, Vickers hardness and impact fracture tests have been carried out particularly for the welding sample for testing. The higher tensile strength is achieved for both 60mm and 40mm thickness plate respectively and also the side bend test shows that no crake on the weld surface is observed. Finally the impact facture energy of WZ was less compare to base metal and heat effected zone respectively good result obtain form the experiment.

V Anand Rao et.al [15]In this present study of work the parameters like current, filler materials, welding speed are selected for the experimental work to be perform with the ease. One DT test named by tensile strength and also bend test was done in this experimental work. After that the result wear obtained from the experiment work shown: welding current 120A and filler wire ER309L has produced greater tensile strength of 454.6MPa and while a welding current 80A and filler wire ER316L has produced minimum tensile strength of 51.79MPa for the specimen studied under the tensile strength respectively. Form the experimental work the bend test results -welding current :120 A and filler wire ER316L has produced maximum bending strength of 646.55MPa and at the other end while the same welding current with electrode ER347L has produced minimum bending strength of 211.37MPa achieved form the experimental work respectively. The filler wire ER309L has produced good tensile strength and bending strength compare to other filler metal during the experimental work.

Navid Moslemi et.al [16] In this present experimental study, 316 stainless steel pipes with the od 73 mm and the thickness of the pipe was 7mm welding with the GTAW welding process used respectively. Then after the different current settings were used to obtain the maximum joint mechanical properties and also minimize defects in the welding of the pipe joint that due to defect cost was increase gradually. Some DT test also perform to test the Mechanical properties of the welded alloys were carried out tensile strength and hardness of the welded joint respectively. Then after the DT test result obtains from the experiment shown: arc current of 100A has identified as the most influencing current that gets the highest tensile strength among all the rest of the specimen respectively.

Hongbin Dai et.al [17] In this present study the author has considered some most important input Welding parameter such as welding current, Arc length, angle of tungsten, Shielding gas flow rate, and Welding speed as input process parameters for the experimental work should be carried out to perform some mechanical test. Then after form the experimental work the result they get the distribution of the current density on the weld joint was more uniform under the different ratios of helium + argon used as shielding gases for the experimental work according to the software experimental setup respectively.

Ario Sunar Baskoro et.al [18] In this research paper the researcher had given the main most effective parameter used in the experimental work like: Position of magnets, magnetic poles Configuration, Category based on arc phenomenon, and also the where the magnet should be put that means Distance between magnets while doing the experiment. Then after he reveal that using an external permanent magnet in the experiment, power consumption can be reduced dramatically and due to this overall efficiency is increased for the experiment to be perform respectively. We can concluded that with the help of reduction in power consumption, the penetration of the welding can be improved with the ease during the experiment. Fig 2.5 shows the experimental set up for the project work.

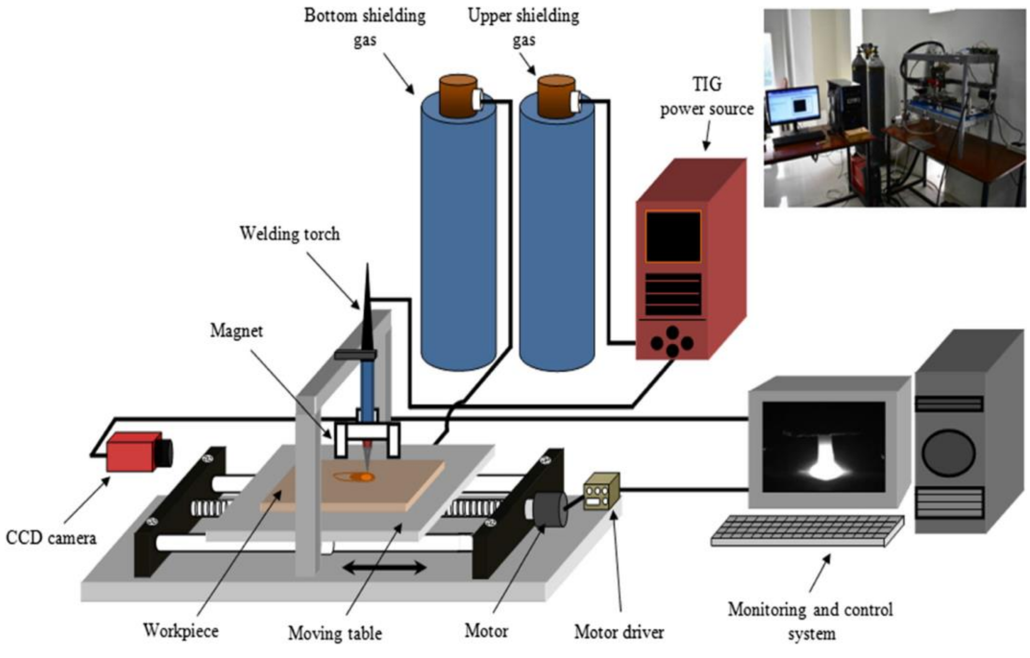


Fig 2.5 Schematic diagram of experimental set up [18]

Wichan Chuaiphan et.al [19] The researchers done dissimilar welding of AISI 304 stainless steel and AISI 201stainless steel with the different most effective input parameter for performing the experiment respectively. Then after from the experiment result, they concluded that if the increase of the welding speed results in a lower heat input compare to the other specimen and also they conclude that decreases in the width of the weld at the other side increases depth per-width ratio respectively while doing the experiment.

A. A. Shukla et.al [20] In this experiment the researchers have used the SMAW welding process for welding the similar material AISI 1020 stainless steel respectively. The output resultant parameter for the experiment was depth of penetration by using the RSM method form the design of experiment in Minitab software. Then after the input parameters which they had selected for the experimental work that wear polarity, welding current and also electrode angle particularly for the work. Form the experimental work the researcher, get the result that the best polarity to achieve maximum penetration during the welding was Direct Current Electrode Negative (DCEN) that means the earthing was connected to positive terminal and also they concluded the most suitable electrode angle is 90 degrees with the suitable current with respect to it was 120A respectively.

B. P. Agrawal et.al [21] In this investigation the authors had used the material AISI304 thin sheet round about 2 mm Thickness was used for the experimental work with GTAW pulsed welding was used for the work. After doing the experiment it was concluded that the GTAW pulsed welding was suitable for weld the 2 mm thickness sheet with no defect observed. They have also concluded that the current was the most effective parameter for getting higher tensile strength and speed was the most effective parameter for getting higher bend strength among all the specimen.

Ajay kumar et.al [22] In this experimental work researcher has investigated the metal deposition rate of SS 304 plate welded by GTAW welding process respectively. The TAGUCHI methodology was used to optimize the input process parameter like Current (A), Gas Flow Rate (L/min), Root Face (mm) and also Welding Time (sec) from the different DOE method. From the experimental work they concluded that the current and root face affects more the output parameter deposition rate very highly. So that finally from the experimental result the most effective input parameters setting shown: current (A), gas flow rate (L/min), root face (mm) and welding time (sec) are 90, 2,2,95 respectively.

Chun-Ming Lin et.al [23] this research work is totally based on based on the GTAW clad welding process as Inconel 52M as interlayer material and austenitic stainless as the main material for the whole experimental work respectively. By gone through the number of experiment they gives the conclusion that the hardness value decreased as the number of cladding layers increased, due to change in microstructure of the cladding specimen respectively.

S. P. Gadewer et. al [24]this research work is based on the welding of austenitic stainless steel SS304 specimen welded by the gas tungsten arc welding process respectively. For the experimental work they used the input parameters like Welding current[A], Gas flow rate[L/min], and also thickness 1mm, 2mm, 3mm for getting the good mechanical properties. The experimental result shows that, due to the increase in the welding current the heat input also increasing respectively. For increasing the heat diffusion rate the gas flow rate must be increase result getting from the experimental work.

Ugur Esme et. al [25] In this experimental research work both DOE method is used one was TAGUCHI methodology used with the Grey relation analysis and welding process used mane by GTAW accordingly.1.2 mm thickness of the SS304 sheet was used for the experimental work. From the experimental work it was concluded that the due to the less amount of gas flow rate porosity was generated in the weld joint of the sheet and also for controlling the heat input speed and current both wear the most effective input controllable parameter. Table 2.1 shows the process parameter and their limits.

Table 2.1 –Process parameter and their limits [25]

Parameter	**Notation**	**Unit**	**Factor of level**			
			1	2	3	4
Travel speed	V	Mm/s	1.06*	1.99	2.31	3.55
Current	I	A	40*	55	55	85
Gas flow rate	F	l/min	8*	10	10	14
Gap distance	G	mm	1.5*	2	2	3

S. P. Lu et.al [26] This experimental research work is totally based on the effect of oxygen content when it was used with the helium as shielding gas and the output parameter was weld shape in ultra-deep penetration, the specimen was welded by gas tungsten arc welding process respectively. After the doing the experimental work they gives the result that the oxygen was the surface-active element that why small amount of the oxygen content added with the helium gas as the shielding gas used in GTAW welding process. Form the experimental work they concluded that He–O2 shielding gas used in GTAW welding process the liquid pool convection was mostly governed by the Marangoni force respectively.

2.3 Research gap:

1. As per the first hand information collected form the industries and exhausted literature survey the following search gap are identified.

2. Establish the relationship between TIG welding input parameter and expected output of the mechanical properties of 6 mm thickness SS317L receiver.

3. Need the standard procedure of welding.

4. Identify the process parameter to solve the problem.

2.4 Summary of literature review:

1. From the above literature review conclude that for achieve required good mechanical properties of weldment the most effective input process parameter like current, gas flow rate, included angle wear essential and also these wear available in the ASME section IX QW-256 WPS for GTAW welding.
2. And also with the controllable heat input is the maximum tensile and hardness of the material was achieved.
3. By observed most of the research paper heat input increase –hardness decrease – tensile strength decrease respectively.

Table 2.2 - Relationship between input controllable parameters and output result from literature review

INPUT PARAMETER	OUT PUT RESULT
Current(A)	Most influencing parameter for getting higher tensile strength
Speed(mm/sec)	Most influencing parameter for getting higher bend strength
Heat input increase(KJ/sec)	Hardness and tensile strength decrease
Low heat input(KJ/sec)	Hardness and tensile strength increase
Ferrite content increase	Impact energy decrease, hardness and tensile strength decrease
Increase Gas flow rate(L/min	Increase depth of penetration and the bed width, and Height Decrease

The above table 2.2 shows the relationship between input controllable parameter and output result from literature review. Some other things that if the ferrite content increase the hardness and tensile strength of the weldment increase. If the higher current observe the toughness decrease and ferrite content increase [6].

2.5 Objectives:

1. To evaluate the process parameters for AISI SS317L material.
2. To analyze the impact input of process parameters such as current, gas flow rate and, included angle on tensile strength and hardness of the weld joint.
3. To optimize the process parameters with the help of taguchi method.
4. To give the WPS model with the experimental work particularly for the material SS317L.

2.6 Specification of welding machine:

This arc welding rectifier machine manufactured by BEST TECHNO CRATE PVT.LTD. This arc welding rectifier machine manufactured at Mansarovar complex Vadodara, Gujarat. The below figure 2.6 shows the TIG welding machine used in Sai ratna engineering & fabricators vapi.

Figure 2.6 – TIG welding machine

Table 2.3 shows the specification of TIG welding machine.

Table 2.3 -Specification of TIG welding machine

Term	Value
Company name	BEST TECHNO CRATE PVT.LTD
Model number	MALUV-400
Frequency	50Hz
Phase	3ø
Cooling medium	Air
Tare weight	200Kg
Polarity	DCEN
Cooling for torch	Water cooling

CHAPTER – 3

METHODOLOGY

The showcased below are the step followed during the entire project study in company:

1. Perform pilot tests particularly for checking the feasibility of the material during the welding of it.
2. Selection of input and output process parameters for getting the good mechanical property and optimization of this input parameter.
3. Create Design of Experiments (DOE) using 3*3 Taguchi method for the optimization of input parameter.
4. Perform the experiments respectively using the selected values of input parameters.
5. Inspection and testing of the experimental samples for tensile strength and Hardness testing of the weldment sample.
6. Generate mathematical equations by regression analysis for the Taguchi model respectively.
7. Optimize of the input parameters and compute the values of output parameters for the same for getting the better result.
8. Carry out sample weld using the optimized input parameters and test it for the tensile strength and hardness of the weldment.
9. Compare and validate results respectively in MINITAB software.
10. Identification of plate material and grade by Optical Emission Spectrometry and also identification of filler wire chemical composition.

The figure 3.1 shows the flow chart of the entire work done during the Dissertation study.

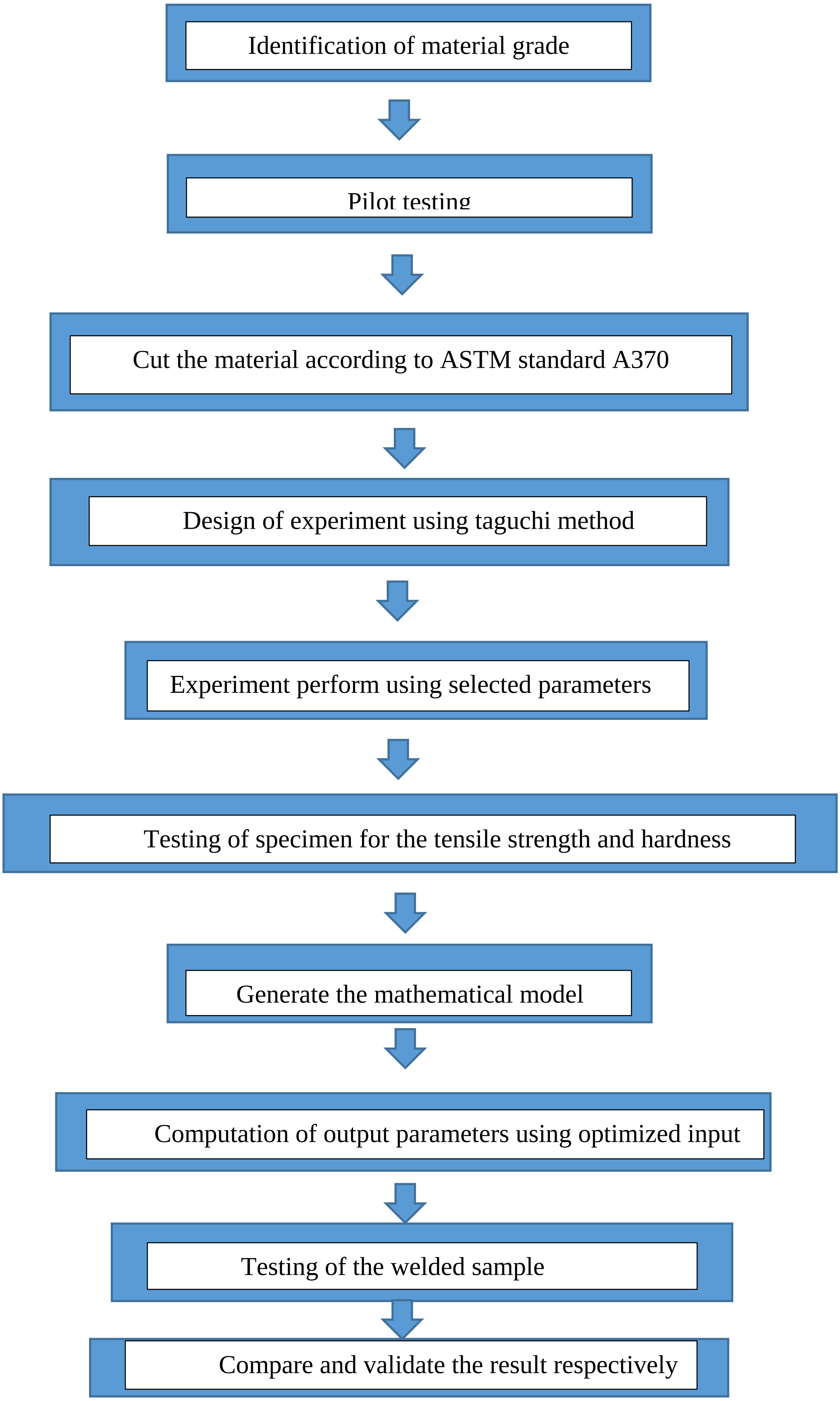


Fig 3.1-Flow chart for entire work

3.1 Identification of Plate Material:

The identification of the base material SS 317L was important in order to know the chemical composition and mechanical properties of the base material respectively. The certificate or test report given below accordingly. The test was done by Vapi METALLURGICAL SERVICES at Ani steel compound, 1st Floor, 2nd phase GIDC, Vapi. The Material is meeting the requirements of chemical composition of SS317L Material. The fig 3.2 shows the material test report for AISI SS317L material.

VAPI METALLURGICAL SERVICES

METAL TESTING LABORATORY

Phone : 9824712912
9825009768
9925039768
(0260) 2400220

Ani Steel Compound, 1st Floor, Plot No. 145/B, 2nd Phase, Nr. Hotel Tulsi, 3rd Phase Road, G.I.D.C., Vapi - 396 195 | Email : vmsvapi2009@gmail.com

TEST REPORT **WO:** 94/12 **SrNo.**1 C/1 30-Cr

Name of The Customer : PRASHANT PANDYA
SONAM APPARTMENT, OPP TARAKUND,
SALIM GENERAL STORE, VALSAD

Test Report No.:362-ZB/2019
Date :31/12/2019
Date of Receipt:30/12/2019

Particular of Sample : 6MM THK PLATE CUT PC.

Material Specification : AISI-317L

Identification Of Sample : ---

Type of Test Required : Chemical Analysis [SPECTRO FE BASE] By E-1009:1995
Equipment Used: Make: SHIMADZU, Model: OES-5500 II
(Sr no.: B-15044200035)

Customer's Ref. No. : CHALLAN NO: -----, DTD: 30/12/2019

Result :

	Obtained Value	Required Value
%CARBON(Cr)	0.018	[0.030 Max]
%NICKEL(Ni)	11.479	[11.000 - 15.000]
%CHROMIUM(Cr)	18.181	[18.000 - 20.000]
%MOLYBDENUM(Mo)	3.045	[3.000 - 4.000]
%MANGANESE(Mn)	1.858	[2.000 Max]
%SILICON(Si)	0.393	[1.000 Max]
%PHOSPHORUS(P)	0.032	[0.045 Max]
%SULPHUR(S)	0.002	[0.030 Max]

Above result are meeting with Chemical requirements of AISI-317L Specification in respect of test carried out.

-----------x---------

VAPI METALLURGICAL SERVICES VAPI

Tested By **Authorised Signatory** **Witnessed By**
K.B.Tandel (QM) / A.M.Dave(MD)

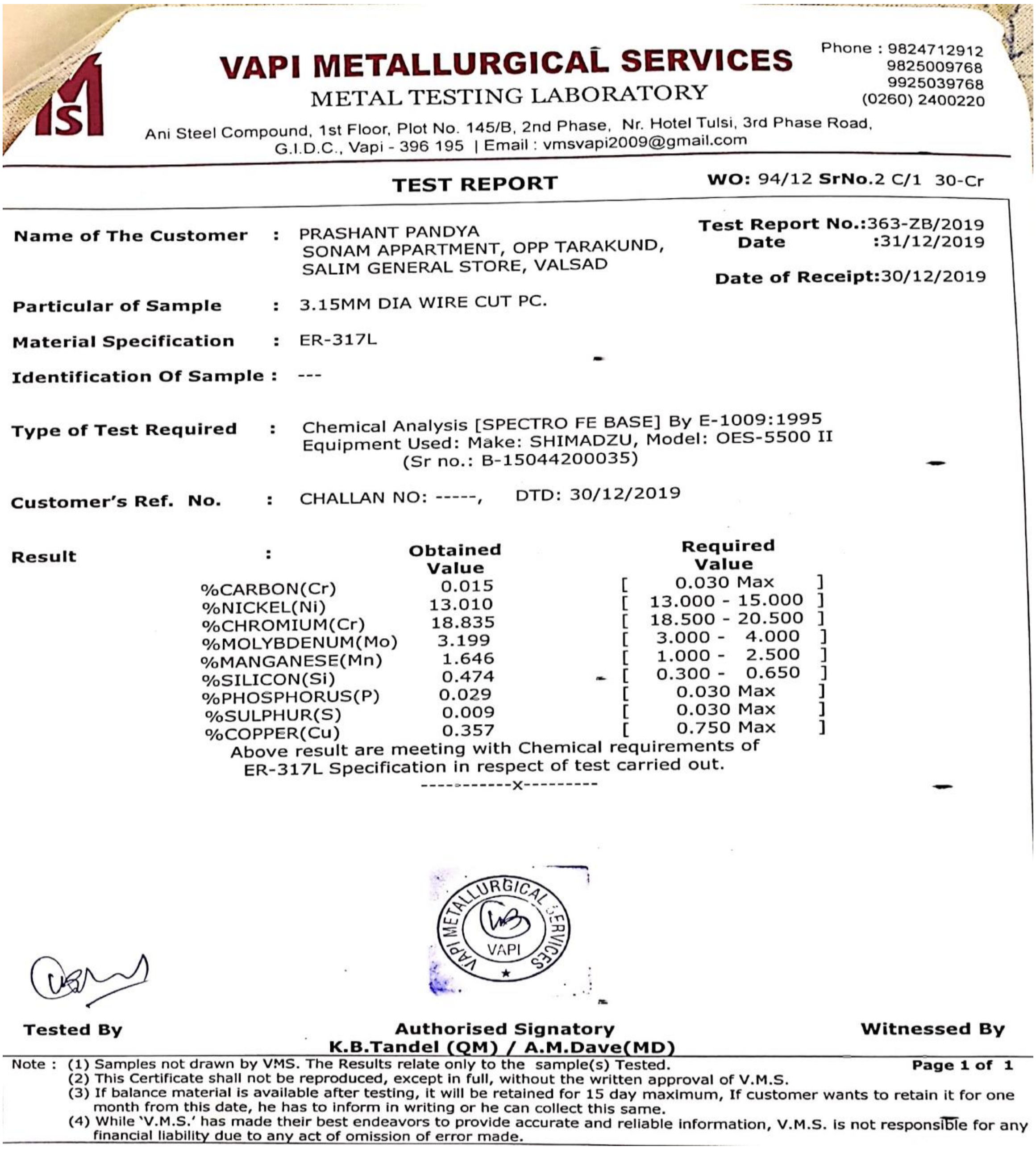
Note : (1) Samples not drawn by VMS. The Results relate only to the sample(s) Tested. **Page 1 of 1**
(2) This Certificate shall not be reproduced, except in full, without the written approval of V.M.S.
(3) If balance material is available after testing, it will be retained for 15 day maximum, If customer wants to retain it for one month from this date, he has to inform in writing or he can collect this same.
(4) While 'V.M.S.' has made their best endeavors to provide accurate and reliable information, V.M.S. is not responsible for any financial liability due to any act of omission of error made.

Fig 3.2- SS 317L material test report

3.2 Identification of Filler Wire:

The identification of filler wire ER SS317L was imported in order to know the chemical composition. The certificate or the test report given below accordingly. . The test was done by Vapi Metallurgical Services at Ani steel compound, 1st Floor, 2nd phase GIDC, Vapi, Gujarat.

This filler wire is meeting the requirements of chemical composition of ER SS317L Material respectively according to ASME section 2(C). The Fig 3.3 shows the filler wire chemical test report meeting the requirement of ER SS317L.



VAPI METALLURGICAL SERVICES
METAL TESTING LABORATORY
Phone : 9824712912, 9825009768, 9925039768, (0260) 2400220
Ani Steel Compound, 1st Floor, Plot No. 145/B, 2nd Phase, Nr. Hotel Tulsi, 3rd Phase Road, G.I.D.C., Vapi - 396 195 | Email : vmsvapi2009@gmail.com

TEST REPORT — **WO:** 94/12 **SrNo.**2 C/1 30-Cr

Name of The Customer : PRASHANT PANDYA, SONAM APPARTMENT, OPP TARAKUND, SALIM GENERAL STORE, VALSAD
Test Report No.:363-ZB/2019
Date :31/12/2019
Date of Receipt:30/12/2019

Particular of Sample : 3.15MM DIA WIRE CUT PC.

Material Specification : ER-317L

Identification Of Sample : ---

Type of Test Required : Chemical Analysis [SPECTRO FE BASE] By E-1009:1995, Equipment Used: Make: SHIMADZU, Model: OES-5500 II (Sr no.: B-15044200035)

Customer's Ref. No. : CHALLAN NO: -----, DTD: 30/12/2019

Result :

	Obtained Value	Required Value
%CARBON(Cr)	0.015	[0.030 Max]
%NICKEL(Ni)	13.010	[13.000 - 15.000]
%CHROMIUM(Cr)	18.835	[18.500 - 20.500]
%MOLYBDENUM(Mo)	3.199	[3.000 - 4.000]
%MANGANESE(Mn)	1.646	[1.000 - 2.500]
%SILICON(Si)	0.474	[0.300 - 0.650]
%PHOSPHORUS(P)	0.029	[0.030 Max]
%SULPHUR(S)	0.009	[0.030 Max]
%COPPER(Cu)	0.357	[0.750 Max]

Above result are meeting with Chemical requirements of ER-317L Specification in respect of test carried out.
-----------x---------

Tested By — **Authorised Signatory** K.B.Tandel (QM) / A.M.Dave(MD) — **Witnessed By**

Note : (1) Samples not drawn by VMS. The Results relate only to the sample(s) Tested. **Page 1 of 1**
(2) This Certificate shall not be reproduced, except in full, without the written approval of V.M.S.
(3) If balance material is available after testing, it will be retained for 15 day maximum, If customer wants to retain it for one month from this date, he has to inform in writing or he can collect this same.
(4) While 'V.M.S.' has made their best endeavors to provide accurate and reliable information, V.M.S. is not responsible for any financial liability due to any act of omission of error made.

Fig 3.3-ER 317L filler wire test report

3.3 Pilot testing:

The pilot testing of proposed method has been done on SS317L bead on plate for fining the proper range of input parameters at Sai ratna engineering fabricators at vapi GIDC 3rd phase. Pilot test carried out on bead on plate.

The experiment having current 115A, 130A, 145A, 160A, 175A respectively and the gas flow rate changes to 8 L/min to 16 L/min respectively. The below table 3.1 shows the pilot value experiment table obtain form the TAGUCHI method.

Table 3.1- Pilot value experiment table form using taguchi method

SR no	Current [A]	Gas flow rate[L/min]
1	130	8
2	130	10
3	130	12
4	130	14
5	130	16
6	145	8
7	145	10
8	145	12
9	145	14
10	145	16
11	160	8
12	160	10
13	160	12
14	160	14
15	160	16
16	115	8
17	115	10
18	115	12
19	115	14
20	115	16
21	175	8
22	175	10
23	175	12
24	175	14
25	175	16

(A)

(B)

(C)

(D)

(E)

Fig 3.4-(A), (B), (C), (D), (E) Pilot test carried out on bead on plate

The above fig 3.4 shows that the pilot experiment was carried out on bead on plate for find the range of the current and gas flow rate. The range of included angle selected form the ASME section IIX Div-2 respectively.

Range find out from the pilot value experiment is listed in table 3.2-

Table 3.2-Input parameters range from pilot experiment

Parameter	Range	
	Low	High
Welding current [A]	130	160
Gas flow rate[L/min]	10	14
Included angle[Degree]	45	75

CHAPTER – 4

Design of Experiment

4.1Experimental Design:

Design of Experiments (DOE) or we can say Experimental Design is a procedure under SPC (Statistical Process Control) respectively. In this procedure, different experimental design are utilized for getting the better result. These experimental design are also can demonstrated mathematically to optimize the parameter. There are mainly three type of experimental design are available respectively.

1. Full-factorial Method
2. Response Surface Method
3. Taguchi Method

4.2 Taguchi Method:

This Statistical technique of design of experiments or we can say DOE method including different factors was first created by Englishman, Sir R. A. Fisher respectively. The technique is generally known as the factorial design of experiments respectively.

A full factorial design will recognize by its every combination for a given set of factors Accordingly. A full factorial design results are getting but large number of experiments Carried out for it compare to other DOE method.

The technique of choosing a limited number of experiments which delivers the more information is known as a partial fraction experiment respectively.

Taguchi Method is most preferred method, among all because less number of experiments is carried out particularly for the dissertation work. That’s why Taguchi method gives the least experimental combinations among all.

4.3 Multi-level taguchi design:

For the experimental design, statistical analysis software Minitab version 17.0 was used particularly for the dictation work. In this software, the below fig 4.1 shows the section of Taguchi design form DOE.

Taguchi Method was selected from- start > DOE > Taguchi > Create Taguchi design.

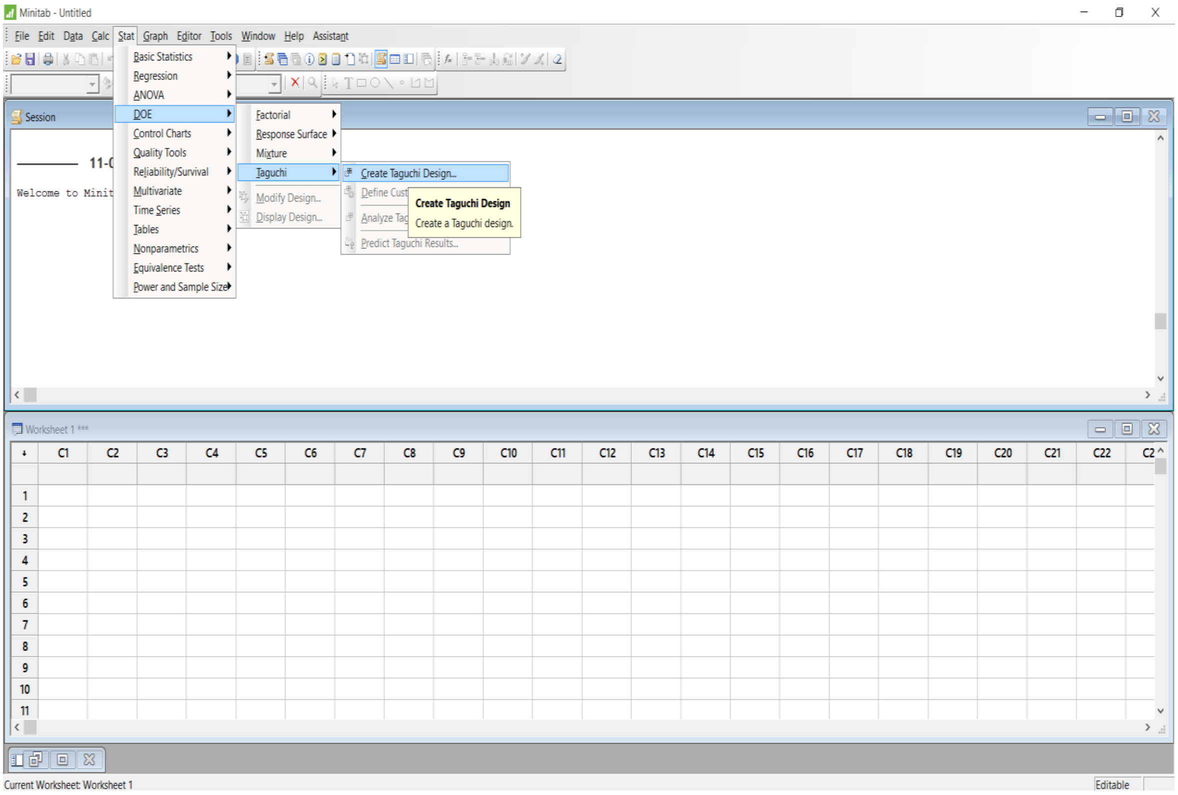


Fig 4.1-Selection of taguchi design

Then after open the menu will be popped-up which will ask for number of level Design as shown in screen respectively. Then By default, type 2 has been displayed on the screen. Then after Select number of level as 3 and select number of factors are 3 respectively. And then after click on ‘OK’ button for further.

The below figure 4.2 shows the select the number of level and factor form the display block.

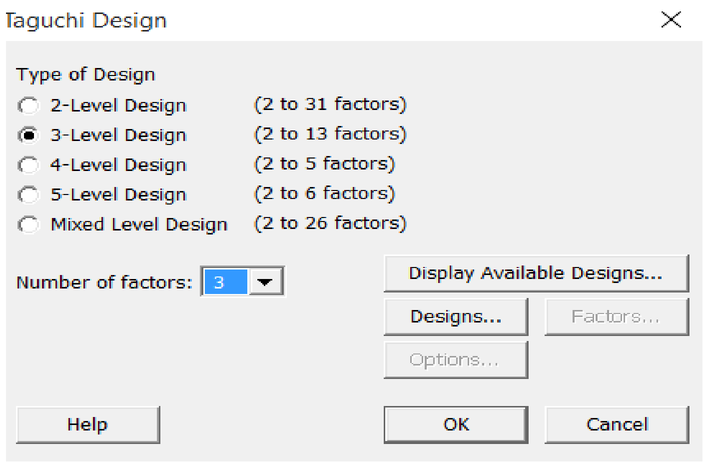


Fig 4.2- Select the number level and factor from block

Then go in "Display available Design" as shown below Fig. 4.3 and select the level 3 in L9 type design and then go on OK button for the further step as shown below.

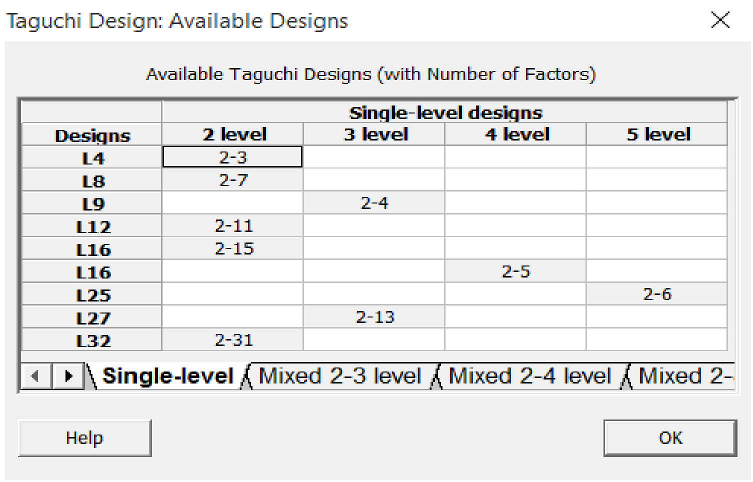


Fig 4.3- Select 3 level and L9 type design for experiment

Then click on 'design' option and for further select L9 runs [3^3 columns] that means factor [level] and click on OK button for complete the task.

The Fig. 4.4 shows that the L9 orthogonal array selected form the display block and 3^3 columns.

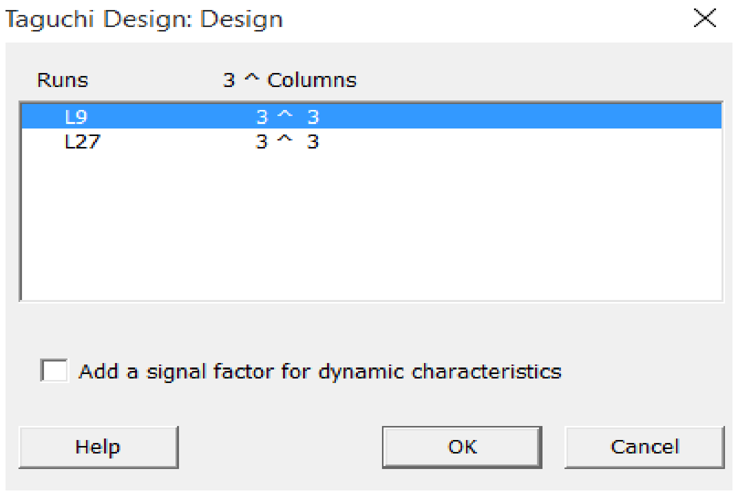


Fig 4.4 - Select L9 from runs and 3^3 columns

Then go to factor and click OK button and put the name of input parameters and assign value to them then click on OK button for further step. Fig. 4.5 shows that three factor and level the factor wear assign.

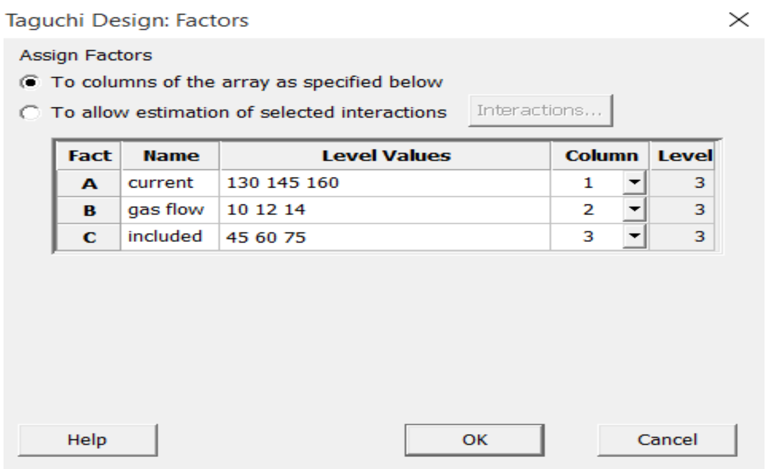


Fig 4.5 - Taguchi design factor and assign value

4.4 Experiment design combination:

After giving Input values in the software windows, then after the experimental design combinations as per the software run order are given accordingly. The experimental design combination was essential because according to that the experiment should be performed.

Table 4.1-Experimental combination from Minitab software

Run order	Welding current	Gas flow rate	Included angle
1	130	10	45
2	130	12	60
3	130	14	75
4	145	10	60
5	145	12	75
6	145	14	45
7	160	10	45
8	160	12	75
9	160	14	60

The above Table 4.1 represent the experimental design combination obtain form software. Notice that totally 25 experiment are performed in industry for the pilot value experiment and for check the tensile strength and hardness 9 specimen was prepared in industry.

4.5 Experiment procedure:

After making the experimental design combinations from the Minitab software 17 version, experimental work is done accordingly.

This includes some following things:

• Assumptions for doing the experiment

• Preparation of specimens according to standard

• Preparing the machine for the experiment

• Then performing experiments according to run order design by Minitab software

• Testing specimen according to the ASTM standard requirement

4.6 Assumptions:

Before preparing the specimen for welding and also for performing the experiment we have going to assume some things for the ease of the experiment and analysis through Minitab software version 17.

✓ Tungsten Electrode is perfect in shape.

- ✓ Working condition in the company are ideal.
- ✓ Welding machine should have calibration certificate.
- ✓ The plate having the homogeneous property.
- ✓ Worker has enough skill to operate the GTAW welding machine.
- ✓ There is no defect in 6 mm thickness plate material.

4.7 Tensile Specimen according to ASTM STD A370:

The tensile specimen prepared according to ASTM STD A370 for doing the tensile strength. The fig 4.6 shows the diagram of the tensile specimen according to Standard.

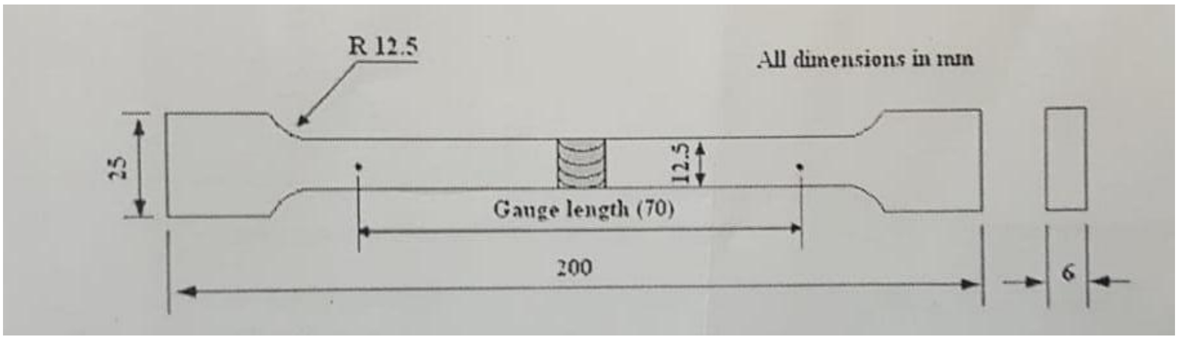


Fig 4.6 – Tensile specimen according to ASTM STD A370

4.8 Specimen preparation:

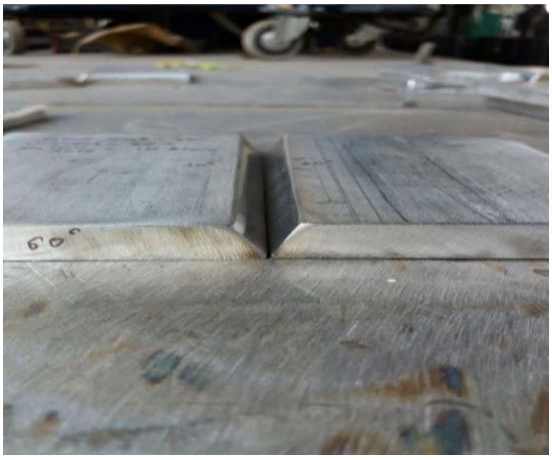
For the experimental work SS317L 6mm plate thickness is used. The work piece is first cut on the SAW cutting machine and fig 4.7 shows the WEP (weld edge preparation) on the shaper machine situated at the AU, Rajkot.

Fig 4.7- Weld edge preparation (WEP) on shaper machine

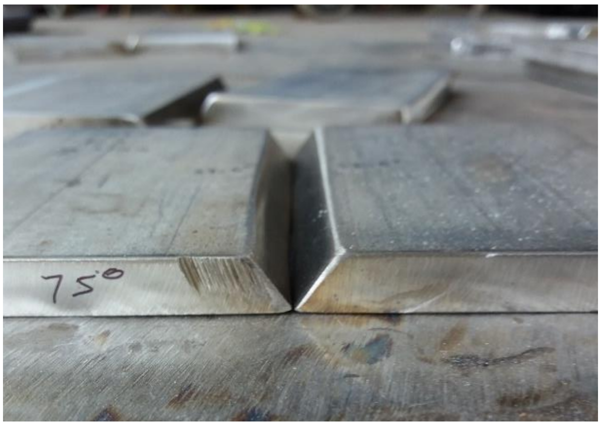
4.9 Performing experiment-

Experiments are performed in the industry name by Sai ratna engineering and fabricators, vapi. The fig 4.8 (A), (B), (C) represents the included angle 45˚, 60˚, and 75˚ respectively. After that the specimen wear welded according to the design block prepared by Minitab software version 17.

(A)



(B)



(C)

Fig 4.8 – (A), (B), and (C) included angle 45˚, 60˚, 75˚ respectively

The Fig. 4.9 shows the TIG welding set up for welding the test piece. Form showing the below figure DCEN (Direct current electrode negative) that means DCSP polarity is used for welding the SS 317L material.

Fig 4.9 – TIG welding machine setup

4.10 Welded specimen:

The below figure 4.10 shows that the specimen was welding according to run order generated by the Minitab software. For the experimental work total 9 specimen was prepare.

Fig 4.10 – Welded Specimen

4.11 Dye Penetrant Test:

To analyse the surface crack in the metal this Dye penetrant test (DP test) and other word is also called liquid penetrant test (LPT) respectively. Generally this technique is low costing testing method for finding the defects like surface cracks of the casting parts, welding joints, and also for the forging parts in the industry.

The procedure for doing the DP test find in ASME section X (Non-destructive testing) Particularly for finding the surface defects respectively.

4.11.1 Inspection steps for DP TEST

1. Pre-cleaning:

At first the test surface should be clean from dirt, oil, grease or any other material, which has been present on the surface of job to be tested and also prevent penetrant should be easy flow in cracks for finding defects. Cleaning of the surface can be done by cotton cloth, solvents, and also alkaline according to the consideration of application.

2. Application of Penetrant:

After pre-cleaning has been done, penetrant is applied to the surface to detect the surface defects. Penetrant is an oily fluorescent liquid. Penetrant has a low surface tension and also the capillary action for finding the defects. The dwell time is dependent upon the type of material to be tested and the dwell time is generally 5 minutes to 30 minutes respectively.

3. Excess Penetrant Removal:

After the dwell time has been completed, excess penetrant was removed from the surface of the job. According to the type of penetrant used the cleaning method was dependent upon on it. In most of the industries water-washable solvent is used for the surface cleaning purpose respectively. Remember note- the cleaner should not be apply on the test surface of the job.

4. Application of Developer:

After the excess penetrant was remove the white developer applied on the surface of the job. There are many developers available in the market like a non-aqueous wet developer, dry powder, waters spendable, and also water-soluble respectively. If the defect was present on the surface that was known as “bleed out”.

5. Inspection:

The inspector will use visible light for testing the defects. The inspection time is generally dependent on the developer and penetrant used it is generally 10 to 30 minutes after the developer applied on the surface of the job.

6. Post cleaning:

After the inspection and recording has been done the surface has been clean properly. And then after the post inspection coating process are schedule according to the requirement of the customer.

4.11.2 Advantages of Dye Penetrant Testing-

1) Speed of the test and the low cost technique for testing the surface defects.
2) Very less tanning is required for the operator for accomplished the test.

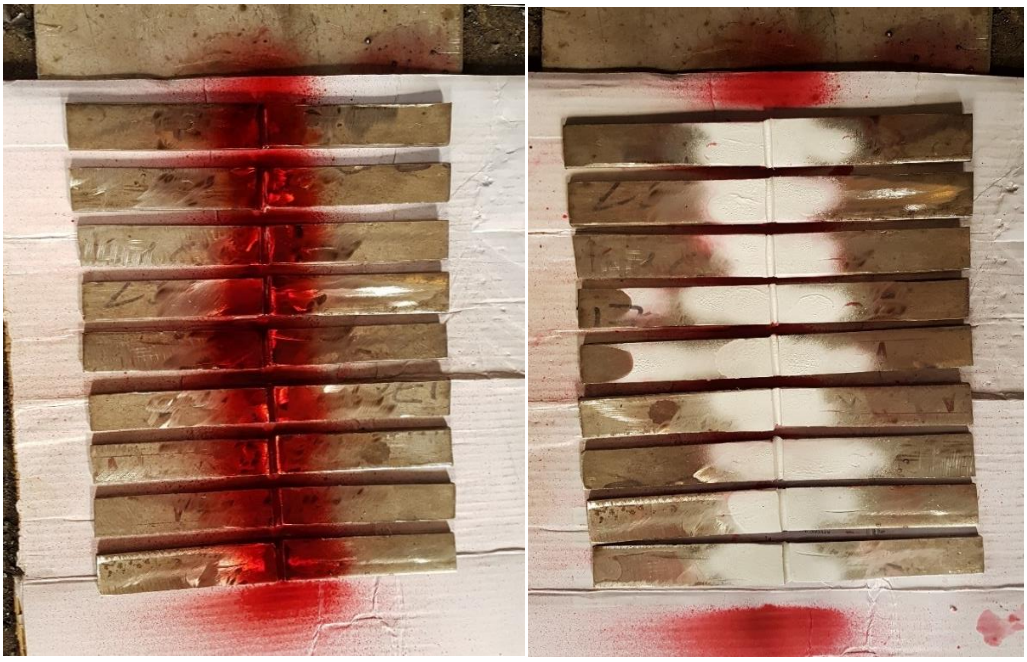
4.11.3 Disadvantages of Dye penetrant testing-

1. Dye penetrant is only used for detecting the surface flaws and skin irritation not for finding the defects in side of the surface mainly.

2. It is very difficult to conduct the test on irregular surface of the job and it could be result in false indications and test not carried out properly.

3. Surface contamination should be removed from the surface of the job that why cleaning and post cleaning are essential.

Fig. 4.11 shows that apply penetrant and developer on the surface to be cheak.



(A) (B)

Fig 4.11 – (A) Apply penetrant on the surface, (B) apply developer on surface

4.12 Hardness testing:

Hardness of the any material defined by ability to withstand the friction or we can say the abrasion resistance. Hardness is essentially measured to ensure that, the material is good enough to resist impact of external load which has been applied on weld joint respectively. For GTAW welding us measure the hardness of the weld joint form the extra discard potion is available for measuring the hardness. The test is done according to the ASTM standard E18-16 for Rockwell hardness test.

For the project work hardness test is done on hardness testing machine as shown in below figure available at AITS, Rajkot. Rockwell hardness test is used for the project work. The specification of hardness testing machine listed below-

Rockwell hardness test-

Force- 100 Kg

Indenter- 1/16 steel ball

Scale-HRB scale

Standard-according to ASTM e 18-16.

(A)

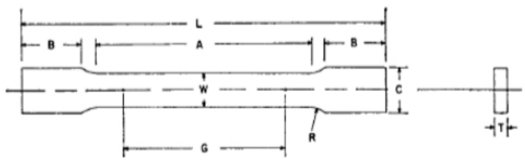
(B)

Fig 4.12 – (A) Rockwell hardness testing machine, (B) Performing hardness test at Atmiya University, Rajkot

4.13 Tensile test specimen:

For the project work tensile test is done at Rajkot Mat lab services, situated at opposite of Tulip party plot, near JCB showroom, Rajkot. The tensile test is done according to the ASTM stranded A370. According to this standard the work piece has been prepared for the tensile test. This test is carried out for checking the quality and strength of the joint. The model number of this UTM machine is **Model: TUTE-40 / SR NO: 2014/405.**

The below fig 4.13 shows the ASTM standard A 370 for tensile test.



DIMENSIONS

	Standard Specimens						Subsize Specimen	
	Plate-Type, 1½-in. (40-mm) Wide							
	8-in. (200-mm) Gauge Length		2-in. (50-mm) Gauge Length		Sheet-Type, ½ in. (12.5-mm) Wide		¼-in. (6-mm) Wide	
	in.	mm	in.	mm	in.	mm	in.	mm
G—Gauge length (Notes 1 and 2)	8.00 ± 0.01	200 ± 0.25	2.000 ± 0.005	50.0 ± 0.10	2.000 ± 0.005	50.0 ± 0.010	1.000 ± 0.003	25.0 ± 0.08
W—Width (Notes 3, 5, and 6)	1½ +⅛ −¼	40 + 3 − 6	1½ +⅛ −¼	40 + 3 − 6	0.500 ± 0.010	12.5 ± 0.25	0.250 ± 0.002	6.25 ± 0.05
T—Thickness (Note 7)					Thickness of Material			
R—Radius of fillet, min (Note 4)	½	13	½	13	½	13	¼	6
L—Overall length, min (Notes 2 and 8)	18	450	8	200	8	200	4	100
A—Length of reduced section, min	9	225	2¼	60	2¼	60	1¼	32
B—Length of grip section, min (Note 9)	3	75	2	50	2	50	1¼	32
C—Width of grip section, approximate (Notes 4, 10, and 11)	2	50	2	50	¾	20	⅜	10

Fig 4.13 - ASTM standard A370 for tensile test

The Fig. 4.14 shows the tensile test specimen prepared on the shaper machine according to the ASTM standard A370 respectively.

Fig 4.14 – Specimen for tensile test

Fig 4.15 (A),(B) shows the perform the tensile test at RAJKOT METLAB. And fig 4.15 (C) shows the specimen after tensile test.

(A)

(B)

(C)

Fig 4.15-(A), (B) Performing tensile test at RAJKOT METLAB (C)Specimen after tensile test

4.14 Tensile test and hardness test result-

The tensile test and hardness test was done according to the ASTM standard A370. And ASTM standard e 18-16 respectively.

The following table 4.2 is the result of both tensile strength and hardness of the weld-Metal.

Table 4.2- Tensile strength and hardness result

SR no	Current (A)	Gas flow rate(L/min)	Included angle(˚)	Tensile strength(MPa)	Hardness test(HRB)		
					BM	HAZ	WM
1	130	10	45	610.24	86	83	82
2	130	12	60	658.01	86	86	85
3	130	14	75	712.07	88	85	84
4	145	10	60	679.53	86	81	78
5	145	12	75	716.54	85	82	80
6	145	14	45	727.82	86	83	81
7	160	10	75	670.08	86	75	73
8	160	12	45	675.33	85	78	75
9	160	14	60	697.64	87	80	76

As per the above experiment it is clear that the best result is obtain form the sample number 6. Which has current-145A,gas flow rate-14L/min, and included angle 45˚ respectively that gives the maximum tensile strength round about 727.82 MPa and hardness value obtain 81(HRB) at weld metal.

Fig 4.16 load vs. displacement graph particularly for the sample no 6 show cased below-

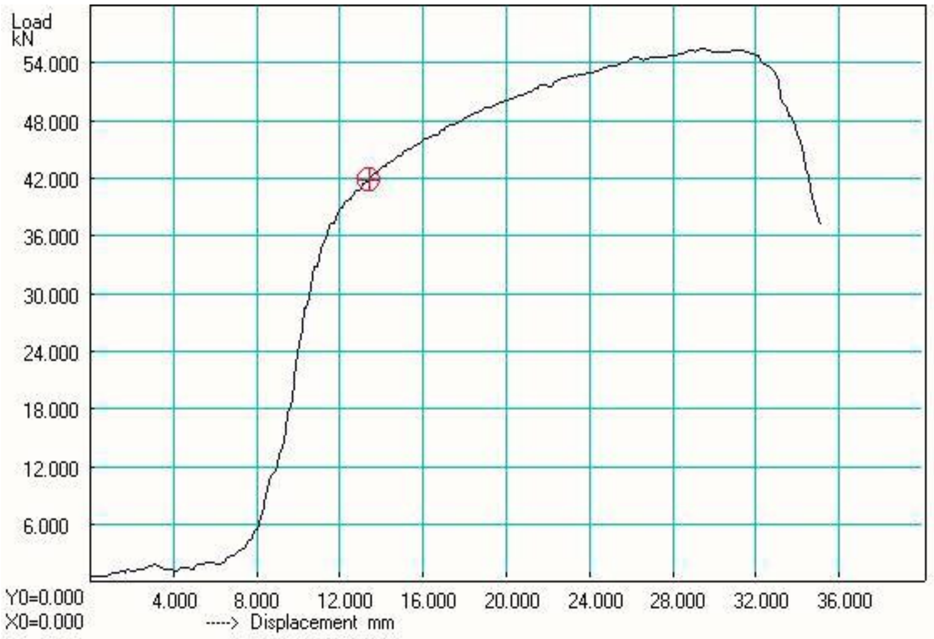


Fig 4.16–Load vs. Displacement graph for sample no 6

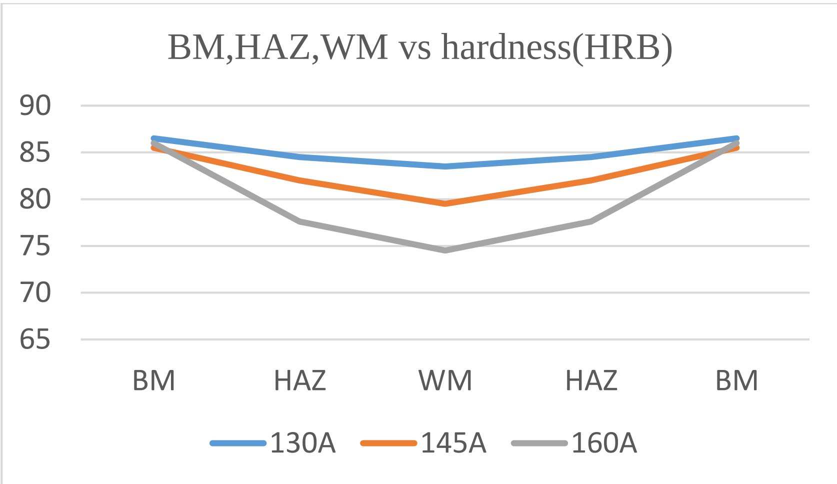


Fig 4.17–BM, HAZ, WM vs. hardness

Form above Fig 4.17 it is clearly seen that due to the increase in the current the harness value decrease towards to the WM. Because of the heat input increase the dendrite and inter dendrite spacing in the weld metal also increase due to the increased in current and cooling rate is slower which provides the ample time for dendrite to grow in to the fusion zone [9].And if the heat input decrease cooling rate is higher, lesser time for the dendrite to grow that why the hardness value is high at the WM [9].

CHAPTER – 5

Results and Discussion

5.1 Regression analysis:

The main aim or we can say the objective of regression analysis is to make an equation by utilizing the statistical techniques in Minitab software, which can used to predict the behaviour of a system or output with giving response to the input selected variable. It is also used for making the mathematical equation from the observation taken form the experiment and also based on the input which has been given to the particular system.

Based on relation regression analysis has two types listed below-

-Linear Regression

-Non-linear Regression

Generally the Linear regression used for giving the linear relationship between output variable and input variable particularly for one selected system to be observed.it is also possible that linear regression may have non-linear terms, but it has only linear relationship shows while giving the result. Non-linear regression analysis it gives the relationship between the output and input variable in terms of exponential, quadratic, and also logarithmic etc for doing the statistical analysis of the given system.

Generally for the linear regression analysis, there may be one or more output parameters was selected on the basis of the number of selected input parameter respectively. There are mainly two types of liner regression analysis shown below-

- Simple-linear Regression

-Multiple-linear Regression

If one can observed the system that has only one input variable that is called Simple-linear Regression and if there are more then on input variable in the system to observe that is called Multiple-linear Regression.

A simple regression analysis formula show cased below:

$Y = \alpha + \beta.x\,[n] + \varepsilon$…………………………………………………………....... (5.1)

Where, Y = Output Parameter of the system

α =intercept or Constant value or we can say Coefficient

β = slope or we can say the input variable coefficient

ε = non-measurable variables, which can't be included in system for analysis or we can say as error of the given system, n= n^{th} variable of the system respectively.

5.2 Analysis through software:

Minitab version 17 software for used for the analysis of the result. Go to the Minitab software and click on analyse the taguchi design show on figure 5.1.

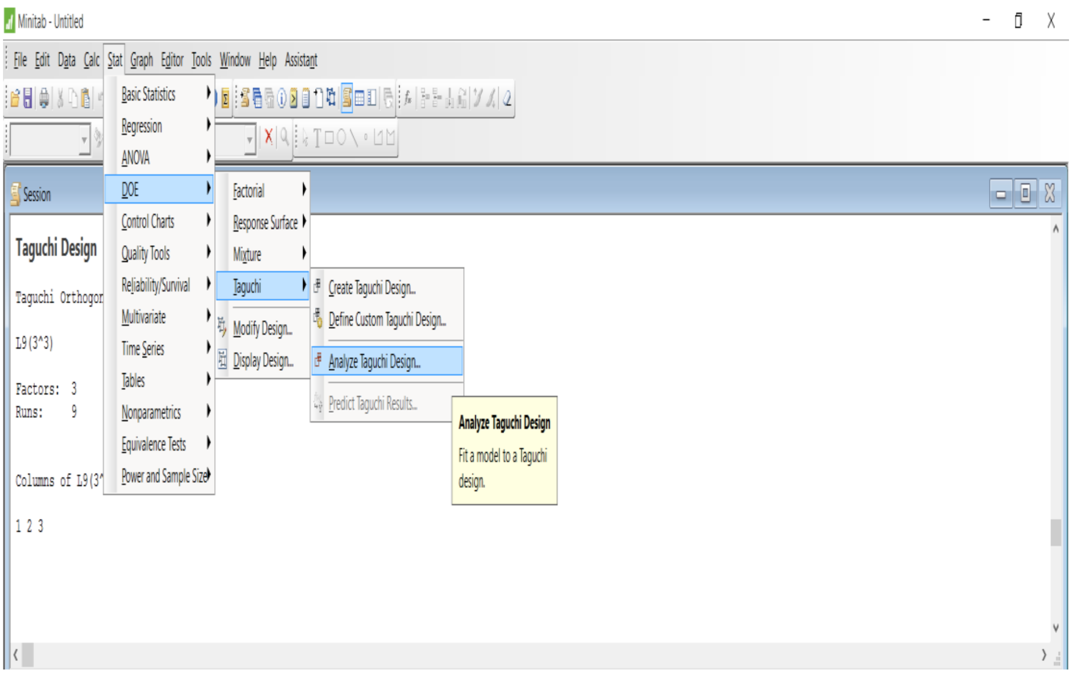


Fig 5.1 - Select the option analyse the Taguchi design

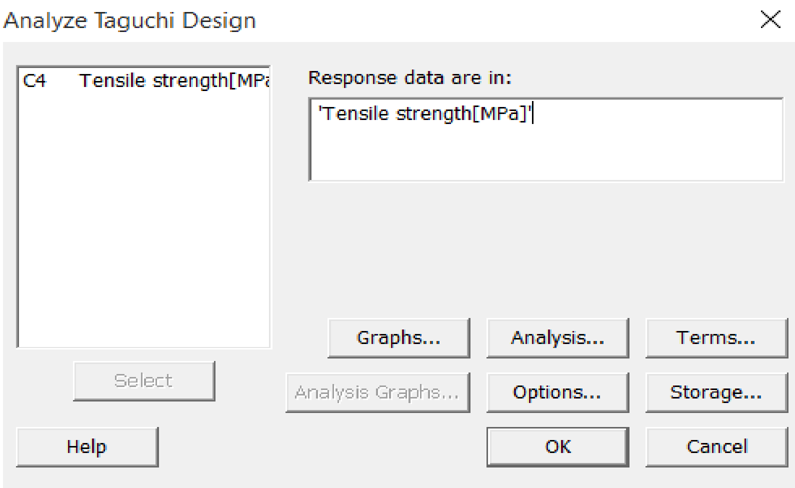


Fig 5.2 - Analyse Taguchi Design Menu for Tensile Strength

Form the above Fig.5.2 -After selecting the option the new menu will be open and select the tensile strength as output response for the further step.

Generally the output will be in the form of table with parameter and regression equation, and also the value or R-square, R-prediction, and R-adjacent respectively.

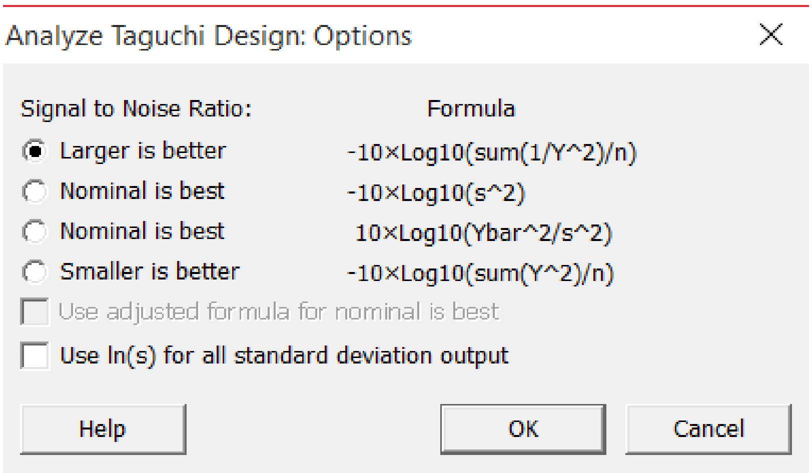


Fig 5.3- Analyse Taguchi Design Option for Tensile Strength

Fig.5.3 represent that for the tensile strength signal to noise ratio selected “larger is better” option because it will be gives the best output form all the result obtain form the test carried out.

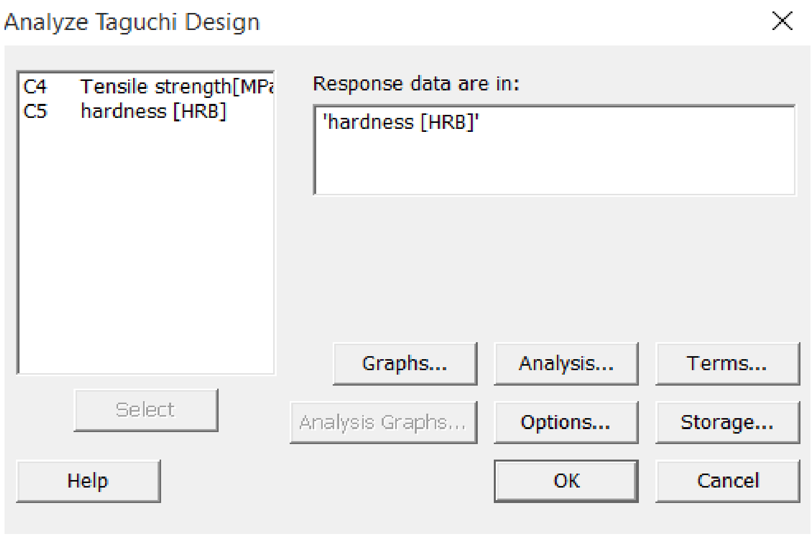


Fig 5.4- Analyse taguchi design menu for hardness

After selecting the option the new menu will be open and select the hardness (HRB) as output response for the further step as shown in fig 5.4 respectively.

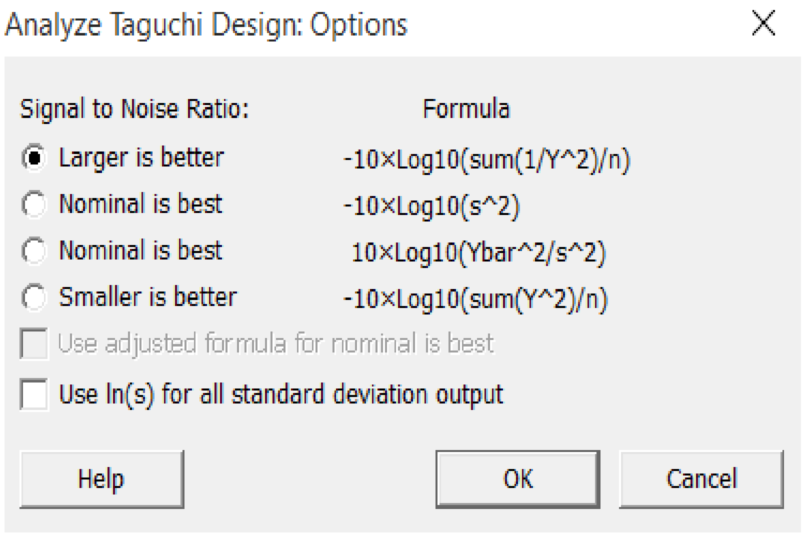


Fig 5.5- Analyse taguchi design option for hardness

Figure 5.5 represents that for the hardness test signal to noise ratio selected larger is better option because it will gives the best output form all the result obtain form the test carried out for the hardness.

5.2.1 Main effects plot for SN ratio-tensile strength:

The fig.5.6 represents the main effects plot for SN ratio for tensile strength.

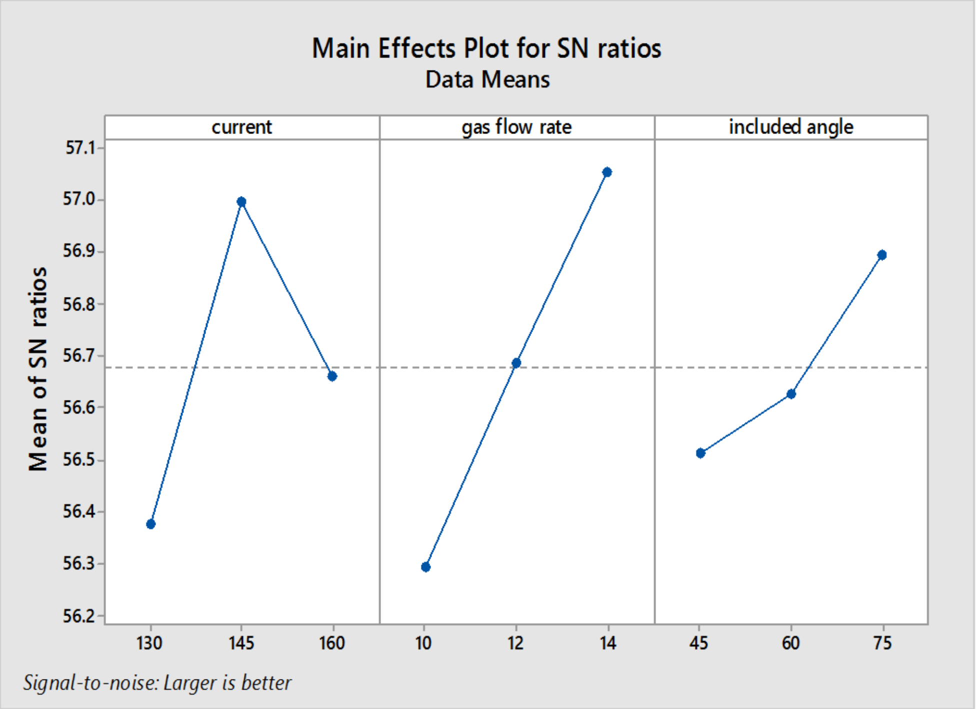


Fig 5.6- Main effects plot for SN ratio for tensile strength

The fig.5.7 represents the main effects plot for Means for tensile strength.

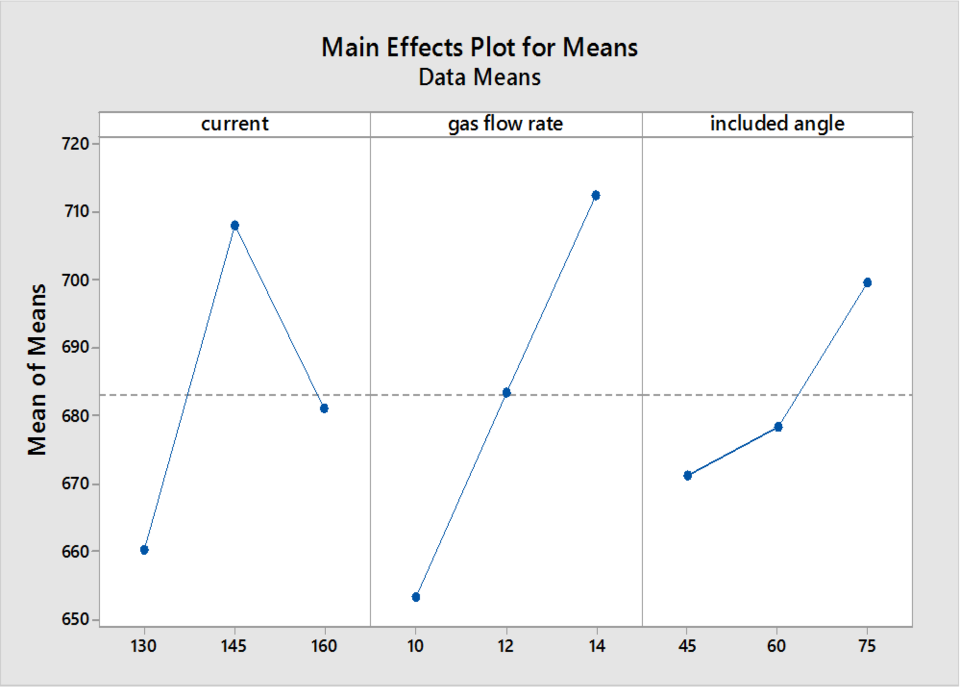


Fig 5.7 - Main effects plot for means of tensile strength

From showing both of the graph like Main effects plot for SN ratio for tensile strength and Main effects plot for means of tensile strength we can conclude that the gas flow rate effect the most among all the input parameter on the output response respectively.

5.2.2 Main effects plot for SN ratio-Hardness (HRB):

The Fig.5.8 represents the main effects plot for SN ratio for Hardness (HRB).

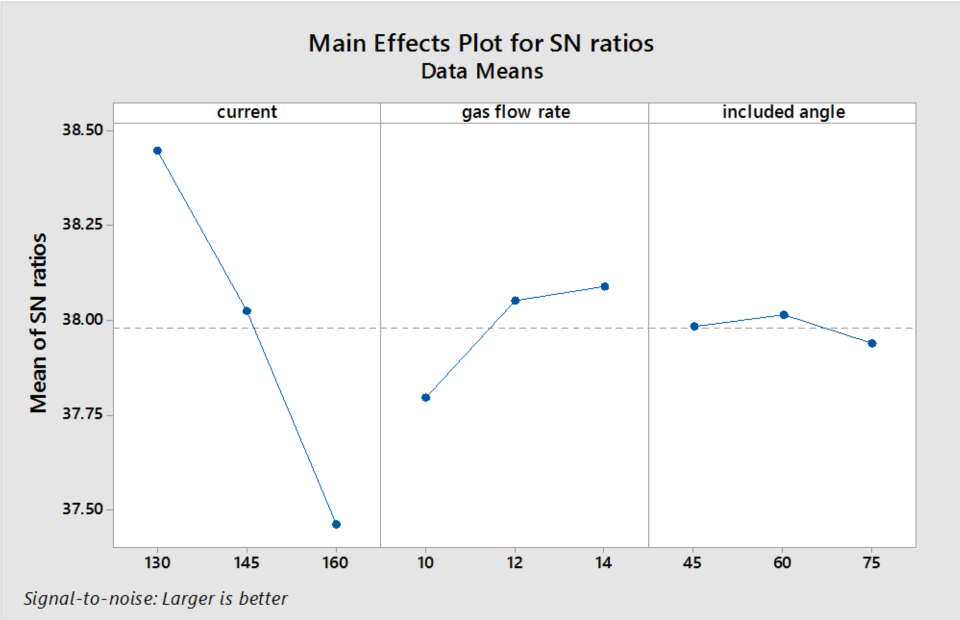


Fig 5.8- Main effects plot for SN ratio-Hardness (HRB)

The Fig.5.9 represents the main effects plot for Means for hardness (HRB).

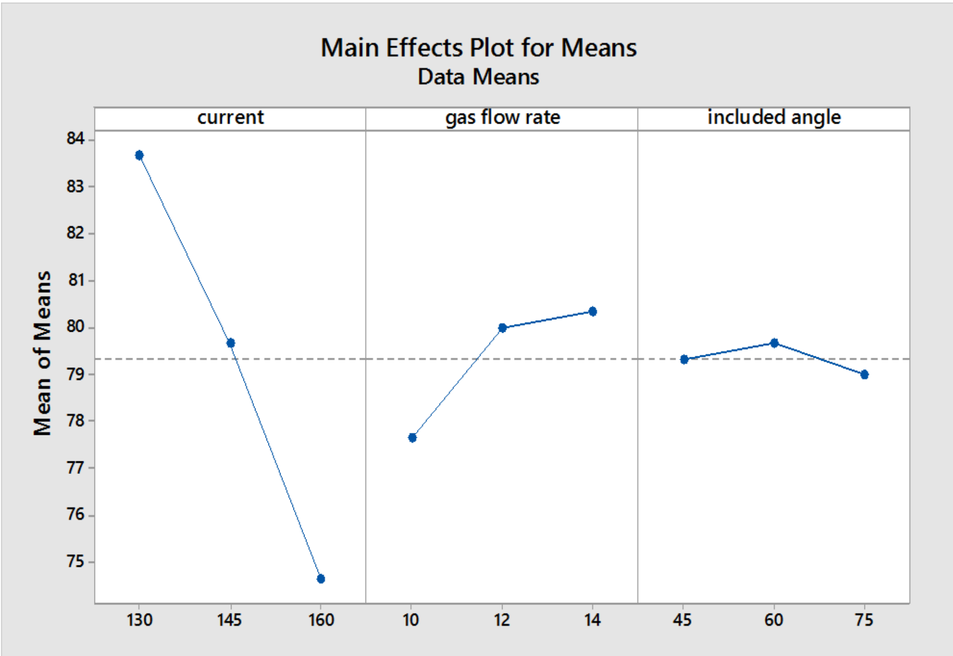


Fig 5.9- Main effects plot for SN means-Hardness (HRB)

From showing both of the graph like Main effects plot for SN ratio for hardness(HRB) and Main effects plot for means of hardness(HRB) we can conclude that the current effect the most among all the parameter on the output response.

5.3 Analysis Of Variance(ANOVA):

ANOVA or we can say Analysis of Variance is a method to determine the most effective influencing input parameter on the output variable and it is generally available in Minitab software. By doing the regression analysis we can get the P-value but generally it doesn't gives the much accurate result compare to analysis of variances.

In ANOVA technique, each term which has been present in the equation will be taken in to account while doing ANOVA analysis. The P-value which has been present in the given equation calculated each and every time in accordingly run order. In accordance with the hypothesis the P-value has been given by ANOVA.

95 % is selected as the confidence level for the equation given respectively. At the other side it means that if the P-value increase from 5% then with the ease we can reject this parameter influences. In other word if the P-value for any term in ANOVA analysis is higher than 0.05, so we can neglect the influences of that term with the ease and also the term taken out form the equation.

ANOVA is also helps to reduce the calculation time required for the equation to solve. And also ANOVA not only gives the impact of each and every term but also help us to remove the unnecessary term which has been present in the equation particularly.

Steps-

START>ANOVA>General liner model>Fit general liner model

5.3.1 ANOVA analysis for tensile strength and hardness:

Fig. 5.10 for the open ANOVA in Minitab software version 17.

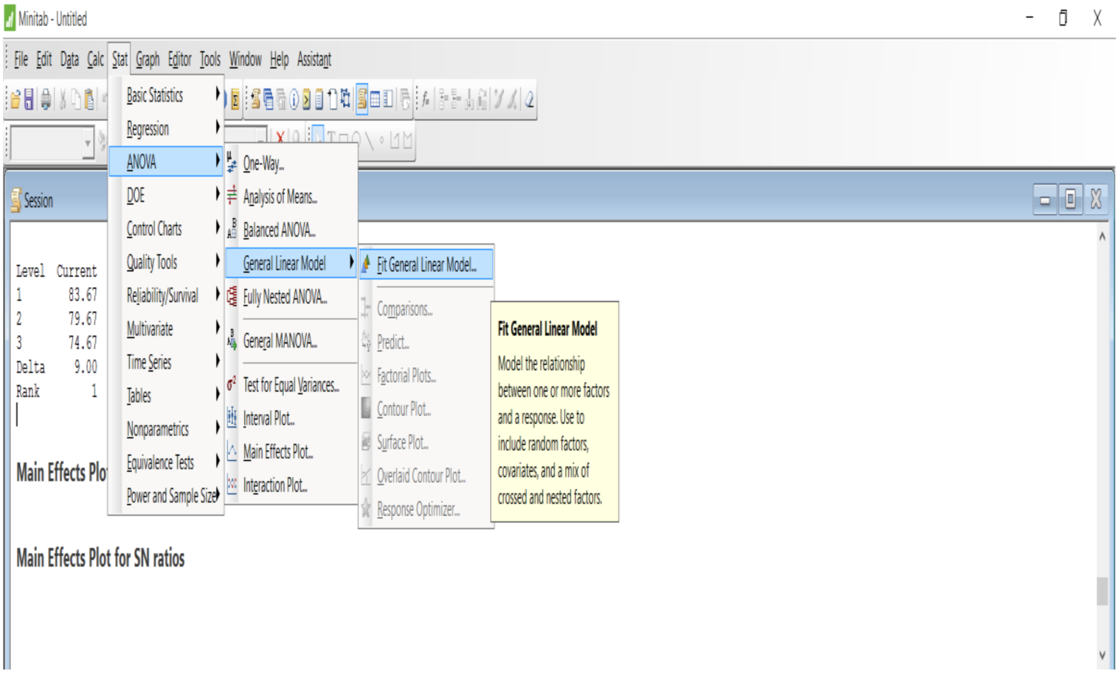


Fig 5.10 - Open ANOVA in Minitab software version 17

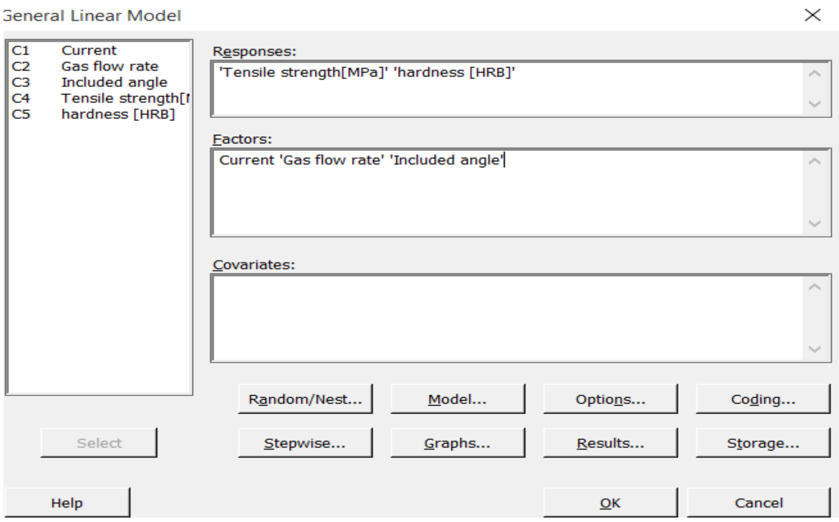


Fig 5.11 - General liner model

Form the Fig.5.11 it was clearly seen that the selection of Tensile strength and hardness(HRB) as the response variable and select factors like welding current(A) ,gas flow rate(L/min) and included angel(˚) respectively. After that click on the OK button and get the equation of both tensile strength and hardness (HRB) respectively form the Minitab software version 17.

Table 5.1– Analysis of variance tensile strength

Source	DF	Adj SS	Adj MS	F-value	P-value
Current	2	3453.6	1726.8	10.64	0.086
Gas flow rate	2	5262.0	2631.0	16.22	0.058
Included angle	2	1309.4	654.7	4.04	0.199
Error	2	324.5	162.2		
Total	8	10349.5			

Table 5.2- Model summary of tensile strength

S	R-Sq	R-Sq[adj]	R-Sq[pred]
12.7370	96.86%	87.46%	36.51%

Regression equation –

Tensile strength [MPa] = 683.03 - 22.92 Current_130 + 24.93 Current_145 -2.01 Current_160- 29.75 Gas flow rate_10 + 0.26 Gas flow rate_12+ 29.48 Gas flow rate_14 - 11.90 included angle_45- 4.64 included angle_60 + 16.53 included angle_75

Table 5.3 – Analysis of variance hardness (HRB)

Source	DF	Adj SS	Adj MS	F- value	P-value
Current	2	122.000	61.0000	183.00	0.005
Gas flow rate	2	12.667	6.3333	19.00	0.050
Included angle	2	0.667	0.3333	1.00	0.500
Error	2	0.667	0.3333		
Total	8	136.000			

Table 5.4- Model summary of Hardness (HRB)

S	R-Sq	R-Sq[Adj]	R-Sq[pred]
0.577350	99.51%	98.04%	90.07%

Regression equation –

Hardness [HRB] = 79.333 + 4.333 Current_130 + 0.333 Current_145 - 4.667Current_160- 1.667 Gas flow rate_10+ 0.667 Gas flow rate_12+ 1.000 Gas flow rate_14+ 0.000 Included angle_45 + 0.333 Included angle_60 - 0.333 Included angle_75

5.4 Response surface optimizer:

After doing the experiment in the form of run order, statistical models wear develop for the further step and analysed that particular system. Then the next step should be the model should be check for the validation. By doing this we can the idea that the model should be valid for the given input or output parameter or not that must be cleared.

For full fill this need, we have one option in Minitab version 17 that is ANOVA Response optimizer as shown in below figure 5.12 respectively.

Do the following step –

START>ANOVA>General liner model>Response optimizer

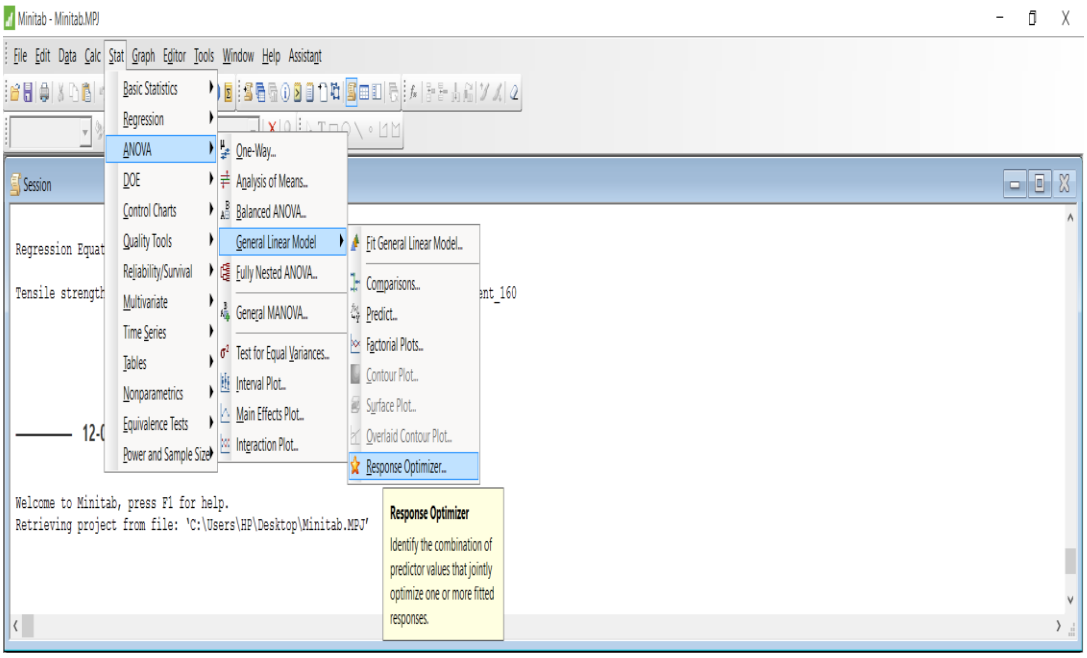


Fig 5.12- Selection of response optimizer

For the optimization purpose and particularly for the project work we will used the target method. Then give the minimum and maximum value of most influence input parameter and finally assign the target. Generally particularly for the desirable target software will gives us the input values respectively. After that done the experiment on the values of input and then compare with the output value of experiment with target set, by doing all this things statistical model will be validate with the ease. For this validation purpose we will set the criteria the 10 %. At the final stage if the difference between target and result from experiment is achieve more than 10%, then finally the validation should be failed according with the software analysis.

5.5 Result of optimization by response optimizer:

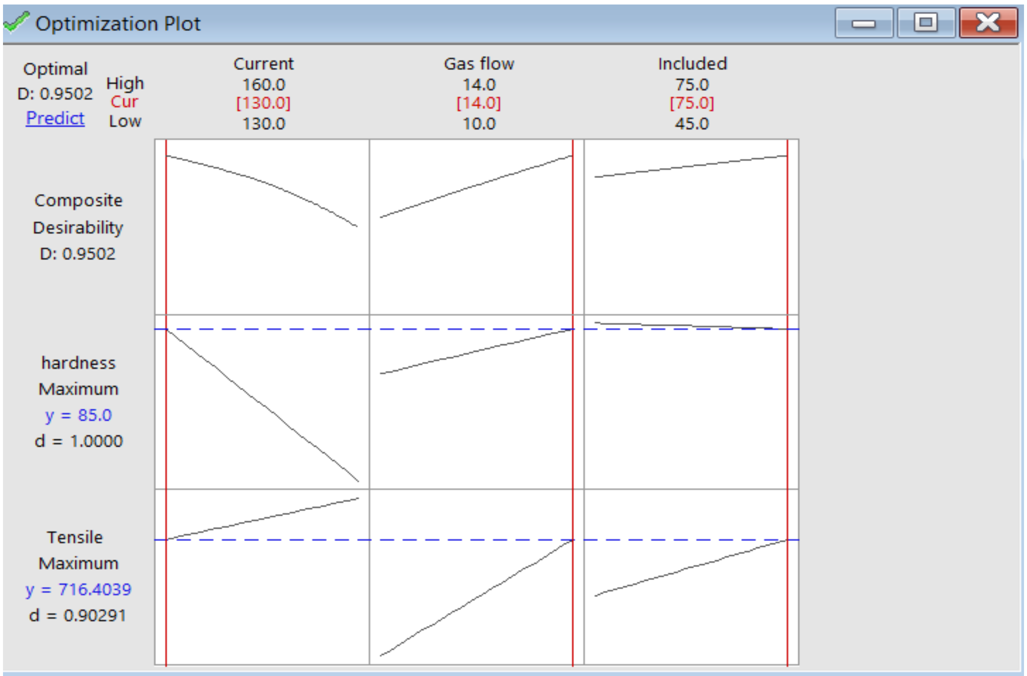


Fig 5.13- Optimization plot from responses optimizer

It is clearly seen form the above Fig. 5.13 response optimizer plot that the value of tensile strength 716 MPa and the optimum value of hardness is 85(HRB) both are the optimum value of the output parameter obtain.

Optimum input parameter-

- Welding current-130A
- Gas flow rate –14 L/min
- Included angle-75˚

Optimum output parameter-

- Tensile strength-716MPa
- Hardness-85 (HRB)

Finally the result of obtain value of both tensile strength (MPa) and hardness (HRB) shown in below table 5.5 respectively-

Table 5.5-Result of validation test

Sr. No	**Parameters**	**Minitab result**	**Experimental result**	**Error**
1	Tensile strength	716.40(MPa)	727.82(MPa)	1.59%
2	hardness	85(HRB)	81(HRB)	4.7%

CHAPTER – 6

Conclusions and Future Scope

6.1 Conclusion:

- From the above dissertation work we can conclude some of the suggestions were given to the industry about the selection of input parameters range for doing the defect free weld. The following conclusion can be made listed below-

- The most affecting or we can say the influence parameters on the quality of welding for the top production receiver which has been used in chemical plant are welding current(A), gas flow rate(L/min) and included angle(˚) respectively.

- All the project work is done according to ASME section IIX division 2, ASME section IX, and ASME section X. all the input parameter and output parameter are selected form the standard.

- With the help of the TAGUCHI design the statistical model was validated and also found less error in tensile strength 1.59% and in hardness 4.7% error respectively.

- With the optimization of input parameters the value achieved that are current-145A,gas flow rate-14 L/min, and included angle 45˚ gives the best tensile strength-727.82 MPa and hardness achieved 81(HRB) and finally make the WPS(Welding procedure specification) model according to this parameter respectively.

- The experimental result which has been achieved particularly for output parameters are quite accurate and also some % error was found when compared with the software result that wear obtain within the acceptable limits.

6.2 Future scope:

There are number of parameters that effect the mechanical properties of the weld joint that can be added for research work that must be pick up form the ASME section IX. The output parameters like tensile strength and hardness can be studied by selecting the proper input parameters and its effects on weld joint respectively and finally identify the changes in tensile strength and hardness of the weld joint and then optimization with the used of DOE. The mechanical properties change, microstructure of the weld joint and its failure can be studied for the future work.

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Standard:

[32] **A.S.M.E. Section II A:** Boiler, A. S. M. E., & Code, P. V. (2019). Section II Materials. Part A–Properties.

[33] **A.S.M.E. section II C**: Boiler, A.S.M.E., & Code, P.V. (2010). Section II Material. Part C- Welding Consumables.

[34] **A.S.M.E. section V:** Boiler, A.S.M.E., & Code, P.V.(2017). Section V Non-destructive examination.

[35] **A.S.M.E. Section IX:** Boiler, A. S. M. E., & Code, P. V. (2013). Section IX: Welding and Brazing Qualifications.

Appendix A: Review Card

ATMIYA UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY

ATMIYA UNIVERSITY सुहृदं सर्वभूतानाम्

Master of Technology

(Dissertation Review Card)

Name of Student : Pandya Prashant Rameshkumar

Enrollment No. : 1 8 0 0 4 4 0 0 3

Student's Mail ID:- Prashant.Pandya65@gmail.com

Student's Contact No. : 9712684271

College Name : Atmiya university, Rajkot

College Code :

Branch Name : M.Tech Mechanical [Production]

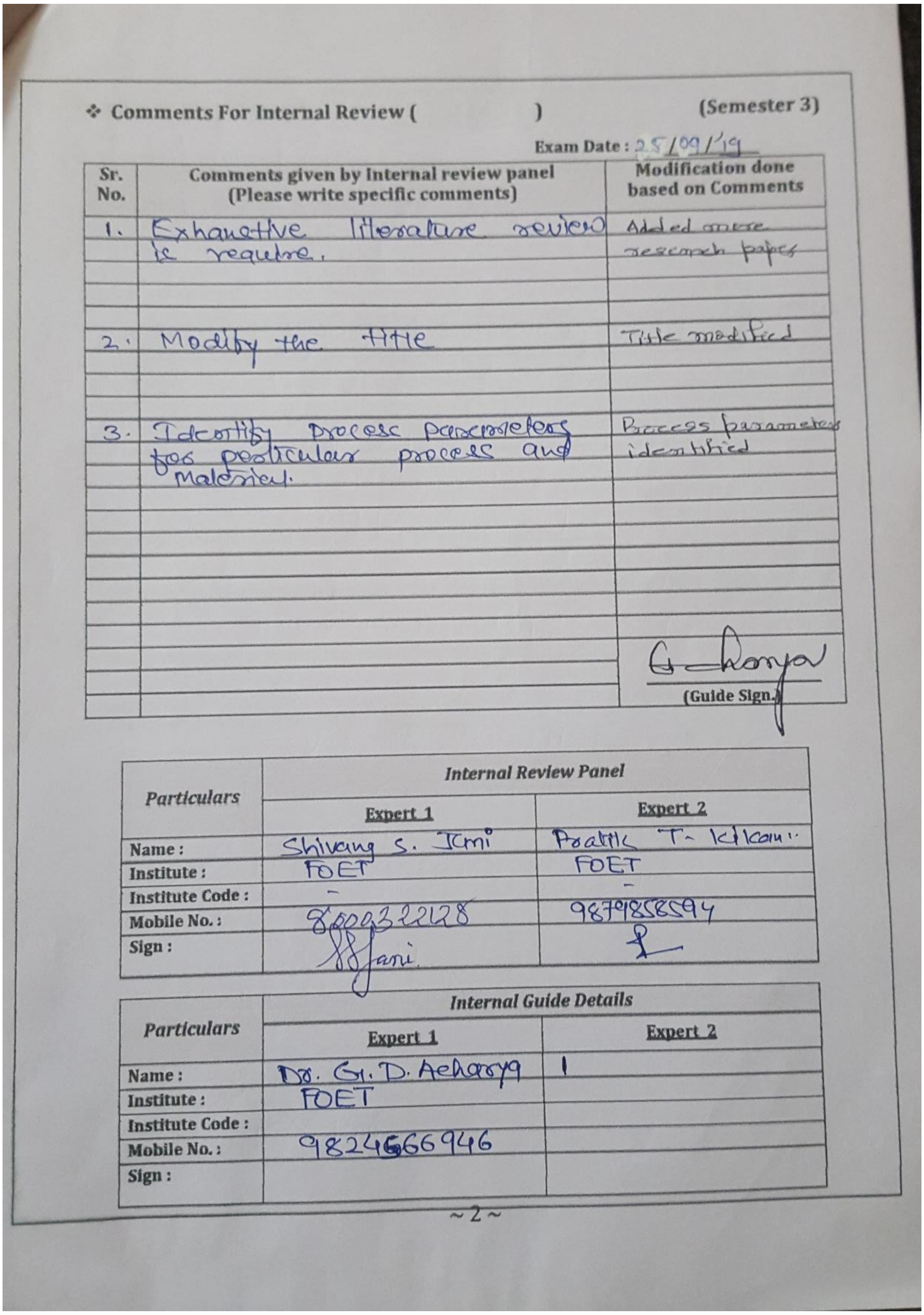
Theme of Title :

Title of Thesis : "Evaluate the effect of Process Parameter on mechanical properties of 6mm thick SS 317L weld joint for receiver application GTAW welding"

Supervisor's Detail	
Name :	DR. G. D. Acharya
Institute :	FOET
Institute Code :	
Mail Id :	Principal@aits.edu.in
Mobile No. :	9824566946

Co-supervisor's Detail	
Name :	
Institute :	
Institute Code :	
Mail Id :	
Mobile No. :	

~ 1 ~



❖ Comments For Internal Review ( ) (Semester 3)

Exam Date : 25/09/19

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	Exhaustive literature review is require.	Added more research papers
2.	Modify the title	Title modified
3.	Identify process parameters for particular process and material.	Process parameters identified

(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Shivang S. Jani	Pratik T. Kikani
Institute :	FOET	FOET
Institute Code :	–	–
Mobile No. :	8000322128	9879858594
Sign :	SSJani	

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Dr. G. D. Acharya	
Institute :	FOET	
Institute Code :		
Mobile No. :	9824566946	
Sign :		

~ 2 ~

Enrollment No. of Student : 1 8 0 0 4 4 0 0 3

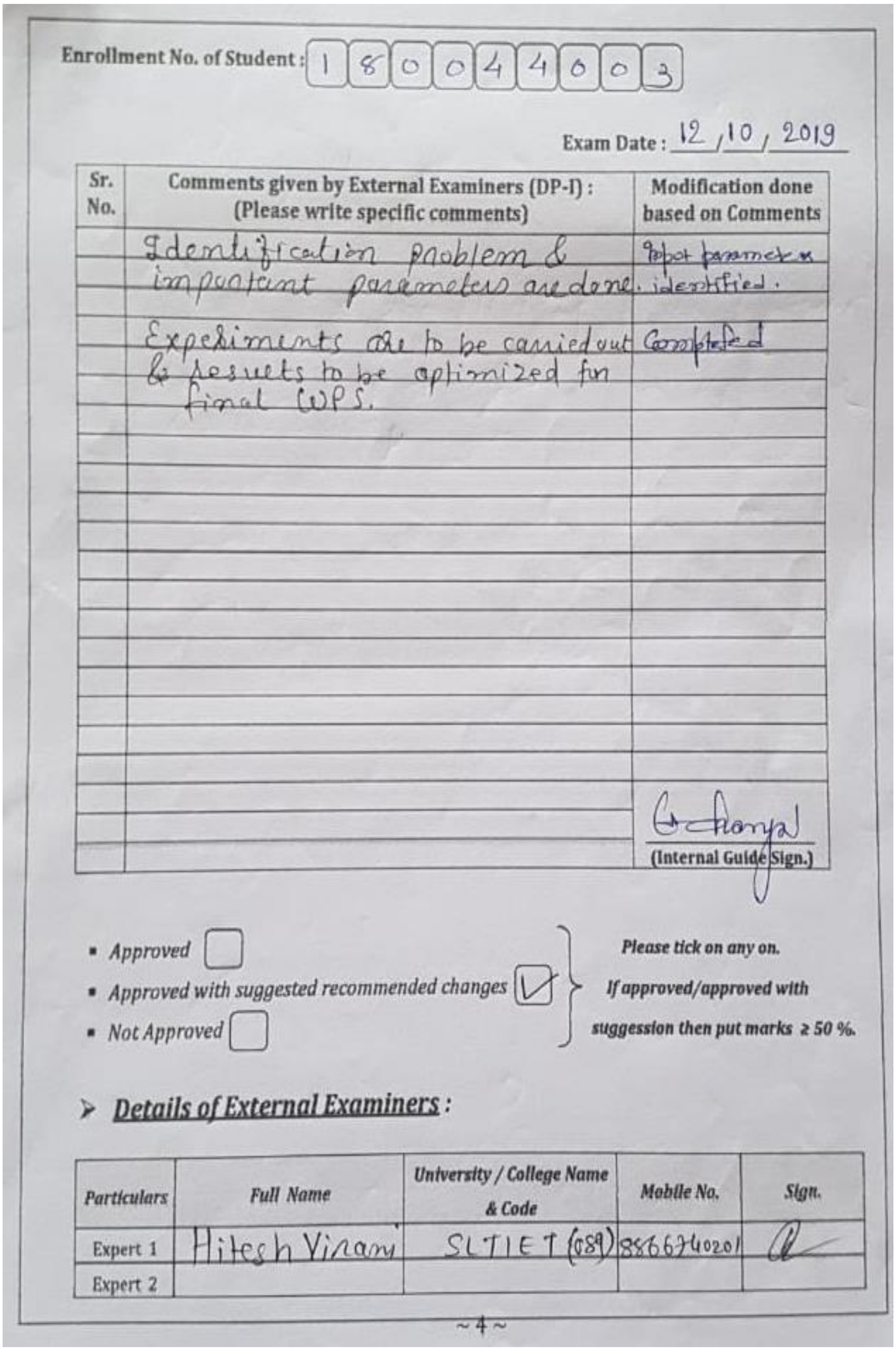
❖ **Comments of Dissertation Phase-1** (18MMEPICC305 **(Semester 3)**

Exam Date : 12/10/19

Title : "Evaluate the effect of process Parameter on mechanical properties of 6mm thick SS 317L weldjoint for Scciever application GTAW welding"

1. Appropriateness of title with proposal. (Yes/ ~~No~~) Yes
2. Whether the selected theme is appropriate according to the title ? (Yes / ~~No~~) Yes
3. Justify rational of proposed research. (Yes/ ~~No~~) Yes
4. Clarity of objectives. (Yes/ ~~No~~) Yes

~ 3 ~



Enrollment No. of Student : 1 8 0 0 4 4 0 0 3

Exam Date : 12 / 10 / 2019

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
	Identification problem & important parameters are done.	Input parameters identified.
	Experiments are to be carried out & results to be optimized for final WPS.	Completed
		(Internal Guide Sign.)

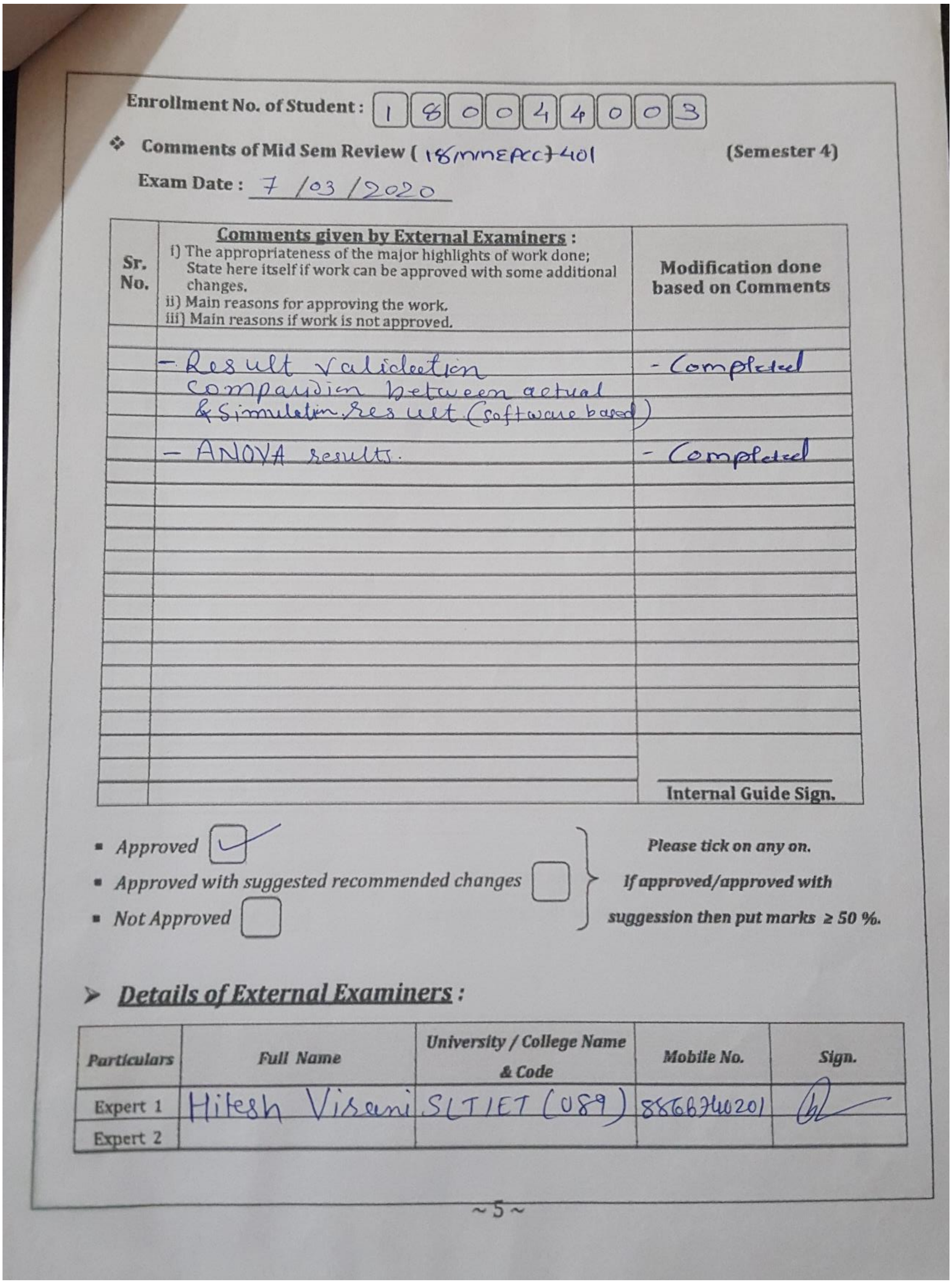
- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggestion then put marks ≥ 50 %.

➢ **Details of External Examiners :**

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	Hitesh Virani	SLTIET (089)	8866740201	
Expert 2				

~ 4 ~



Enrollment No. of Student: 1 8 0 0 4 4 0 0 3

❖ Comments of Mid Sem Review (18MMEPCC7401 (Semester 4)

Exam Date: 7 /03 /2020

Sr. No.	**Comments given by External Examiners:** i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
	- Result validation comparision between actual & Simulation result (software based)	- Completed
	- ANOVA results.	- Completed
		Internal Guide Sign.

- Approved ☑
- Approved with suggested recommended changes ☐
- Not Approved ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners:***

Particulars	Full Name	University / College Name & Code	Mobile No.	Sign.
Expert 1	Hitesh Visani	SLTIET (089)	8866740201	
Expert 2				

~ 5 ~

Enrollment No. of Student : 1 8 0 0 4 4 0 0 3

❖ Comments of DP-II Review (18MMEPCC403 (Semester 4)

Exam Date : 07/07/2020.

Sr. No.	**Comments given by External Examiners** : i) Main reasons for approving the work. ii) Main reasons if work is not approved.	Modification done based on Comments
	Work is Satisfactory	

- *Approved* ✓
- *Not Approved*

Please tick on any one.

If approved then put marks ≥ 50 %.

➢ ***Details of External Examiners*** :

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1	Hitesh Virani	SLTIET (089)	8866740201	
Expert 2				

~ 6 ~

Appendix B: Compliance Report

Comments given during Dissertation Phase-1 and Mid-Sem Review are given below with required actions taken for their fulfilment:

➢ Comments for Dissertation Phase – 1:

Sr. No.	Comments Given	Actions
1	Identification of problem and important parameter are done.	Important parameter identified
2	Experiment are to carried out &result to be optimized and final WPS.	Completed

➢ Comments for Mid-Semester Review:

Sr. No.	Comments Given	Actions
1	Result validation, comparisons between actual &simulation result[software based]	Completed
2	ANOVA result.	Completed

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ACCEPTANCE LETTER

Dear Prashant R. Pandya,

Greetings from STM Journals!

We feel glad to inform you that your manuscript entitled **"A review on Evaluate the effect of process parameter on mechanical properties 6mm thickness SS317L weld joint for receiver application GTAW welding"** has been accepted for publication in the **"Trends in Mechanical Engineering & Technology (TMET)", eISSN: 2231-1793; ISSN: 2347-9965, Volume 10 Issue 3, 2020.**

Have A Great Future Ahead.

Thanking you with best regards

Archana Mehrotra

Dr. Archana Mehrotra
Director
Publication Management Team –
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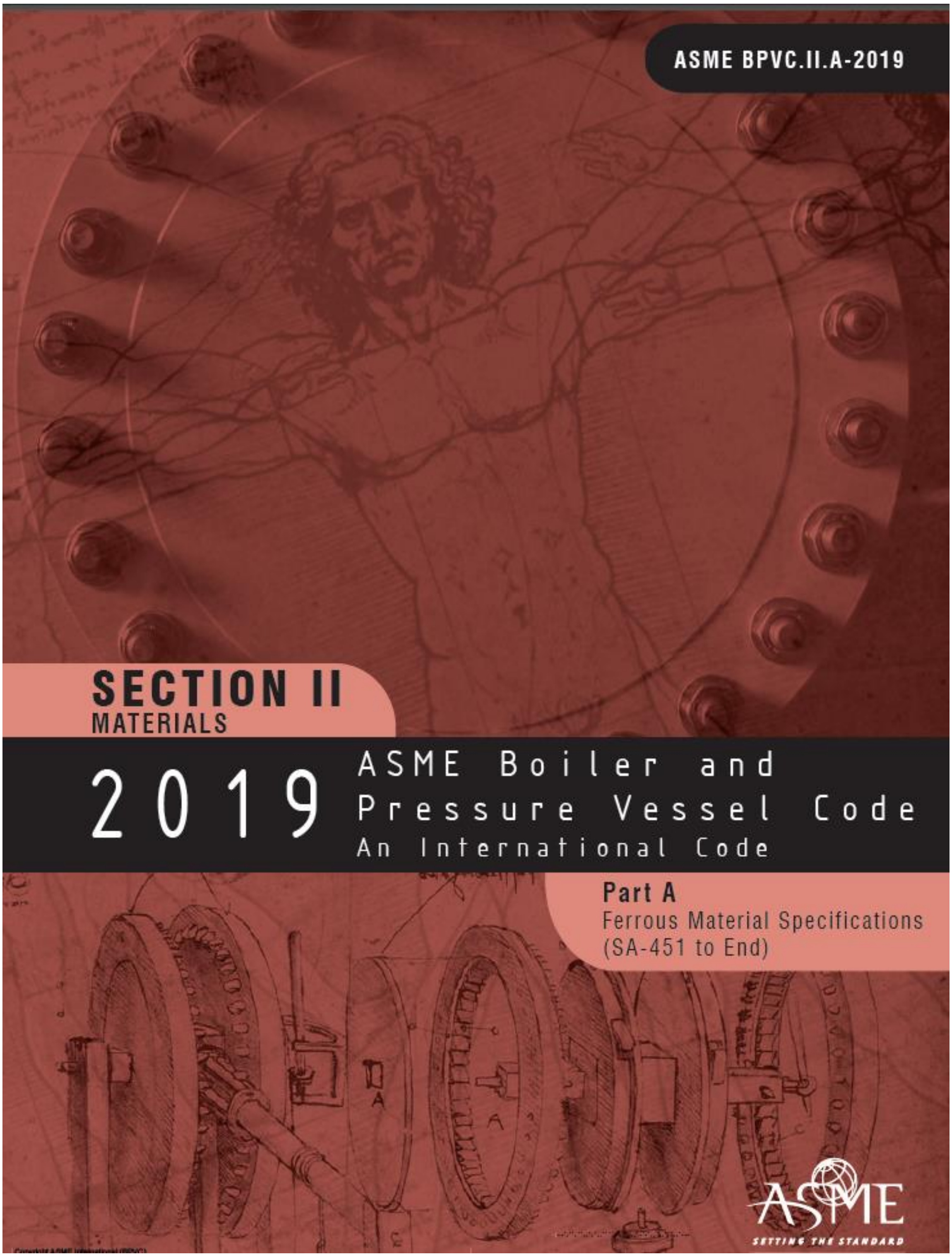
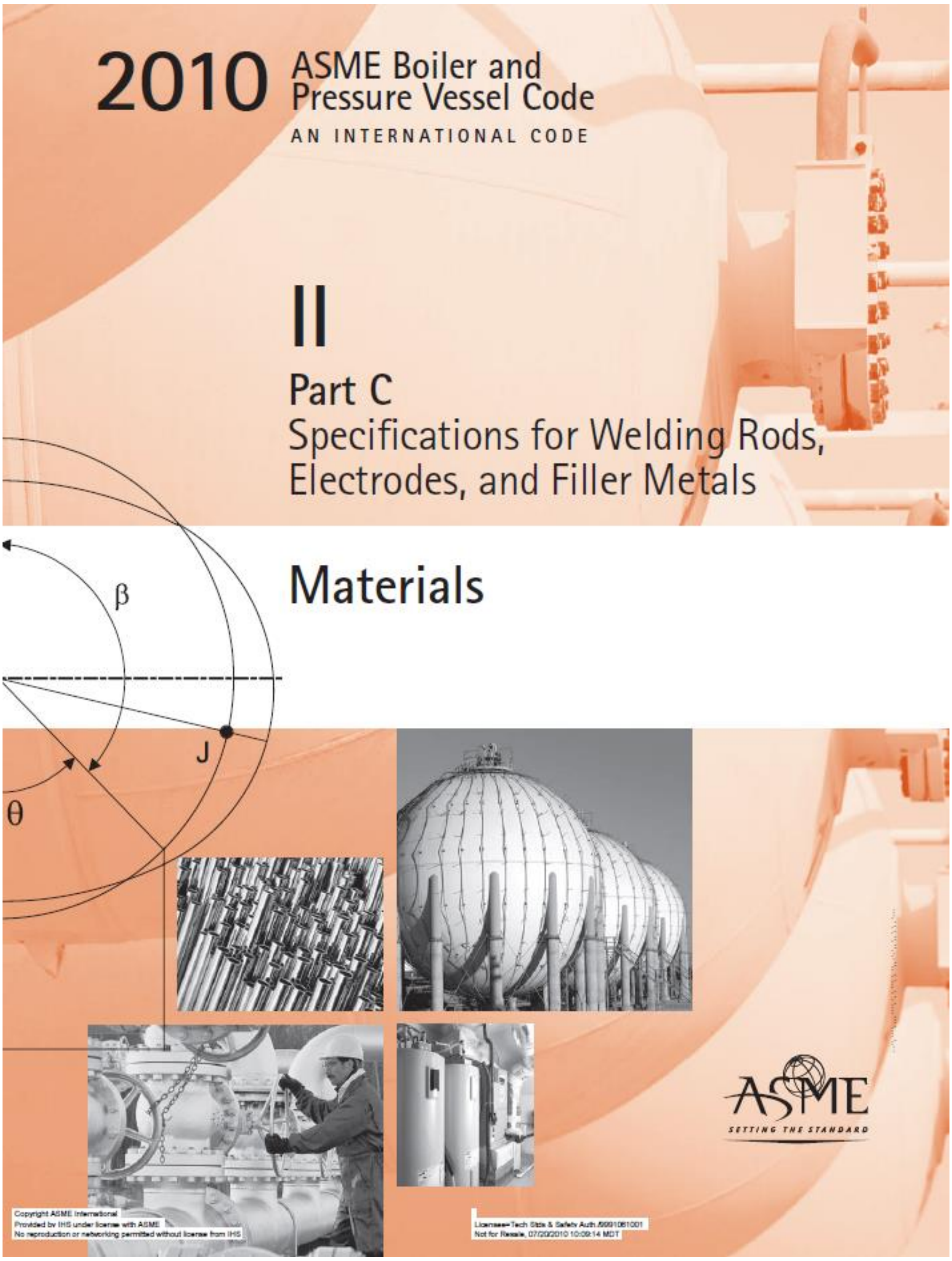

ASME BPVC.II.A-2019
SECTION II
MATERIALS
2019
ASME Boiler and
Pressure Vessel Code
An International Code
Part A
Ferrous Material Specifications
(SA-451 to End)
ASME
SETTING THE STANDARD

Front page


2010 ASME Boiler and Pressure Vessel Code
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II
Part C
Specifications for Welding Rods, Electrodes, and Filler Metals
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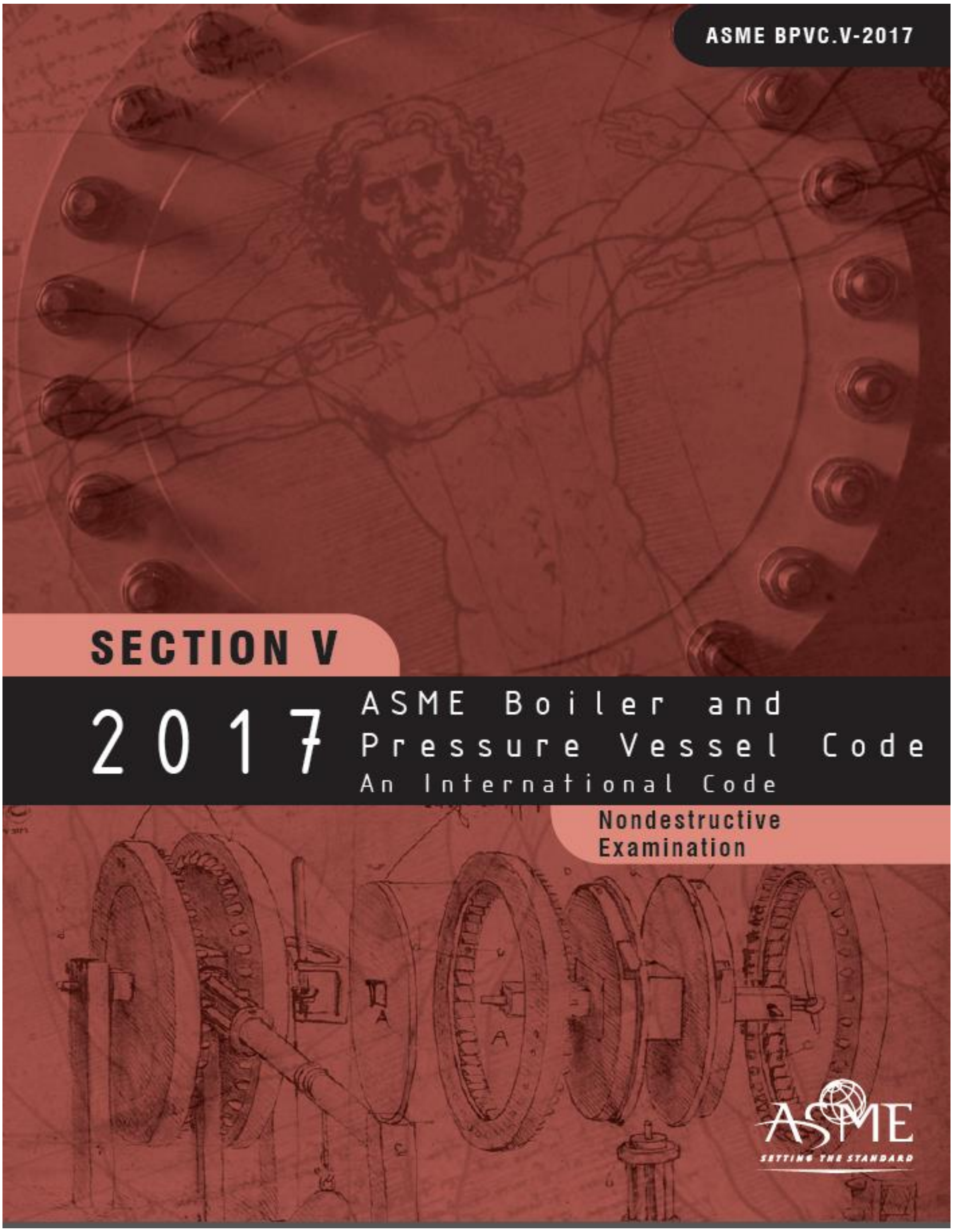
ASME
SETTING THE STANDARD

Front page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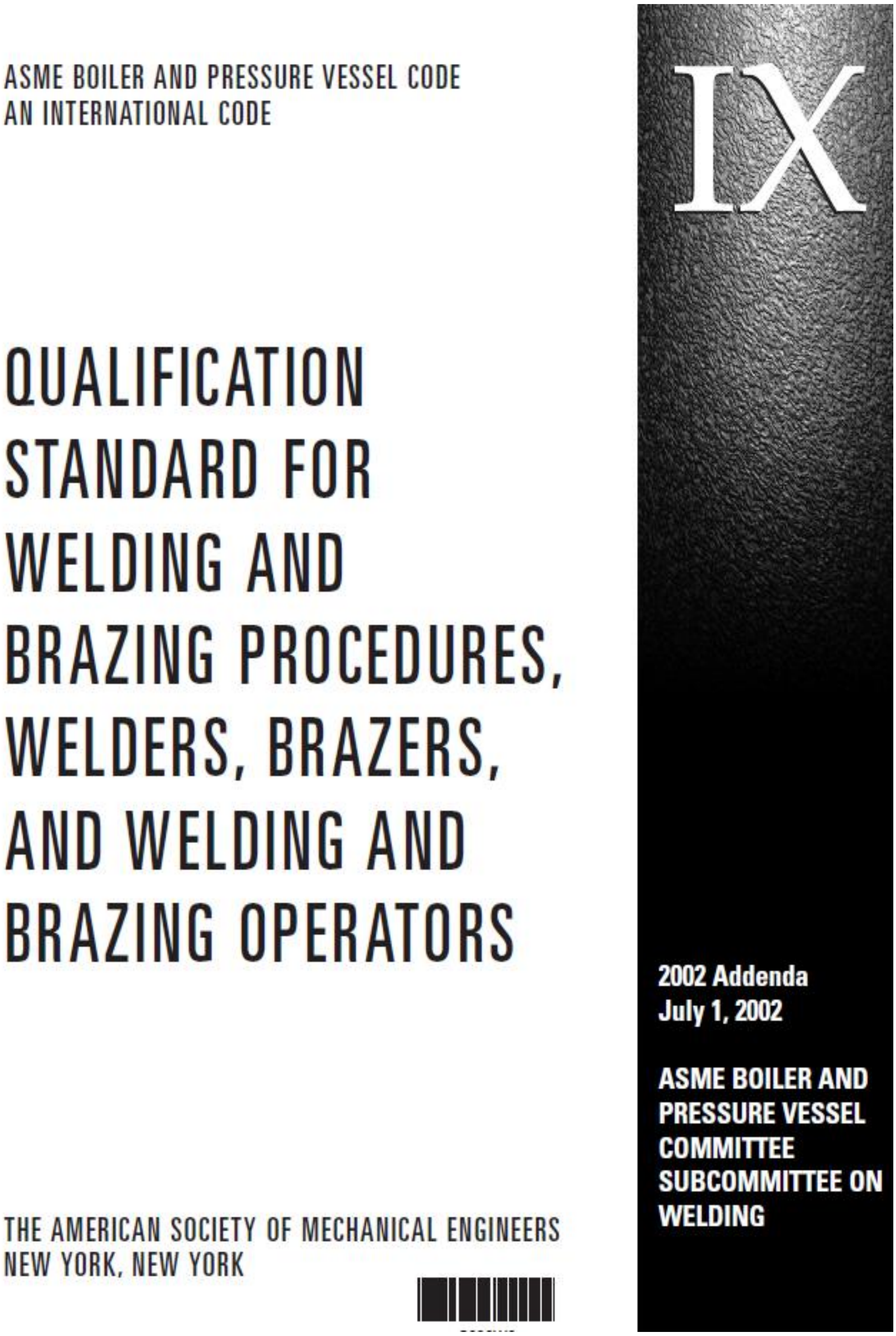
2017
ASME Boiler and Pressure Vessel Code
An International Code
Nondestructive Examination
ASME
SETTING THE STANDARD

Front page



ASME BOILER AND PRESSURE VESSEL CODE
AN INTERNATIONAL CODE

IX

QUALIFICATION STANDARD FOR WELDING AND BRAZING PROCEDURES, WELDERS, BRAZERS, AND WELDING AND BRAZING OPERATORS

2002 Addenda
July 1, 2002

ASME BOILER AND PRESSURE VESSEL COMMITTEE SUBCOMMITTEE ON WELDING

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
NEW YORK, NEW YORK

Front page

Conformation test Report

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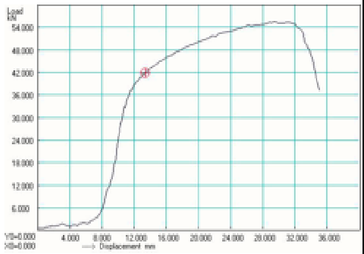
TEST REPORT

Customer Name : Mr. Prashant Pandya Address : Atmiya College, Kalawad Road, Rajkot - 360005 (Gujarat, India)	ULR No. : TC521220000004911F Report No. : DTF-0932.1 Report Date : 11/06/2020 Date of Receipt : 11/06/2020

Type of Test	: Tensile Test
Discipline & Group	: Mechanical Testing & Fe & Fe Alloys
Instrument Utilized	: UTM: TUTE-40/SR NO:2014/405
Test Method	: ASTM A370-19
**Identification of Sample	: Sample - 1
**Customer's Reference	: Nil
**Condition of Sample	: Test Piece
**Material Specification	: AISI 317L
Date of Testing	: 11/06/2020
Width	: 12.70 mm
Thickness	: 6.00 mm
Initial Gauge Length	: 50.00 mm
Initial Area	: 76.20 mm²



Result :

Final Width	:	9.25 mm
Final Thickness	:	3.05 mm
Final Gauge Length	:	60.19 mm
Final Area	:	28.21 mm²
Tensile Load / Peak Load	:	55460.00 N
Tensile Stress	:	722.82 MPa
Yield Load	:	41880.00 N
Yield Stress	:	549.61 MPa
Elongation	:	20.38 %
Reduction in Area	:	62.98 %
Fracture	:	OGL

Statement of Conformity : --

Remarks : -
Hardness : - 87,82,81 (HRB)

Kishan Tested by	Authorized signatory Kuldip (TM)	Witnessed by

Terms & Conditions :
1. The results relate only to the sample tested, Sample(s) drawn by party.
2. Test Certificate shall not be re-produced except in full without the written approval of Laboratory.
3. RMS has made their best endeavors to provide accurate and reliable information. RMS is not responsible for any financial liability due to any act of omission or error made

Welding Procedure Specifications

FORM QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATIONS (WPS)
(See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Organization Name Sri Ratna Engineering, Vapi By Prashant. R. Pandya

Welding Procedure Specification No. 1 Date 04-03-2020 Supporting PQR No.(s) 06

Revision No. 01 Date 04-03-2020

Welding Process(es) GTAW Type(s) Manual
(Automatic, Manual, Machine, or Semi-Automatic)

JOINTS (QW-402)

Joint Design Single "V" butt joint

Root Spacing 2mm

Backing: Yes ____ No ✓

Backing Material (Type) NO
(Refer to both backing and retainers)

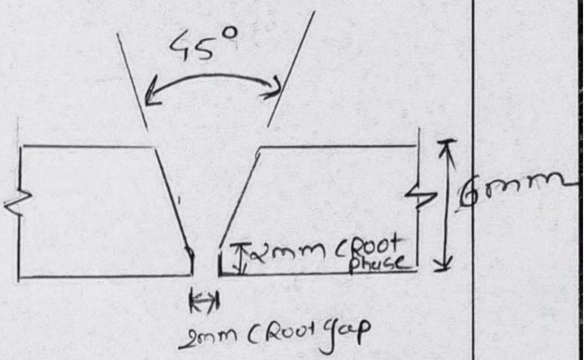
☑ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols, or Written Description should show the general arrangement of the parts to be welded. Where applicable, the details of weld groove may be specified.

Sketches may be attached to illustrate joint design, weld layers, and bead sequence (e.g., for notch toughness procedures, for multiple process procedures, etc.)]

Details



***BASE METALS (QW-403)**

P-No. 8 Group No. 1 to P-No. 8 Group No. 1

OR

Specification and type/grade or UNS Number S31703

to Specification and type/grade or UNS Number S31703

OR

Chem. Analysis and Mech. Prop. Tensile 515mP, Hardness 95 HRB

to Chem. Analysis and Mech. Prop. Tensile 515mP, hardness 95HRB

Thickness Range: 6mm

Base Metal: Groove ____ Fillet ____

Maximum Pass Thickness ≤ $^1/_2$ in. (13 mm) (Yes) ____ (No) —

Other —

***FILLER METALS (QW-404)**

	1 (SS317L)	2 (SS317L)
Spec. No. (SFA)		
AWS No. (Class)		
F-No.	6	6
A-No.	8	8 (QW44K)
Size of Filler Metals	3.15mm	3.15mm
Filler Metal Product Form		
Supplemental Filler Metal	–	–
Weld Metal		
Deposited Thickness:		
Groove	–	–
Fillet	–	–
Electrode-Flux (Class)	–	–
Flux Type	–	–
Flux Trade Name	–	–
Consumable Insert	–	–
Other	–	–

FORM QW-482 (Back)

WPS No. 1 Rev. 01

POSITIONS (QW-405)
Position(s) of Groove 1G Welding
Welding Progression: Up — Down —
Position(s) of Fillet —
Other —

POSTWELD HEAT TREATMENT (QW-407)
Temperature Range —
Time Range —
Other —

PREHEAT (QW-406)
Preheat Temperature, Minimum —
Interpass Temperature, Maximim —
Preheat Maintenance —
Other —
(Continuous or special heating, where applicable, should be recorded)

GAS (QW-408)

	Gas(es)	Percent Composition (Mixture)	Flow Rate
Shielding	Pure Argon	99.99	14 L/min
Trailing	—	—	—
Backing	—	—	—
Other	—	—	

ELECTRICAL CHARACTERISTICS (QW-409)

Weld Pass(es)	Process	Filler Metal Classification	Filler Metal Diameter	Current Type and Polarity	Amps (Range)	Wire Feed Speed (Range)	Energy or Power (Range)	Volts (Range)	(mm/sec) Travel Speed (Range)	Other (e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, etc.)
Root	GTAW	AWS 5-9	3.15 mm	DCEN = DCSP	145A	—	—	20-25	16sec	—
Fill	GTAW				145A	—	—	20-25	16sec	
Cap	GTAW				145A	—	—	20-25	17sec	

Amps and volts, or power or energy range, should be recorded for each electrode size, position, and thickness, etc.

Pulsing Current — Heat Input (max.) 1,2 1.392 KJ/mm 3 1.479 KJ/mm
Tungsten Electrode Size and Type EWTh-2 (Tungsten + 2% Thorium) 3mm - Red indication.
(Pure Tungsten, 2% Thoriated, etc.)
Mode of Metal Transfer for ~~GMAW~~ (~~FCAW~~) —
(Spray Arc, Short Circuiting Arc, etc.)
Other —

TECHNIQUE (QW-410)
String or Weave Bead String
Orifice, Nozzle, or Gas Cup Size —
Initial and Interpass Cleaning (Brushing, Grinding, etc.) 8" wire wheel & wire Brush
Method of Back Gouging —
Oscillation —
Contact Tube to Work Distance —
Multiple or Single Pass (Per Side) —
Multiple or Single Electrodes —
Electrode Spacing —
Peening —
Other —

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xii "Evaluate the effect of process parameter on mechanical properties 6mm thickness SS317L weld joint for receiver application GTAW welding " (180044003) Prashant R Pandya FOET, Department of mechanical engineering, Atmiya University, RAJKOT prashantpandya65@gmail.com ABSTRACT GTAW welding is most important especially welding of stainless steel and aluminum are more difficult to do. Nowadays SS317L materiel is used in top production receiver application in chemical and Pharma Company. That's why this must have contain good mechanical properties and also resistance to corrosion. For achieving the good mechanical properties of weld ment, the optimal selection of process parameters is very important. For the GTAW welding the most influence input parameter are selected form the ASME section IX. In this work, the effect of different welding parameters like gas flow rate, current and included angle is selected for the project work. The filler wire which is used for the project work that is ER317L for similar welding of SS317L 6mm thickness plate joint. Tensile test and hardness test is done for check the mechanical properties of weld joint respectively. ANOVA is used for finding out the most influencing input parameter on output result. Optimization of selected parameter done by response surface optimizer. After the optimization validate the result obtain. Taguchi L9 orthogonal array in DOE is used for the optimization with MINITAB 17 version is used. Keywords: Austenitic stainless steel 317 L , TIG welding, WPS

Introduction 1 CHAPTER – 1 Introduction 1.1 Background: Nowadays manufacturing industries performs very important role in the growth of the any country to be develop. The economic strength of any developing country dependent on the performances of manufacturing company. And also the growth of manufacturing sector can develop the employment for the people and by doing this any country can go towards to the progress. In manufacturing industries joining is also the one of the most important phenomenon. In other words Joining can be defined as the "metal or non-metal metal can be join to serve some desired purpose" that purpose can be anything dependent upon application. Joining have many process like welding, soldering and brazing also whatever may be used according to application. Welding can be defined as "

a process of joining two similar or dissimilar metals by fusion,

with or without the application of

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pressure and a filler metal may or may not be used

if required particularly for the application". The G.T.A.W welding process is most preferable welding process for the manufacture for the household appliance product. This process is most widely used in industries because it is cheap, easy to use and it can be automated with the ease. For manufacturing the chemical plant receiver, at first nozzle orientation is mark on top dish then tacking the nozzle and nozzle welded with the top dish. The shell and both dish end are welding with the help of the GTAW welding process. This welding process is more preferable for manufacturing stainless steel vessel.

Introduction 2 The below fig 1.1 show the project boundary condition for the project work. Fig 1.1-Project boundary condition Manufactring process casting,joining,machining,metal forming,powder metallurgy Brazing,soldering,welding Arc welding,GTAW welding,Thermit welding,EBW,LBW Welding parameter current,gas flow rate,included angle experimental work Validation of experimental result

Introduction 3 1.2 Tungsten inert gas welding process: Manual GTAW welding is very difficult amongst all the welding processes commonly used in industrial application because it is totally dependent on craft man experience respectively. To prevent the electrode great care and skill are required and the welders must maintain a short arc length during the welding so for doing the welding of pressure vessel WPQ is essential for the welder.

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Welder manually feed a filler metal into the weld area with only one hand

and at the other hand manipulating the welding torch in the form of weave bead respectively. The GTAW welding process comes under the fusion welding process categorised shown in below fig 1.2. In this type of welding process the joining

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strength S R-Sq R-Sq(adj) R-Sq(pred) 12.7370 96.86% 87.46% 36.51%

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Source DF Adj SS Adj MS F- value P-value Current 2 122.000 61.0000 183.00 0.005 Gas flow rate 2 12.667 6.3333 19.00 0.050 Included angle 2 0.667 0.3333 1.00 0.500 Error 2 0.667 0.3333 Total 8 136.000 Table 5.4-

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