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Analysis of Weldability AISI 202 SS (Stainless Steel)

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Abstract – AISI 202 SS (stainless steel) has comparative mechanical property as contrast with AISI 304 SS, yet its capacity to oppose erosion is to some degree less as contrast with AISI 304 SS in chloride condition. But due to its lower cost we can utilize it in indoor applications like indoor fabrication, vehicle rim etc. In any case, there is less research which an account the of welding properties analysis of AISI 202 SS. In this work we utilize Gas Tungsten Arc Welding technique (GTAW) procedure to join AISI 202 SS. GTAW process benefits the welded joint with most extreme quality and better deposition rate. The outcomes got subsequent to welding of AISI 202 are compared to results of welding of AISI 304 SS. The comparison provides some very close results. Henceforth AISI 202 SS can be utilized rather than 304 type SS for the previously mentioned applications.

Index Terms – AISI 202 SS, AISI 304 SS, GTAW, Strength, Chloride Condition Weldability.

1. INTRODUCTION

Welding is one of the major processes by which the materials are fabricated. The joining of similar or different materials is referred to as welding process. With the application of heat, pressure and filler material, the materials can be welded using different welding processes. The stainless steel itself specifies its properties through name steel without stain i.e. “stainless”. Stainless steel is a precious metal known for corrosion resistant properties. For this present work a stainless steel AISI 202 (austenitic) grade is used as the base material for welding. These steels are generally recognized as nonmagnetic in nature. Austenitic stainless steel contains chromium between 16% to 25% and also nitrogen which are important constituent contributing in high corrosion resistant property. The weldability of austenitic stainless steels AISI 202 grade is fairly good than from the other stainless-steel members and they can be divided rather loosely into three groups: (300 series) chromium-nickel steel, (200series) manganese-chromium-nickel-nitrogen steel and specialty alloys.

Some element like Manganese, iron and chromium are most effective constituents in plasma. It was very difficult to measure the temperature of weld area because this region is surrounded by plasma [1].

A slight reduction in nitrogen and dissolved oxygen concentration was observed at the surface of welded specimens of AISI 201 and AISI202 [2].

2. RELATED WORK

A broad study has been done to attain the current learning including substantive discoveries, and additionally hypothetical and methodological study about the weldability issues in the AISI 202. The statuses of research work did in this field are given underneath:

The three main failure modes for steel which is used to measure the weldability are: cold cracking due to induced hydrogen, spot-weld peeling and lamellar tearing, Out of these three, the most the first one (cold cracking due to induced hydrogen) is very prominent. [3, 4, 5]

The microstructure of stainless steel consists of delta ferrite and gamma ferrite phase. [6, 7, 8]

3. PORPOSED MODELLING

To meet the required objectives set forth, the experimental work was planned in two phases. In the first phase, trial runs were conducted based upon which the process control parameters were selected and in the second phase experimentation or actual runs were conducted for which further investigation was carried out.

3.1 Conducting trial runs:

Trials were conducted in which the weldability of AISI 202 stainless steel was investigated. GTAW technique was used for welding in butt welding position with single-V groove preparation. Welded joints were analyzed for visual and destructive testing. The visual testing of joint inspects for spatter, cracks, undercuts, distortion and unevenly spaced ripples of weld bead. The strength of the joint was obtained through tensile test. The joint strength obtained was as desired, which laid the way to further extension of the work.

The process parameters were obtained by weld beads were laid with the welding currents ranging from 120A to 200A, then after carefully examination of the weld beads it was found that current ranging between 140A and 180A produce satisfactory results. The other parameters were also finalized as welding speed form 160 mm/min to 180 mm/min using transverse travelling carriage. Similarly, the third parameter shielding gas flow rate was finalized ranging from 5 lit/min to 9 lit/mi.

Austenitic stainless steel AISI 202 grade of 6 mm type was selected as the base material for experimentation. The chemical compositions of AISI 202 stainless steel grade are show in table1.

Table 1: Chemical compositions of AISI-202

Element	**C**	**Mn**	**Si**	**Cr**	**Ni**	**P**	**S**	**N**
Wt. %	0.15	7.5-10	1	16-18	4-6	0.06	0.03	0.25

The recommended filler metal for GTAW process to weld 202 stainless steel grade is 308l stainless steel (Ø 2.4 mm). It is low carbon filler material reduces the sensitization effect.

For welding, the equipment has a power source of constant voltage type. The experimental setup also consists of a travelling carriage which was built to provide constant welding speed of three levels. The welding gun was stationary for this work.

The (transverse travelling carriage) workstation designed for the present work has been shown in the figure given below figure 1.

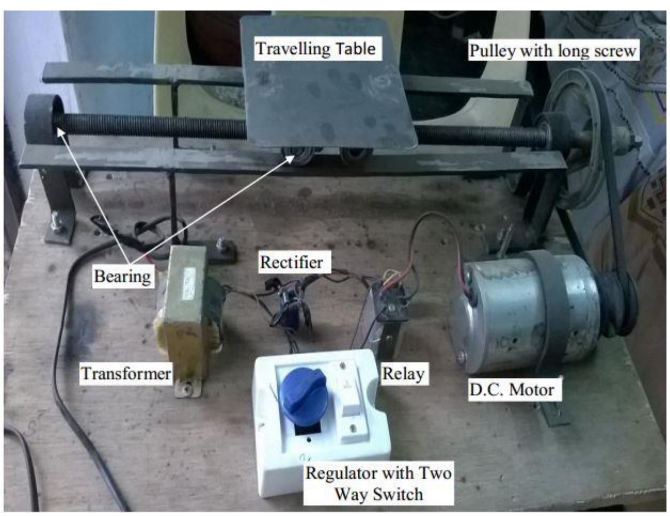

Fig 1 Transverse Travelling carriage (Work Station)

The welding operation was performed according to the design matrix that complies with the L9 orthogonal array design. To avoid systematic error in the experiment, the welding was done in a sequential order. During the gas tungsten arc welding operation, the plates were tacked rigidly to avoid any deformation which may affect the results. Welding was done by laying two passes i.e. root pass and final pass. The interposes temperature maintained was 150 C. The problem of earthling of work station was resolved by attaching the earth wire to the table during welding.

Figure 2 represents the schematic way of the welding process performed in this present work.

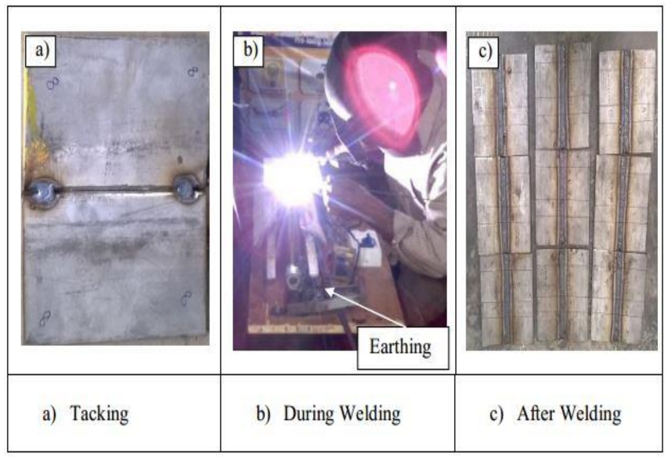

Fig 2 Schematic way of welding process performed

3.2 Mechanical and Metallurgical Testing:

The specimens for testing were sampled out from the weld joints. In view of the experimental design, 27 specimens for tensile testing (three specimens from one plate), 27 samples for impact strength and a specimen for microstructure and microhardness were obtained from nine welded plates (samples). After preparation of the specimens as discussed above, the following testing are carried out:

- Tensile testing
- Micro hardness testing
- Impact testing
- Microstructural examination.

4. RESULTS AND DISCUSSIONS

Results depict the behavior of the material towards welding conditions and input parameters which are shown and discussed systematically in this section.

4.1 Tensile Testing

Tensile strength is calculated experimentally on UTM-100 having capacity of 1000 KN following the testing method IS:

1608:2005. Taguchi method & ANOVA technique is applied for the analysis of results.

The S/N ratios are shown with the help of plots in figure 3. The plots shows the variations in S/N ratio of tensile strength (MPa) with respect to input parameter. In the plot, the x-axis indicates the value of input parameters at three levels and y-axis shows the value of output variable (tensile strength). The graph are ploetd between the following parameters

- Tensile Strength (MPa) vs. Welding current (A)
- Tensile Strength (MPa) vs. Gas flow rate (lit/min)
- Tensile Strength (MPa) vs. Welding Speed (mm/min)

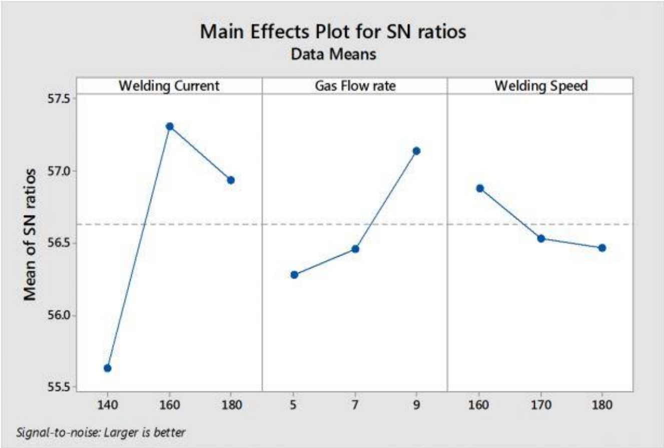

Fig 3 Graphical representation of S/N ratios of Tensile Strength (MPa)

4.2. Microhardness Testing

The results of microhardness testing are tabulated in table 4.5. It has been analysed that at 160 A of welding current, 9 lit/mm of gas flow rate and 160 mm/min of welding speed the microhardness is maximum. At these optimum parameters the maximum value of microhardness obtained may be due to the formation of fine dendritic structure. At high level welding current (180 A) larger dendrite with large inter-dendritic spacing could be observed due to lower cooling rate, which leads to the decreases in microhardness. At 140 A of welding current the tensile strength is less which may be due to the formation of the coarse dendritic structure as observed from the microstructure.

The for S/N ratios is shown in figure 4with the help of main effects plot. The graph shows the variation of S/N ratios for microhardness (HV) with respect to three input parameters i.e. welding current (A), gas flow rate (lit/min) and welding speed (mm/min). The main effects plot is used to obtain the optimal design conditions to determine the desired microhardness. Main effects plot for micro-hardness are plotted between the follwing parameter.

- Microhardness (HV) vs. Welding current (A)
- Microhardness (HV) vs. Gas flow rate (lit/min)
- Microhardness (HV) vs. Welding Speed (mm/min)

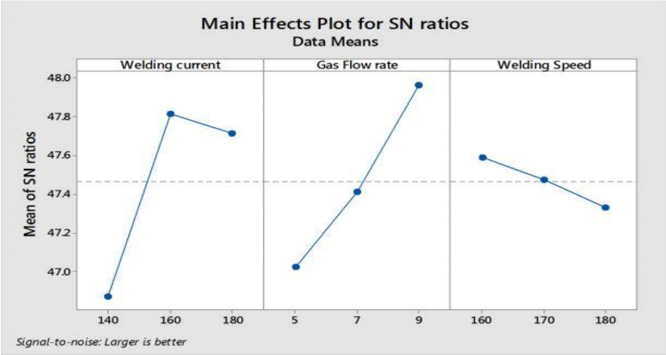

Figure 4. Main effect plot for the S/N ratios of microhardness

4.3 Impact Testing

An upward trend in the impact energy was observed from 140 A to 160 A welding current followed by downward trend when welding current reaches 180 A. The downward trend may be due to the formation of large dendritic size and large dendritic structure at 180 A. The combination of parameters, 160 A welding current, 7 lit/min gas flow rate and 180 mm/min provides the desired result of impact strength.

The main effects plot for S/N ratios is shown in figure 5. The graph shows the variation of Impact Strength (Joules) with respect to process parameters i.e. welding current (A), gas flow rate (lit/min) and welding speed (mm/min). The main effects plot is used to obtain the optimal design conditions to determine the desired Impact Strength (Joules). Main effects plot for Impact Strength are plotted between

- Impact Strength (Joules) vs. Welding current (A)
- Impact Strength (Joules) vs. Gas flow rate (lit/min)
- Impact Strength (Joules) vs. Welding speed (mm/min)

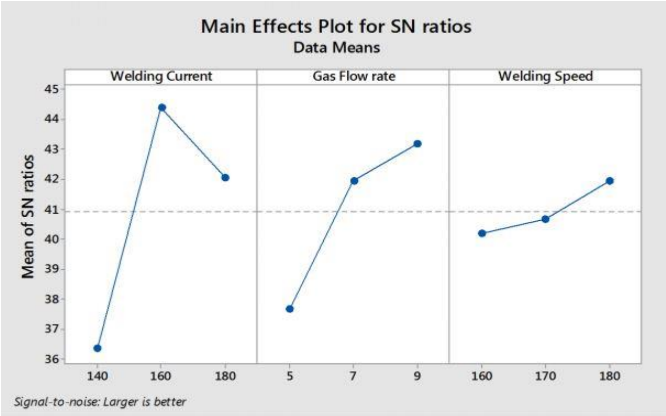

Fig.5 Main Effects Plot for S/N ratios of Impact Strength (Joules)

4.4 Micro structural Analysis

Microstructure is one of the most important metallurgical properties to check out the structure of the material at micron level. The grains of base material aisi 202 before welding are completely visible in the photo-micrograph at 100x magnification in figure 6.

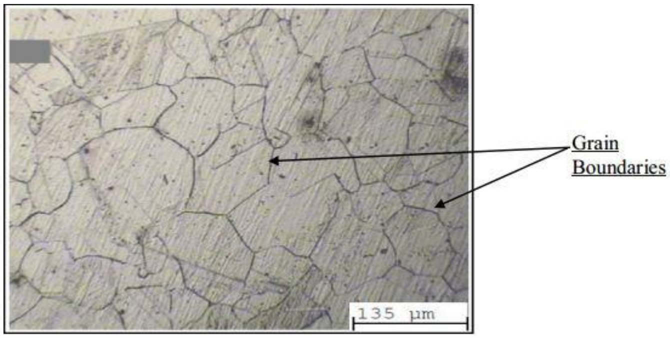

Figure 6: Photomicrograph (100X) of base material.

5. CONCLUSION

Conclusions which are drawn from the analysis of the results obtained from the present work are listed as following:

1. The AISI 202 Stainless Steel grade, when joined with GTAW process using 308l SS filler metal shows good weldability and the joint strength is adequate.

2. Among different welding process control parameters viz. welding current, shielding gas flow rate and welding speed, welding current can be judged as the most significant factor or parameter affecting the tensile strength, micro hardness and impact strength.

3. Corresponding to the welding parameters i.e. Welding Current 160 Amp, Gas flow rate 9 lit/min and Welding Speed 160 mm/min the Ultimate Tensile Strength and Microhardness has the maximum value of 800 MPa and 265 VHN respectively. With relatively lower impact strength. These welding parameters can be recommended for the requirement of joint where maximum the Ultimate Tensile Strength and Microhardness has to be achieved.

4. The desired value of Impact Strength is achieved at the corresponding welding parameters such as welding current 160 Amp, Gas flow rate 7 lit/min and welding speed 180 mm/min. These welding parameters can be recommended for the requirement of joint where maximum Impact Strength has to be achieved.

5. From the results obtained it can be stated that AISI 202 SS can produce the similar mechanical properties in comparison to 300 series type SS. AISI 202 SS is much cheaper than 300 series stainless steel which would reduce the cost when 202 type 67 is used instead of 300 series type SS for the application where tensile strength, hardness and impact strength are the considering factors.

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