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Study the Factors Effecting on Welding Joint of Dissimilar Metals

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Abstract

The aim of this work is to study the factors that affect the welding joint of dissimilar metals. Austenitic stainless steel-type AISI (316L) with a thickness of (2mm) was welded to carbon steel (1mm) using an MIG spot welding. The filler metal is a welding wire of the type E80S-G (according to AWS) is used with (1.2mm) diameter and CO_2 is used as shielding gas with flow rate (7L/min) for all times was used in this work.

The results indicate that the increase of the welding current tends to increase the size of spot weld, and also increases the sheer force. Whereas the sheer force increased inversely with the time of welding. Furthermore, the results indicate that increasing the current and time of welding increases the diameter of weld zone, and decreases the sheer force.

Keyword: *MIG spot, weld dissimilar metals, shielded gas.*

1. Introdaction

According to the good corrosion resistance and the good mechanical properties, the stainless steel, it has been used in many industrial applications, especially those, which need high corrosion resistance, since there are many aggressive mediums responsible for the corrosion of that alloy in chemical, petrochemical industries. The most common used series of stainless steel is austenitic type [1].

Some industries and for the reason of reducing the production cost use lining process (low carbon steel with stainless steel) especially with pressure vassals industry by some types of welding processes; one of these is MIG Spot Welding. Therefore, we study MIG Spot weldments of stainless steel AISI (316L) and low carbon steel in this research.

The AISI (316L) stainless steel is a type of a high alloy steel; it is a very important type because it has certain amounts of the alloying element and these elements increase thermal resistance and strength; therefore; this type of steel is very recommended [2].

Steels with less than (0.15%) carbon, known as low carbon steels, are easily joined by welding; these steels have very low hardenability. Rapidly cooled welded joint in steel containing about (0.10%) carbon and higher can develop cracks during serves cold forming operations because the weld area is harder than the unaffected base metal. Spot weld hardness is not a serious problem with these steels except for some critical applications [2].

1.1. Gas Metal Arc Welding (GMAW)

It is a once welding process that uses an arc between a continuous filler metal electrode and a weld metal**.** The process is used with shielding from an externally supplied gas and without the application of a pressure; it was developed in the late 1940 s for welding aluminum and has become very popular. This process is also called metal in arc gas (MIG) welding .There are many variations depending on the type of shielding gas, type of the metal transfer, type of the metal welded and so on. It has been given many names for example (MIG Welding, Co_2 welding, Fin wire welding, Spray arc welding, Pals arc welding, Dip transfer welding, Short circuit arc welding and various trade names) [3].

1.2. Gas Metal Arc Spot Welding (MIG Spot) (GMAW)

It is a process in which coalescence is produced by heating them with an arc between a continuous filler metal electrodes and the metal welded. Shielding is obtained entirely from an externally supplied gas or gas mixture. There is a number of variations of gas metal arc welding process and the process has been given many different trade names, which tend to create confusion. This method involves inert gas pumping during the welding process [4].

These inert gases are Argon, Helium or may be active gas such as Carbon-dioxide. Sometimes the gas used during the process is a mixture of two or more gases. The purpose of using inert gases is to prevent oxygen and waste gases from entering the welding region which causes failure in the welded joint [4].

2. Experimental Work

MIG spot welding process was selected to weld sheets of austenitic stainless steel – type AISI (316L) with thickness of (2mm) and the low carbon steel with thickness of (1mm). Tables (1) & (2) show the chemical compositions and the mechanical properties of the materials selected.

Table 1,
Chemical Compositions.

Specimen Materials	Composition wt %									
	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	Al
Stainless steel	0.03	1.48	0.58	0.025	0.01	18.33	8.33	0.2	0.19	0.01
Carbon steel	0.14	0.92	0.26	0.01	0.014	0.05	0.08	0.03	0.05	0.03

Table 2,
Mechanical Properties.

	Mechanical Properties	
	Stainless steel	Low Carbon steel
Tensile Strength (N/mm^2)	558.9	345
Yield Strength (N/mm^2)	269.1	193.2
Elongation%	55	28

Table 3,
Chemical Composition of the Welding Wire.

Elements	C	Si	Mn	Mo
Weight %	0.1	0.6	1.1	0.6

Yield strength = 460 (MPa).
Tensile strength = 530 – 570 (MPa).
Impact strength = 47J.
Elongation =22%

2.1. Welding filler metal

The type of filler metal used is AWS (E80S-G) of (1.2mm) diameter; this type consists of (Mn) (Si) as a deoxidize element added to obtain a high quality weldment using (Co_2) as a protective gas. Table (3) shows the chemical composition and properties for a filler metal [5].

2.2. Shielded Gas

The shielding gas is (Co_2) used with flow rate (7L/min.) for all times. (Co_2) gas is a protective gas; it is used to weld the steel and low alloy steel because sweetening (Co_2) to (Co + O).

2.3. Preparation of the Specimen

Preparation of the welding specimens depends on standers; see Figure (1) [6] .Table (4) shows the dimensions of the specimen.

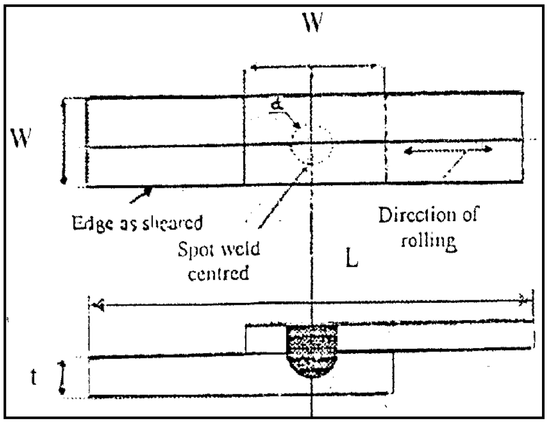

Fig.1. Specimen Dimensions' Dateless)[6].

Table 4,
Specimen Dimensions.

(t_1) Thickness of St.St. strip (mm)	(t_2) Thickness of C.St. strip (mm)	(w) Specimen width (mm)	(W_1) Lap width (mm)	(L) Specimen length (mm)
2	1	25	25	102

3. Results and Discussions

Table (5) shows the parameters used during welding and the results obtained from the share force test.

Table 5,
The Condition of Weld When the Flow Rate is (7L/min).

Specimen No.	Feed of wire (cm/min.)	Time of feed wire (sec)	Weld current (Amp)	Diameter of spot (mm)
1	109	1.5	300	8.5
2	109	3	270	7.2
3	109	3	300	9.5
4	127	1.5	220	8
5	127	1.5	240	8.5
6	127	1.5	270	9.5
7	127	1.5	300	12.5
8	127	3	180	7.25
9	127	3	200	7.25
10	127	3	220	7.5
11	127	3	240	7.5
12	127	3	270	9
13	127	3	300	11
14	204	1.5	180	8
15	204	1.5	200	9.25
16	204	1.5	220	9.5
17	204	1.5	240	10
18	204	1.5	270	11
19	204	1.5	300	12.1
20	204	3	200	8.5
21	204	3	220	9.75
22	204	3	240	11.5
23	204	3	270	12.2
24	470	1.5	220	7.8
25	470	1.5	240	9.5
26	470	1.5	270	12.2
27	470	1.5	300	13.75

Figure (2) shows that the shear force increases when the current increases from (180Amp to 300) at weld time (3sec.).

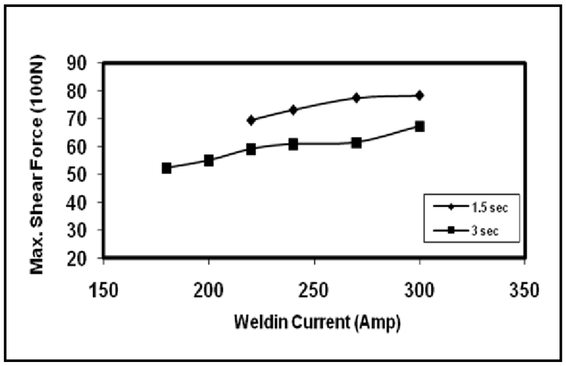

Fig.2. Relationship between Welding Current and the Max. Shear Force for Different Time of Weld With Wire Feed 127 cm/min.

These increases depend on the welding penetration and the size of weld spot; see figures (3&4).

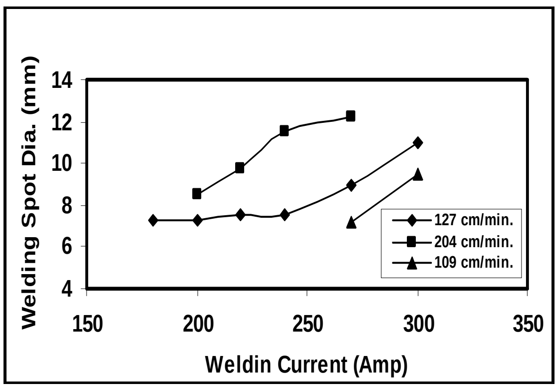

Fig.3. Relationship between Welding Current and Welding Spot Diameter for Different Wire Feeding at 3 Sec. Time of Weld.

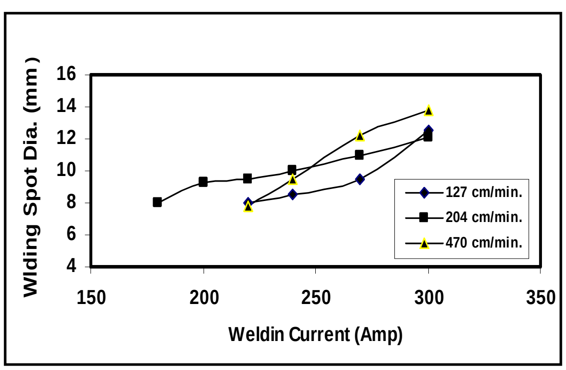

Fig.4. Relationship between Welding Current and Welding Spot Diameter for Different Wire Feeding at 1.5 Sec. Time of Weld.

But, at weld time (1.5 sec.) and current from (180Amp to220), no welding happens, because this period of welding time is not enough for thermal energy to pass through metal; see figures (2 & 4).

Figure (5) shows that increasing wire feed at (1.5 sec.) tend to increase shear force from (6821N at 180 Amp) to (7456 N at 300 Amp).

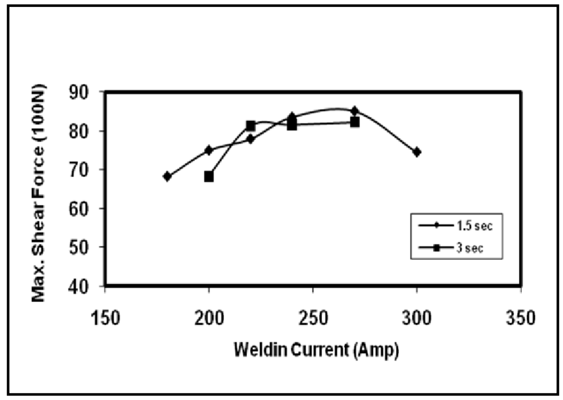

Fig.5. Relationship between Welding Current and the Max. Shear Force for Different Time of Weld With Wire Feed 204 cm/min.

So, when comparing figures (2 & 5), we found that welding took place at the rang (180 Amp to 220) when wire feed increased from (127 cm/min) to (204 cm/min).

Welding time is an important factor as a result of the amount of heat input effects. The shear force is proportional with the time at different wire feeds (figure 6) until it reaches the max value at (270 Amp); then it is proportional inversely because more heat input (long time of current flow) gives spattering of electrode metal's and over grain growth at the heat affected zone. Therefore, the failure occurs on the HAZ after welding in the range (270Amp to300) [7][8].

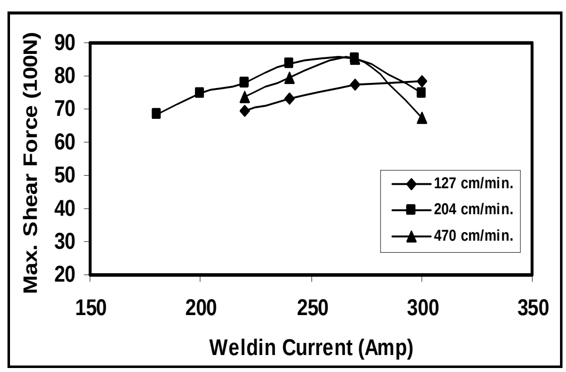

Fig.6. Relationship between Current and Shear Force for Different Wire Feeding at 1.5sec Welding Time.

4. Conclusion

1) Increase welding current tend to increase the size of spot weld, and also increases the shear force.
2) Shear force is proportional with welding time until it reaches the max value; then it is inversely proportional because of more heat input and over grain growth at heat affected zone with high current.
3) Increase the current and time of welding is proportional with the diameter of welding spot.
4) Increasing the wire feeding with the time of feed is proportional with diameter of spot.
5) The mig spot can be useful to lining process of stainless steel insipid of the traditional methods or process that be used recently.

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دراسة العوامل المؤثرة على وصلة اللحام لمعادن مختلفة

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الخلاصة

يهدف البحث الى دراسة العوامل المؤثرة على وصلة اللحام لمعادن مختلفة. تم استخدام الصلب المقاوم للصدأ الاوستنايتي – نوع (316L) وبسمك (2mm) والصلب المنخفض الكاربون بسمك (1mm) وتم لحامها بطريقة لحام النقطة باستعمال الغازات الواقية .تم أستخدام سلك لحام من نوع E80S-G) وبقطر (1.2mm) بالاعتماد على مواصفات جمعية اللحامين الأمريكية (AWS) . كما تم أستخدام غاز ثاني أوكسيد الكاربون كغاز عازل وبسرعة جريان (7L/min) لكل الازمان المستخدمة في هذا العمل.

اشارت النتائج الى ان الزيادة في تيار اللحام تؤدي الى زيادة في قطر نقطة اللحام والزيادة في قوة القص لوصلة اللحام ايضا. كما اظهرت النتائج الى ان زيادة قوة القص تتناسب عكسيا مع زمن اللحام للوصلة. كذلك اشارت النتائج الى ان زيادة تيار وزمن اللحام يؤدي الى زيادة قطر نقطة اللحام ويؤدي ذلك الى النقصان في قوة القص لوصلة اللحام.