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Evaluate the Weldability of Stainless Steel Welded in Different Methods

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Abstract

Weldability of duplex stainless steel (308) in leaser and tungsten inert gas (TIG) welding was studied in this paper. The conduct of this alloy has been compared with that of the austenitic (304) in tungsten inert gas process, welding has been performed without using fillers to weld austenitic stainless steel; While welding the duplex stainless steel, the filler was applied. In addition to laser welding process with (Nd-YAG) device in (1.25 KV) energy. Results showed increasing in heat input value during tungsten inert gas welding which produced mechanical brittleness in both steels types. In austenitic stainless steel, was attributed due to precipitation of carbides and the coarsening of austenite grains in the weld and (HAZ) regions, while that found in the duplex was attributed due to precipitate of sigma phase, and cabinetries. When welding by tungsten inert gas process using the respective filler for both steel, on mechanical brittleness was found to grow. And then as that laser welding did not produce mechanical brittleness in both steel, due to high rates cooling produced by laser welding that would prevent the precipitation of the press responsible for this brittleness.

Keywords: *Leaser welding; Tungsten inert gas welding (TIG); Duplex Stainless Steel*

Introduction

Duplex stainless steel consisting of two phases of transactions thermal expansion different made Weldability him less than Steel Austenitic, because the metallurgical composition consisting of two stages with different thermal expansion coefficient which causes the occurrence of cracks and other phenomena, which has reduced susceptibility butchery [1,2]. The choice of welding method suitable for duplex stainless steel depends on several considerations, including the design part to be butchery and thickness metal welded [3,4]. There are several variables for each welding method depends on the type of metal welded and desired depth for example, when welding in a way the tungsten inert gas (TIG) is the current user on several types of direct current with polar straight and direct current with polar reverse or AC with high frequency [5,6,7]. But when welding beam laser, the most important characteristic of this type of welding is not heating a large area adjacent to the weld any (HAZ) and that leads to reduce problems welding in addition to the precision with which we get from this type of welding through welding parts complex, especially for welding materials with contrasting thermal conductivity, as it is through this type beam energy can be converted to up to (50) which helps in welding operations and maintenance inside nuclear reactors [8,9].

Methodology

In this paper two types of alloy, stainless steel to alloy duplex stainless steel (308) and alloy, stainless steel Austenitic (304) were used and identified as ratios plug them as they are received and Table 1 shows the outcomes of the analysis of the Spartan used in the research.

Comp. %	Cr	Ni	Mo	Mn	C	Si	P	S	N	V	Nb	Ti
308	20.8	5.7	2.5	1.5	2.02	0.63	0.13	0.01	0.13	0.64	0.03	0.01
304	17.5	8.2	0.15	0.63	0.05	0.91	0.03	0.08	0.08	0.05	0.03	0.01

Table 1: *Chemical Analysis of Alloys Used.*

Table 2 shows details of the welding operation, where you can modify the value of the heat entering through the control of each of the electromotive force or speed welding and through the next equation:

$$HI = (V \times I) / T_S$$

Where:

HI = Heat input.

V = Voltage.

I = Current.

T_S = Travel speed.

Velocity of welding procedure is not being able to hold it very carefully because the welding process was manual and not automatic that affect not equal the sum of heat entering along the weld seam. To thin out this problem has conducted preliminary welding processes numerous other pieces (Scraps) before starting weld any piece to check the focal ratio of welding. The welding process Laser has been applying a device (YAG) single card is (1.25 KV) and time-pulse welding (Pulse Duration) (10) milliseconds wavelength (1.60) in the middle of the samples after cutting operations so as to compare them with the Method (TIC) hand, and has welding process these overlapping pulses (so that the length between the heartbeat and other (0.2) mm and at a rate (20) beats/minute.

Gas %	Gas pumps velocity (liter/min)	Shield welding diameter (mm)	Tungsten electrode diameter (mm)	Wire feed velocity (m/min)
Argon % 99.99	10	1.56	1.56	120

Table 2: *Details of the Welding Operation.*

Parameter Input Heat	Voltage (V)	Current (A)	Velocity (mm/min)	Input Heat (J/mm)
First heat (Low)	34	8	148/60	110
Second heat (Medium)	40	12	128/60	225
Third heat (High)	49	15	120/60	267.5

Table 3: *Welding Process without Using a Welding Shield.*

Parameter Input Heat	Voltage (V)	Current (A)	Velocity (mm/min)	Input Heat (J/mm)
First heat (Low)	42	13	126/60	260
Second heat (Medium)	44	14	123/60	300
Third heat (High)	50	16	100/60	480

Table 4: *Welding Process by Using a Welding Shield.*

Results and Discussion

Welding by Tungsten inert gas (TIG)

In Figure 1, the effect of heat input the stress, strain curve, where show decreasing in ductility on Austenitic steel when increasing the value of heat input during the welding process, so that the value of the elongation percentage using high heat included (390 J/mm) is 28%, while it will be This value of (84%) for Stainless Steel, and the reason for this is to increase the value of the heat input that lead to obtain big Austenitic particles in the area of thermal effects (HAZ). As easily as the endurance of this region when high temperatures for a long time relatively leads to probability of precipitation of brittleness phases in this arena.

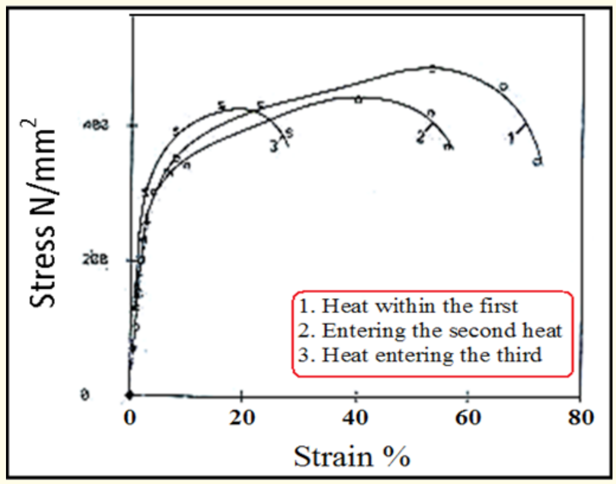


Figure 1: *Austenitic Stainless Steel (304) Welded Without the Use of Welding and Fillings.*

Despite the fact that it has not been brought out clearly through research in addition to the high temperatures lead to get the dendrite particles in the wedding ring and that's show installation metallurgical Austenitic steel welded using temperatures falling as high as shown in Figure 2, so we can say that stainless steel cannot be welded to these wires when using high temperature, but when you use welding fillings.

Notice that the effect of heat input be clear on the value of the elongation percentage, as shown in Figure 3 where reduced ductility at increasing input heat, so that the elongation percentage using heat included and low (110) J/mm is (32) while this value using heat included high (390) J/mm is (12) while this value Double X Stainless Steel is (45%). The reason for this is due to the increased value of the heat input leads to a shift a large part of the process Ferrite to Austenitic in welding as well as in the area of thermal effects (HAZ).

It is known that the process of Austenitic characterized fragility, high (after conversion to Martensite) so it's whenever increasing quantity increase heat input increases brittleness as shown in Figure 4. In addition to the high temperatures lead to get particles thick in the area of thermal effects due to the survival phase in that region long period of time and relatively get crystal growing of these particles, as though the survival of steel double for a long time when these grades thermal working on the deposition carbides brittle in the welding and (HAZ) and this carbides are clear in the area of thermal effects (HAZ). Figure 5 represent the effect of heat input on the value of elongation percentage of Austenitic stainless steel where noted that the decline in the percentage of elongation (ductility) at increasing the value of heat input during the welding process and using padding welding is not clear which is the opposite of what has been observed when conducting welding without use padding where there is no reduction in the percentage elongation at use heat lowlands and medium either when using the high temperature there was a slight decline.

The main reason for this is due to the use of fillings welding that help stabilize composition metallurgical to the regions of the welding area thermal effects as a result of nickel content high in this type of charge, either when you use high heat, can explain the decrease in ductility to the formation of Dendrite particles in welding as well as for crystal growth Austenitic particles. Figure 6 represent the effect of heat within the duplex stainless steel when welded using welding filler type (22.8.3.LN) where it is noted that the increase in temperature within lead to a decreasing in the value of the elongation percentage steadily and as it is the case when you are not using filler welding. And the cause of this brittleness that appear are changes metallurgical that lead to get this kind of brittleness through deposition phases fragile like carbon rut and Carbides in the thermal effects that would occur this type of failure, that the use of padding welding contained a high percentage of nickel and nitrogen higher than it is in the metal base where it is not possible to reduce obtain such brittleness but could help in obtaining a result contain filler on nitrogen and containing metal base on carbon so that the use of heat-lying with this kind of charge does not lead to obtain fragility when compared to the value of the percentage of elongation of the metal is welded and welded using this heat and this means that the heat lowlands be optimal to reduce get brittleness.

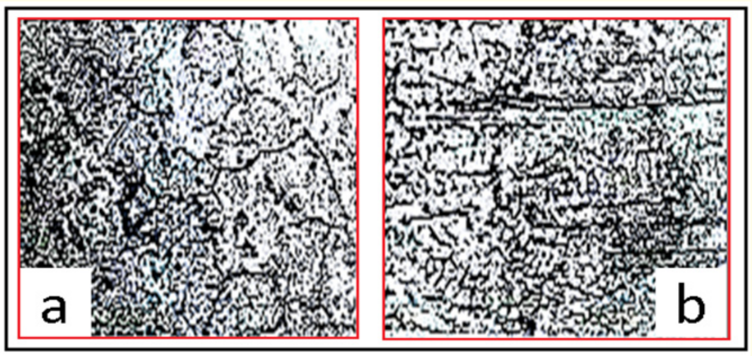


Figure 2: *Austenitic Stainless Steel (304) Microstructure without Using Welding Fillings (200X) (a) The Welding Area When Using Medium Heat (b) Area Welding When Using High Temperature.*

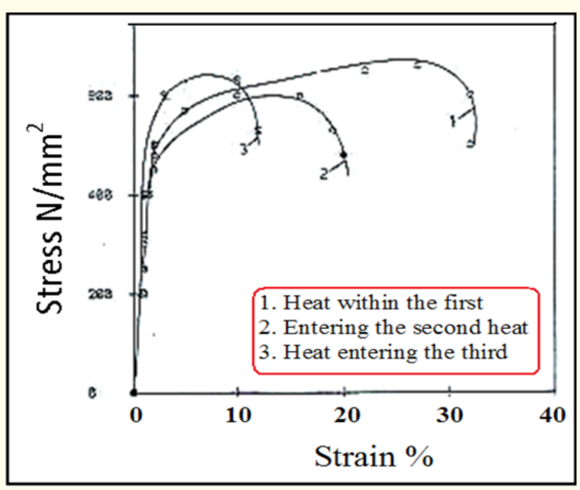
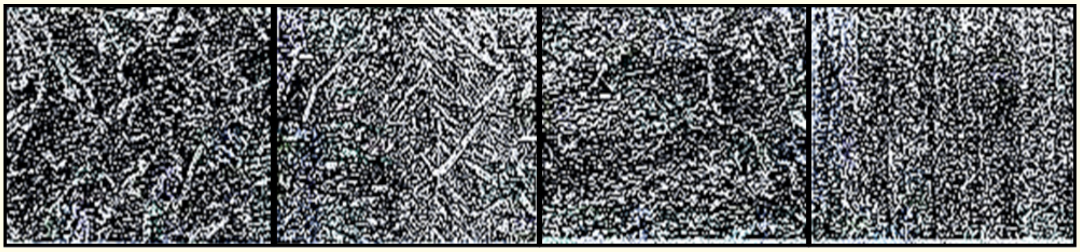


Figure 3: *Duplex Stainless Steel (308) Welded Without the Use of Welding and Fillings.*



Welding at high temperatures without use of filler (the weld HAZ region) | *Welding at medium without use of filler (the weld HAZ region)* | *Welding at low without use of filler (the weld HAZ region)* | *As received*

Figure 4: *Microstructure of Duplex Stainless Steel Welded Without the Use of Welding Fillings (200X).*

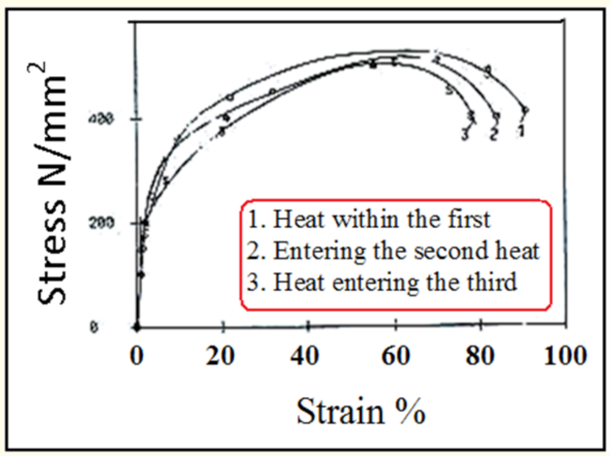


Figure 5: *Austenitic Stainless Steel Welded Using Welding and Fillings.*

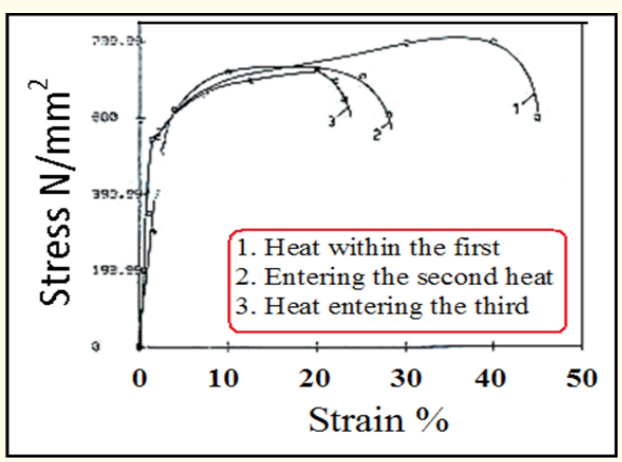


Figure 6: *Duplex Stainless Steel Welded Using Welding Fillings.*

Laser Welding

When you notice the Figure 7, we find that the laser welding of Austenitic stainless steel tip (304) leads to a decline in the value of elongation percentage, and that this decline that accompanies the welding process (TIG) except when using heat-lying and this means that the welding laser does not lead to deposition phases leading to fragile for such a decline and these phases are developed Sakma and carbonated that have an impact in get brittleness. But nonetheless remain the welding area (very weak in this case compared with information (TIG) is the most fragility compared to the base metal as it gets broken then when testing. Notes through the Figure 7 that the laser welding of steel double type (S318), do one hand ductility is less than is the case when welding (TIG) case if Austenitic steel, where shows that the decline in the percentage of elongation associated when laser welding is less than that associated with when welding in a way the (TIG), and reason for this is also that brittle phases deposited in this case and that lead to reduced ductility is less because the process of laser welding accompanied high temperature and cooling rate is too high, where the region molten very narrow and that formed when laser welding solves then fracture, and this shows that the welding area remains weaker than the base metal.

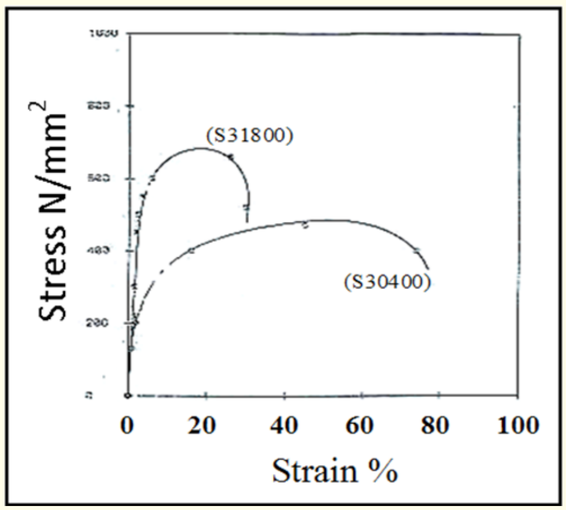


***Figure 7:** Austenitic Stainless Steel (304) and Duplex Stainless Steel (318) Laser Welded.*

Conclusion

Increase heat input when welding in a way tungsten inert gas (TIG) and without the use of welding filler lead to reduced ductility of both steel dual Austenitic and, caused by the deposition phase fragile a Carbides in steel Austenitic developed Sakma and carbon triad steel double. Use stuffing welding type (S 30800) for solid Austenitic type (304) and type (22.8.3.LN) for dual-core type (318) led to maintaining the high ductility characterized by those species in the case of seamless, when welded manner (TIG) and all temperatures involved, except where he accompanied by a slight decrease in ductility. Laser welding did not lead to significantly reduced ductility as it is when all welding temperatures falling way (TIG) without the use of welding filler. Preferably steel welding Austenitic type (304) using welding fillings for welding at high temperature.

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