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Effect of various Shielding gases on the Penetration in the GTA welding Stainless steel- A Review

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Abstract: *One of the most important parameter that affects the strength and stability of the weld joints is Penetration. A comprehensive set of experiments to determine specific effects of shielding gas compositions (consisting of pure argon, pure helium and different argon composition) on penetration was conducted. The performance of various combinations of shielding gas in Gas Tungsten arc weld was observed. The Investigation is undertaken to find the optimum gas composition that will satisfies the penetration with little effect on the Metallurgical properties of stainless steel. Though the addition of SO2 was observed that improves the penetration but also changes the mechanical properties of the weld joints, but it can be studied that the use of Argon with oxygen and carbon dioxide gives the positive result on the penetration of weld joints with considerable effect on the weld properties and welding process.*

I. INTRODUCTION

It The shape of GTA welds has long been of concern, in part because the GTA welding process tends to be used in applications where high quality, high precision welds are required It has been found that in GTA welding the deeper penetration in the stainless steel will ultimately increases the strength and tearing resistance. Deeply penetrating welds showed three to four times the plastic extension as compared to the weld without penetration. (Ref 1).

The penetration in the weld joints is depends upon the many factors like wise static and the variable which can be change during the welding process. Some of static factors are metal composition, internal stresses, contaminants on the metal surfaces etc. While variable factors are tool geometry, flow rate, gas composition, voltage, arc gap, welding speed etc. It have been proposed in different research that joint penetration is altered due to two main parameters

1). Presence of certain trace elements which affects the Surface tension gradient and ultimately fluid flow in weld pool.

2). Thermal conductivity of gas affects the shape of the weld bead and condition of the metal next to the weld [3].

And above two parameters can be found to be greater influence on the gas composition. Different gas composition can be used to have sufficient control on the above parameters and ultimately on weld shape.

It is found that in periodic table Group 6 nonmetal elements can be used as trace elements which increases the surface tension in the weld pool. Example of such surface active trace elements is Bismuth, sulfur, oxygen. Among this all elements the sulfur is effectively work as a surface active trace element. While oxygen have less effectiveness as compared to sulfur.

Thermal conductivity is important, because a gas w i t h good thermal conductivity will help to conduct heat into the work piece. Degree of thermal conductivity has been reported to affect the shape of the weld bead and the c o n d i t i o n of the metal next to the weld. Helium's high thermal conductivity relative to that of argon is one factor why welds made w i t h helium show a broader weld puddle.

II. INVESTIGATION OBJECTIVE

The objectives of this investigation were to:

1. The enhancement of the penetration in weld joint is done by using different Shielding gas composition.
2. The penetration enhancement should not done regardless to the mechanical properties.
3. The optimum balance between the weld penetration and mechanical properties.

III. SHIELDING GASES

In GTA welding of the Stainless steel 304 the inert gas (Ar and He) is used with the certain non-metal gases in order to obtain maximum penetration (C02, SO2 and O2). Since Pure Argon or pure Helium cannot be used on GTA welding for Stainless steel because both have its distinct disadvantages such as helium does not assist in cleaning the oxide from SS304 plate, and its high ionization potential results in difficult arc initiation and poor arc stability. A greater flow rate is also required with helium because of its lower density. (Ref 3)

While Argon has low thermal-heat-conductivity. It has a narrow weld and a deep central penetration. There's not enough heat to "wet out" the puddle to the outer edges. This results in severe undercut.(Ref 4).So metallurgically using a pure inert gas is not advisable. It results in addition of some active gas compound in order to overcome this limitation.

IV. GAS COMPOSITION (ACTIVE GAS COMPONENT)

Surface-active trace elements, when present in sufficient quantity in the weld pool, create a positive surface tension temperature dependence Under these conditions, the surface tension will be highest near the centre of the weld pool and an inward surface fluid flow results relatively deep, narrow weld beads In iron-base alloys, sulfur and oxygen are the surface-active trace elements most commonly present. But stainless

steel content low sulfur and oxygen (less than 10 ppm each). Such steels exhibit poor joint penetration in GTA welding creates wide shallow weld pools create a number of significant welding problems.

One approach to improving GTAW joint penetration and reducing variable joint penetration is to add small concentrations of surface active elements to the weld pool. (Ref 2)with this the same addition of the CO2 also examined for the results Since the addition of these gases may increases the penetration but there is a chances of negative effect on the metal as well as welding process.

Since there is some other gases such as Nitrogen compound gases are also used for the better performance and good results but this compounds have no significant effect on the penetration of the weld joints so it is not included in the study.

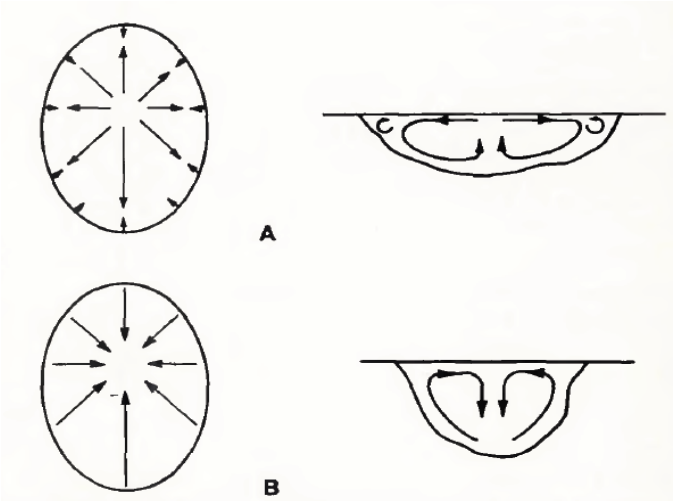

Fig.1. A Fluid Flow in Pure metal B Fluid Flow when surface active trace element is present in metal [2]

V. RESULT AND DISCUSSION

A. Sulfur

Effective penetration is observed if the sulfur content in the Argon is more than 700ppm and effect of sulfur on the penetration is continue until 1400ppm as shown in the fig.

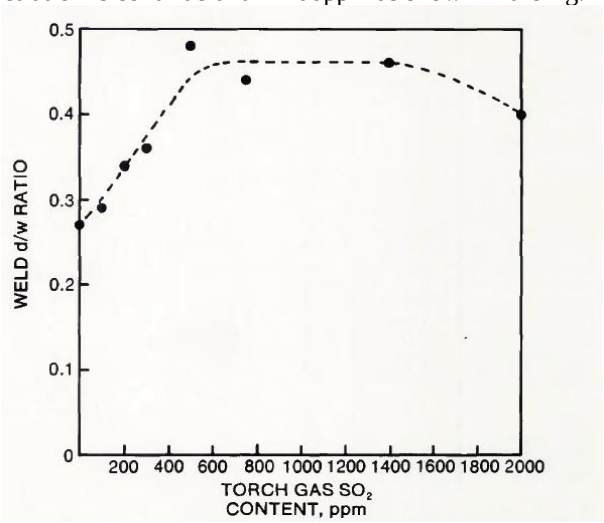

Fig 2 Effect of Sulfur dioxide in shielding gas in GTA welding depth/width ratio (Ref 2)

Penetration is increased with the sulfur content in the shielding gas but Sulfur is generally undesirable in steel may causes hot cracking and reduce the toughness. While addition of 30 ppm sulfur in the stainless steel is tolerable. There are potentially significant problem in using SO2 in the weld shielding gas. Sulfur dioxide is toxic, with permissible concentration far below the levels required for welding [5].

B. Oxygen

As shown in the fig. 3 the penetration become maximum around 400 to 600 ppm of oxygen is mixed with the argon. But oxygen has also its limitation that Beyond 5% Oxygen levels, fume emissions become a problem. And greater content of oxygen in the shielding gas will result in the oxidation of the alloy which is result in lowering the strength and toughness of the Weldments.[6]

C. Carbon dioxide

It is a common shielding gas for any of the stain less steel. Carbon dioxide is composed of 72% oxygen and 29% carbon. Since the pure carbon dioxide is not inert gas because the heat produced will break the whole gas in to CO2 into carbon monoxide and free oxygen. This oxygen will combine with elements transferring across the arc to form oxides which are released from the weld puddle in the form of slag and scale. The pure carbon dioxide does not produce the effective spray transfer and causes lower deposition efficiency for CO_2 caused by spatter loss. So it is impractical to use pure carbon dioxide for shielding gas.[7]

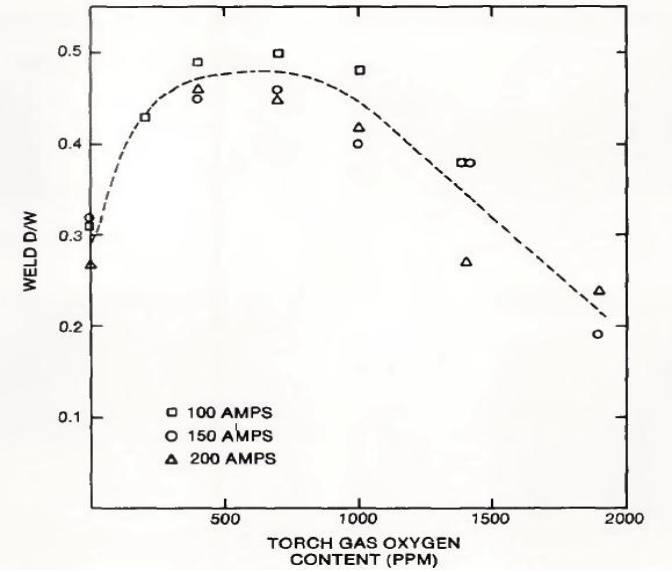

Fig.3 Effect of Oxygen in shielding gas in GTA welding depth/width ratio [2]

D. Gas Compositions (binary and ternary gases)

1) Argon + Carbon dioxide.

Small percentage of CO2 is added to argon in order to get good result in Penetration of weld joints. Since this binary mixture have high heat conductivity due to Carbon dioxide and good spry transfer due to argon. By optimizing the amount of CO2 in the argon mixture, the fluidity of the weld puddle can be controlled to give good bead shape in a variety of welding positions. As the amount of CO2 in the mixture is

increased, penetration will broaden and become less fingerlike. There may be a reduction in fume levels by as much as 25%–50% when using an argon/CO2 mixture as opposed to using 100% CO2[8]

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2) Argon + Oxygen

Oxygen reduces the surface tension of the weld pool and enhances its flow characteristics. This will results in increment in the penetration of the weld joints. On thin material, travel speeds can be increased when using a spray transfer mode due to the lower voltage required. But with all these advantages these mixtures have a tendency for crater cracking due to bead shape and puddle fluidity.[8]

3) Argon + carbon Dioxide + oxygen

The advantage of this mixture is its ability to use any metal transfer mode to shield carbon steel and low-alloy steel of all thicknesses. The disadvantage of this mixture is expense. It also offers no real advantage over dual blend shielding gases of argon/CO2 capable of all modes of metal transfer [8]

VI. Conclusion

Result of the above study indicates the following conclusion on the shielding gas composition and penetration interrelationships in the Gas tungsten arc welding of the stainless steel.

1. Pure argon have problem of the low heat conductivity so its penetration shape become fingerlike.
2. Pure Helium need more flow rate as its density is low and its cost is also focusing parameter.
3. Pure Carbon dioxide cannot be used for the shielding gas because of the low spray transfer
4. Penetration is increased as SO2 content in Argon gas is increased but the presence of SO2 in the stainless steel reducer the toughness and produce Hot cracking in the welding Joint.
5. Penetration is increased if the Oxygen content is increased in the Argon but more than 5% of oxygen will increase the Fume emission and also the tendency of the Crater cracking of the weld bead.
6. CO2 addition in the argon shielding gas will produce the deeper penetration and recommended as a good shielding gas for the effective penetration.
7. Mixture of Ar,Co2 and O2 is effective for all depth of thickness but its cost is high enough and have not considerable advantage on the blend of Ar and Carbon dioxide.

References

1. Robb C. Wilcox 1995.The effect of weld penetration on the tensile strength of fillet weld joint.
2. C r. Heiple and p. Burgardt 1985. Effects of SO2 Shielding Gas Additions on GTA Weld Shape
3. W. R. Reichelt, j. W. Evancho and m. G. Hoy 1980. Effects of Shielding Gas on Gas Metal Arc Welding Aluminium.
4. www.millerwelds.com pure argon with GTA welding of stainless steel.
5. Sax, N. I. 1984. Dangerous Properties of Industrial Materials, 6th Edition: 2486-2487. New York: Van Nostrand Reinhold Co.
6. Viwek vaidya 2003. Applications of Shielding Gases & Modes of Metal Transfer. wps America.com.
7. http://www.esabna.com Handbook shielding gas for the TIG welding.
8. Devid Hoffman, Kevin Dahle, Devide fisher.2012 Welding, PHI publication.