EFFECT OF SHIELDING GASES ON THE PERFORMANCE OF WELD BEAD IN MIG WELDING

36

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ABSTRACT

The function of a shielding gas is to protect the molten metal and the electrode end against atmospheric contamination. The major shielding gases used for metal inert gas (MIG) welding are argon, helium and carbon dioxide. In order to study the effects of these three shielding gases and which gas combination provides the best overall performance and economic advantages, a series of experimental welds were performed employing various gas matures and straight uses of argon, helium and carbon dioxide. Only when no shielding gas was used, the evidence of atmospheric contamination has been found. It appears that the amount of spatter is directly proportional to the amount of carbon dioxide used in the shielding gas. Straight carbon dioxide produced the deepest penetration, but also the worst weld surface appearance. Weld bead profile and finish were significantly enhanced by the addition of either helium or argon.

INTRO DUCTION

Shielding gas series to keep harmful atmospheric gases, such as oxygen, hydrogen and nitrogen away from the weld as the molten metal solidifies. These elements, when not effectively kept away from the liquid metal as it solidifies, produce in ferrous metals the majority of weld defects, such as porosity, blowholes and weld brittleness. Therefore, therefore, the type of shielding gas used can have a profound effect upon many of the weld and base metal properties as well as the finished weld bead appearance.

Effect of Oxygen

Oxygen is a major element in gas contamination of the weld metal as it is present in significant quantities in the electrode wire. Oxygen is also present in the atmosphere, in the parent metal as oxide or scale. Oxygen maybe absorbed into the weld, forming iron oxide. Iron oxide may react with carbon in the stee31 to form carbon monoxide resulting in blowholes. If iron oxide is present, oxidation of the weld will occur and this will produce a great increase in the grain size. Absorption of oxygen by weld reduces its tensile strength and ductility and decreases its corrosive resistance.

Effect of Hydrogen

The main source of hydrogen is the atmosphere. Hydrogen begins to diffuse out of the weld metal immediately after the welding process and continues to do so over a long period. The presence of hydrogen reduces the tensile strength of the weld, makes the arc erratic and contributes to the formation of micro cracks or larger cracks.

Effect of Nitrogen

Nitrogen is present in the parent metal, the electrode wire and in the atmosphere. Because of its solubility in iron at the elevated temperature, nitrogen precipitates out of the iron as it cools, forming iron nitride. Nitrogen tends to increase tensile strength and hardness, decrease ductility and impact resistance and also lowers the corrosion resistance.

EXPERIMENTAL SET UP

In the metal inert gas (MIG) welding process, a consumable wire was fed at a preset speed through a welding torch where in it was provided the electrical connection and the shielding gas. The arc, which was struck by direct contact between the wire electrodes and the work piece, was maintained at a constant length by the interaction of electrical parameters. The system was made sensitive by the use of constant voltage power source and thin welding wire. The welding parameters are given in Table-1. The chemical composition of electrode wire is given in Table-2. The base metal is mild steel. The shielding set up is shown in Fig 1.

SHIELDING GASES

The major shielding gases used for MIG welding are argon, helium and carbon dioxide.

Argon

It is a non-consumable, non-expensive gas obtained from air by deep refrigeration and fractionation, wherein it is present to the extent of 0.93%. It is about 23% heavier than air. Argon is non-toxic but can cause as phyxiation in confined spaces by replacing the air. In a standard cylinder, the gas is kept under a pressure of I5 N/mm^2.

TABLE 1: **Welding Parameters**

Parameters	Units	Quantity
Welding current	amp	280
Wire diameter	mm	1.2
Wire-feed speed	mm/sec	146.7
Melting rate	kg/hour	4.66
Air travel speed	mm/sec	6.17
Electrode extension	mm	21.6
Gas feed rate	litre/min	15
Pre heat and inter V pass temperature	^0C	120-150
Position	—	FLAT

TABLE 2: **Composition of Wire Electrode**

Particular	**% By Weight**
Carbon	0.11
Manganese	1.49
Silicon	0.82
Phosphorous	0.02
Sulphur	0.015
Oxygen	0.0095
Iron	97.53 (Remainder)

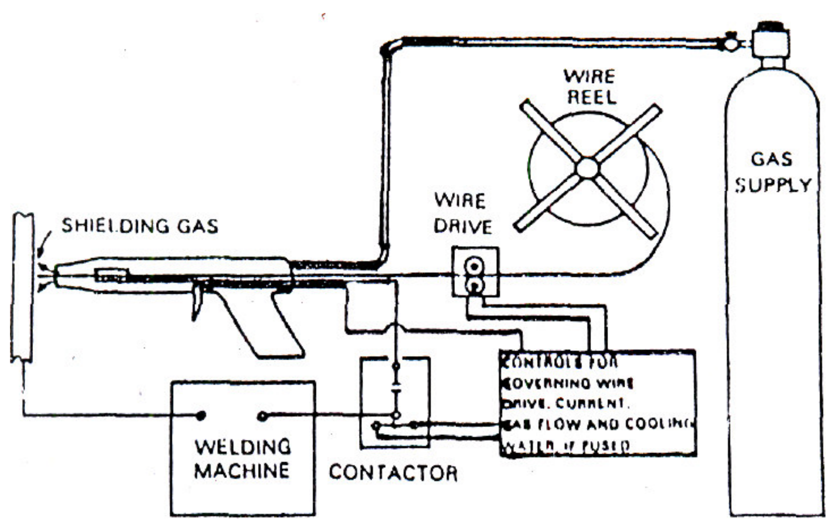

Figure 1: Schematic Representation of MIG Welding

Helium

It is a rare gas. It is present in atmosphere to the extent of only 0.52 x 10^{-1} %. It is a light gas weighing only I/7th that of air. This complicates the weld pool protection and results in increased gas consumption on account of its high cost, helium is comparatively less used inert gas. It is, stored in standard gas cylinder under a pressure of 15N/mm.^{2}

Carbondioxide

It is a colourless gas with a slightly perceptible odour. When dissolved in water it gives an acidic taste. It is about 1.5 times heavier than air. Industrially, carbondioxide is prepared by calcination of coke or anthracite in specially designed boiler fire boxes. A standard 40 litre cylinder holds 25 kg of liquid which produces about 15 m^3 of gas on evaporating. The pressure of the gas in the cylinder depends on the temperature which goes down as more gas is tapped from the cylinder.

A series of experimental welds were performed employing various gas mixtures and straight uses of argon, helium and carbondioxide.

RESULTS AND DISCUSSIONS

Weld beads were made on flat test plates and the test results are discussed.

EFFECT ON BEAD CHARACTERISTICS

No Shielding gas

The effect of no shielding gas on the bead is shown in Fig. 2. Weld porosity and inclusions can be seen very clearly.

100% Argon

The test specimen as illustrated in Fig. 3 has high bead profile and poor penetration. The

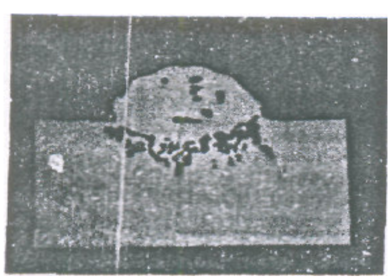

Figure 2: No Shielding gas

Figure 3: 100% Ar

surface appearance was rough with/a number of high and low spots. 100% Argon as a shielding gas is not recommendable because of its high cost and poor penetration.

100% Carbondioxide

The specimen shown in Fig. 4 exhibits a medium rough and irregular surface having a slightly inconsistent bead height and width. It also reveals small glassy scales along the edges. The bead ripples were not uniform. The use of only carbon dioxide produced on aggressive, violent arc and large amounts of spatter around the plate surface. There is deer) weld penetration. Formation of large spatter would be most undesirable, considering operator safety and comfort and also be a nuisance to remove from welded products requiring clean surface.

80% Carbondioxide, 20% Argon

This mixture doesn't produce either a good bead appearance or profile, and it was narrow and irregular in shape with a high bead profile. Fig. 5 reveals a narrow finger of penetration with evidence of unfused metal along the outer edges, as well as an apparent increase in the amount of weld spatter.

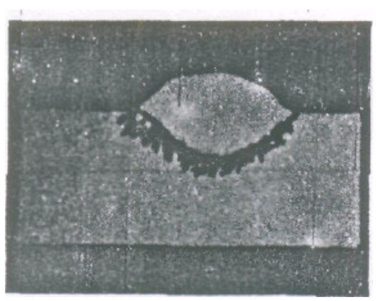

Figure 4: 100% CO_2

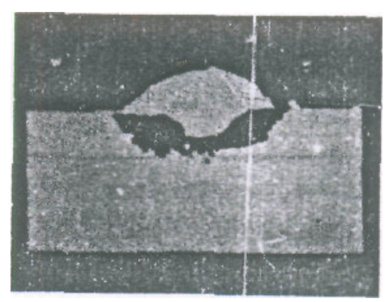

Figure 5: 100% CO_2, 20% Ar

80% Carbondioxide, 20% Helium

This mixture proved to produce good results. The weld bead profile and surface finish of the specimen were excellent as shown Fig. 6. The penetration is deeper and more uniform.

60% Carbondioxide, 20% Argon, 20% Helium

The base surface appearance was nearly the same as that of 80% carbon dioxide and 20% Helium, with a little less regularity in the bead rippling. The penetration is uniform and broader (Fig. 7).

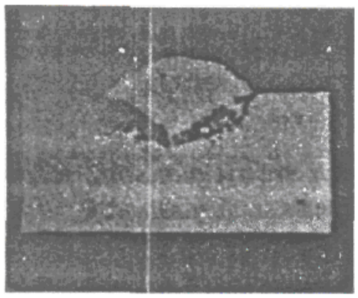

Figure 6: 80% CO_2, 20% He

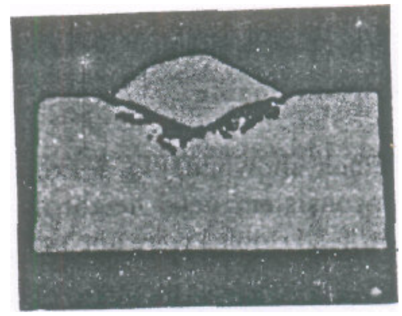

Figure 7: 60% CO_2, 20%Ar, 20% He

EFFECT ON ALL -WELD PROPERTIES

The mechanical properties of weld beads performed with different gas mixtures are given in Table 3. The mechanical properties are improved using gas mixture of 80% carbondioxide and 20% Helium. This gas mixture exhibits high tensile strength and low impact strength. This might be due to deeper and uniform penetration and reduced loss of alloying elements in the form of spatter.

TABLE 3: All Weld Metal Properties

Gas Mixtures	Tensile strength N/mm^2	Yield strength N/mm^2	Elongation %	Reduction of Area %	Impact strength J
100%CO,	538	422	26.9	68	67
80% CO_2 20% Ar	562	435	25.6	68	64
80% CO_2, 20% He	609	490	24.9	66	35
60% CO_2 20% Ar, 20% He	592	485	22.1	66	63

CO_2 : Carbon dioxide

Ar : Argon

He : Helium

CONCLUSION

There was an evidence of atmospheric contamination of weld bead when the shielding gas was not employed. It appears that the amount of spatter is directly proportional to the amount of carbon dioxide used in the shielding gas. The use of carbondioxide only produced the deepest penetration, but also the-Worst surface appearance. Weld bead profile and finish were significantly improved by the addition of argon or helium.

Helium had a greater effect in controlling the amount of spatter than did argon when added with the higher percent mixtures of carbon dioxide. The best over all performance including cost advantages for a given shielding gas used in MIG welding of mild steel was achieved by using a gas mixture of 80% carbon dioxide and 20% Helium. This mixture produced good weld bead profile appearance, uniform and deep penetration with improved all-weld metal properties.

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