CO_2 WELDING

TABLE OF CONTENTS

01 INTRODUCTION

- MAG welding is welding in an atmosphere of reacting gases, or as it is also called: shielded by an active gas.
- This means that the gas is separated in the arc and to a smaller or larger extent reacts with the weld pool.
- CO_2 is mainly used as shielding gas which is why the process is also known as CO_2 welding.
- CO_2 welding is used for welding of carbon and low carbon sheets from 16 gauge (0 to 0.54 inch) to ¼ inch.
- It produces deeper penetration than argon.
- CO_2 is basically a semi automatic process, ion which the arc length and the feeding of electrode wire into the arc automatically controlled.
- CO_2 may be used in mechanized and automatic forms where productivity is to be increased and quality demanded.

02 CO_2 WELDING

- In CO_2 arc welding, the welding wire wound in coil is fed into the welding torch by the feeding motor automatically.
- The welding wire that is electrified through the contact tip becomes the electrode to strike an arc between itself and the base metal.
- The arc heat melts the wire and the base metal to join two pieces of base metal.

- In this case, in order that the weld metal will not be affected by oxygen and nitrogen in the atmosphere, CO_2 gas is supplied from the nozzle of the welding torch to shield the weld pool.
- Its schematic is shown below.

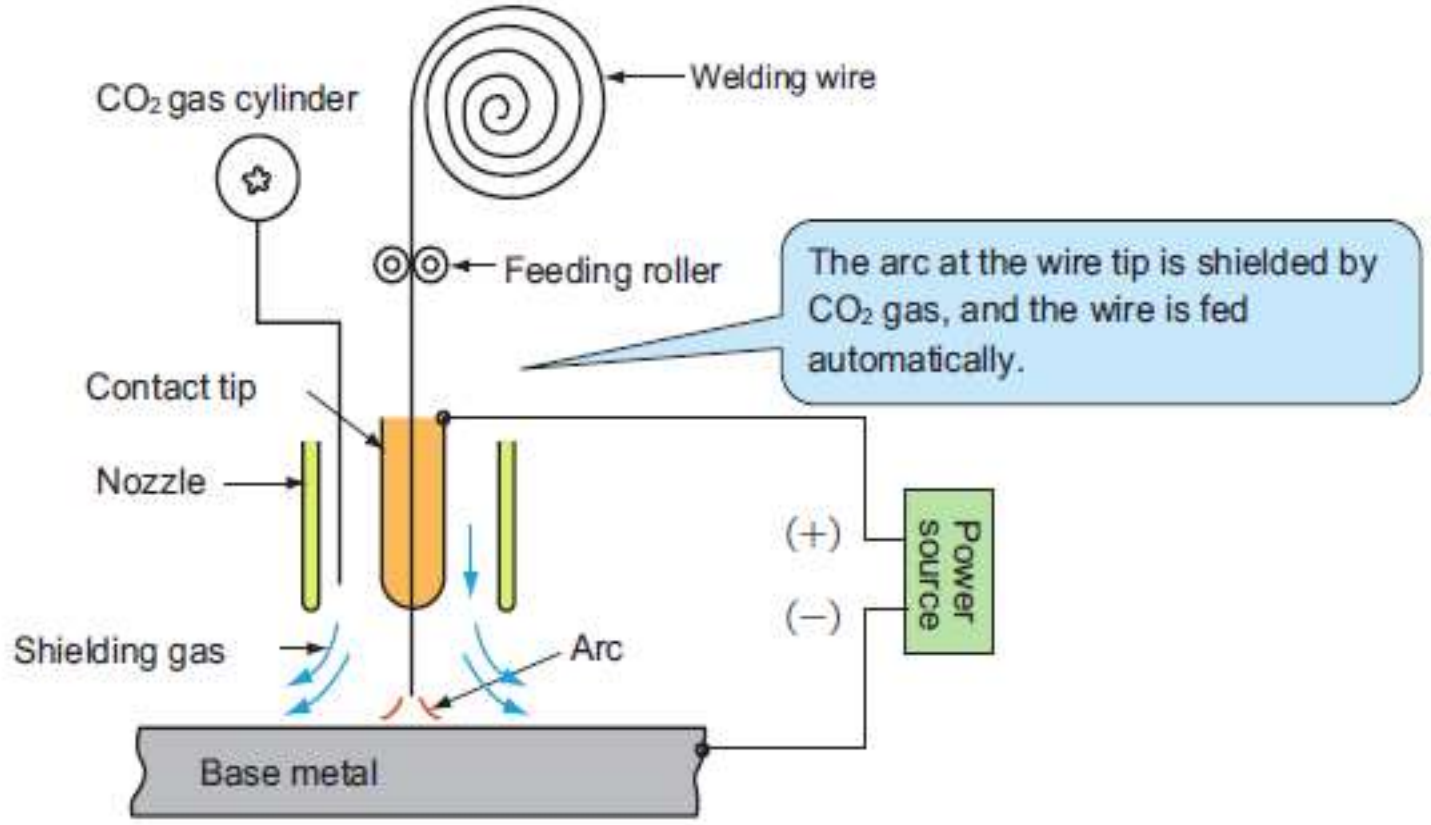


Fig. 1 Schematic diagram of semiautomatic CO_2 arc welding

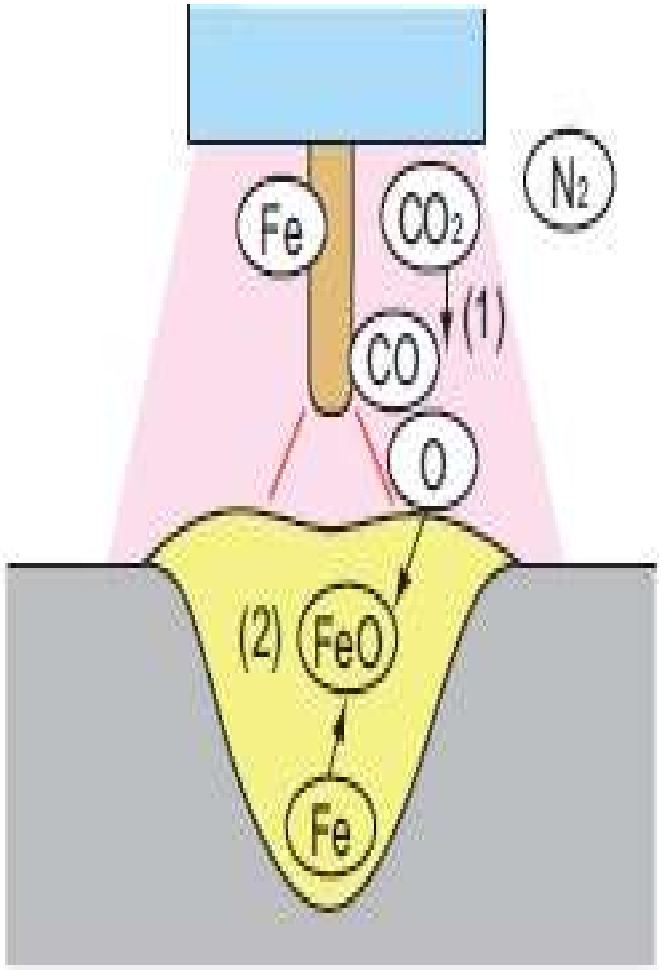
03 PRINCIPLE OF PROCESS

- Iron becomes brittle when it combines with nitrogen that exists much in the atmosphere. CO_2 gas, therefore, is often used to shield the weld pool from the atmosphere. CO_2 gas can be decomposed by the ultra−high temperature arc heat into CO and O near the arc.

$$CO_2 \rightleftarrows CO + O \cdots (1)$$

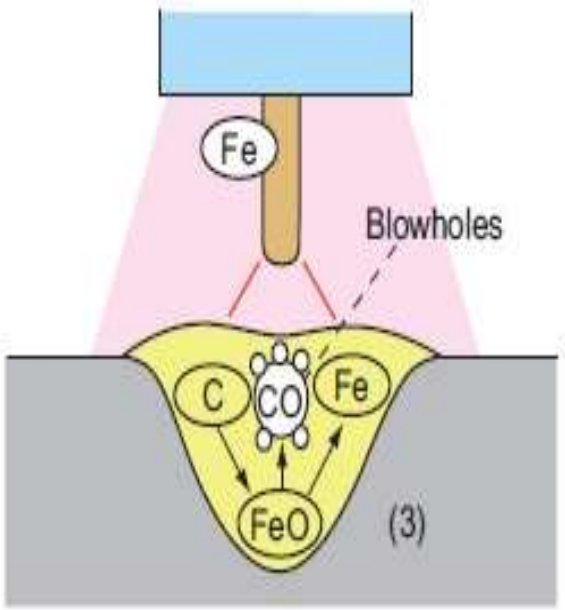
- The decomposed O combines with molten iron to form FeO.

$$Fe + O \rightleftarrows FeO \cdots (2)$$



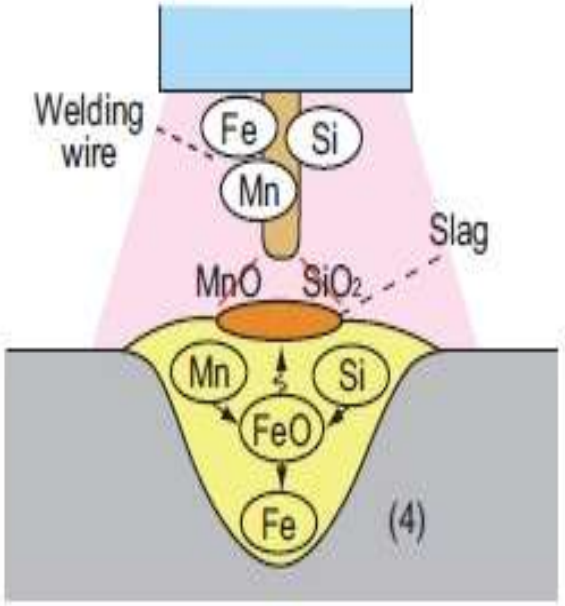
- Sequentially, C that is contained in steel is easier to combine with O than Fe deprives O from FeO to generate CO gas, which is apt to left in the weld metal to form blowholes. A weld metal that contains blowholes cannot be deemed to be sound.

$$FeO + C \rightleftarrows Fe + CO \quad \cdots (3)$$



- To improve the soundness, a welding wire that contains Si and Mn that have stronger affinity with O is used ; in this case, O in FeO combines not with C but with Si and Mn and floats up on the surface of the weld pool to form slag of SiO_2 and MnO.

$$FeO + Mn \rightleftarrows Fe + MnO \quad \cdots (4)$$
$$2FeO + Si \rightleftarrows 2Fe + SiO_2$$



- Though slag is formed, the weld metal becomes sound without blowholes.
- Besides Si and Mn that prevent blowholes, various other chemical elements are added to the welding wire in order to let the weld metal possess required strength, impact toughness, corrosion resistance and other properties.

04 WELDING EQUIPMENT

- Welding equipment for CO_2 welding consists in principle of:
- A shielding gas system with control
- A power source
- A wire feed unit
- A complete welding torch
- A reel of welding wire

SHIELDING GAS SYSTEM:

- The shielding gas is supplied in cylinders of various dimensions and with a pressure of up to 150 kp/cm^2.
- The gas cylinder is fitted with a pressure reducing valve in order to decrease the high pressure inside the cylinder to a lower and less dangerous working pressure, before the gas flows into the hoses.

- After the pressure reducing valve (in connection with it) is a flow meter indicating the gas consumption, usually in litre per minute. The welding machine is equipped with a solenoid valve which controls the gas supply.

❑ **POWER SOURCE:**

- A constant voltage, direct current power source is most commonly used with CO_2 , but constant current systems, as well as alternating current, can be used.

❑ **WIRE FEED UNIT:**

- The wire feed speed is connected with the control of the wire feeding that is with the control system. For the actual mechanical feeding there are three different systems in principle.

1. Separate Wire Feed Unit

- The wire is pushed forward by the wire drive unit through the wire guide liner to the torch.

fig. 2 method 1

2. Wire Feed Unit in the Welding Torch

- The wire is pulled forward to the torch by a wire feed unit in the torch, figure 3A, Both the wire feed unit and the wire rolls are placed inside the welding torch, figure 3B.

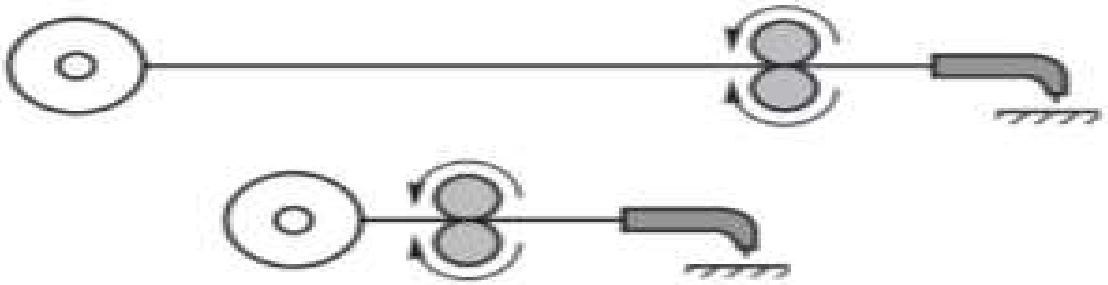


fig.3 A

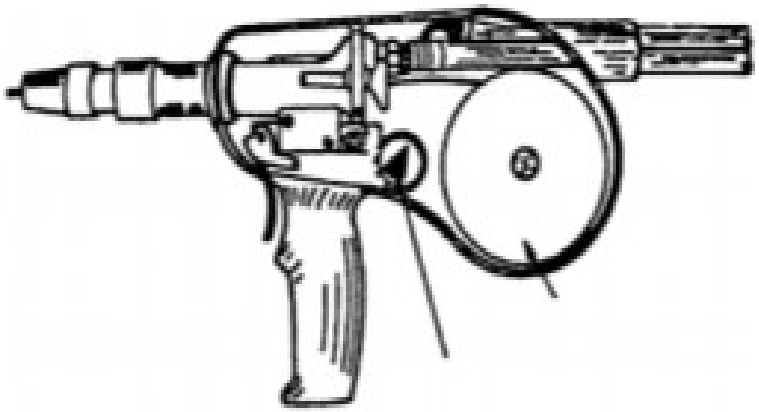


fig.3 B

3. PUSH-PULL METHOD

- The wire is pushed forward by a wire feed unit in the welding machine and at the same time it is pulled through the wire liner by a wire feed unit in the welding torch, the so-called push-pull system, figure 4.

fig.4

❑ WELDING TORCH:

- The welding torch can be either aircooled or watercooled.
- In general aircooled torches are used for all materials at low current intensities and also for welding of ordinary mild steels at higher current intensities.
- An aircooled torch will be rather heavy if it is to be used at higher current intensities.

- Watercooled torches are lighter.
- They are mostly used for welding of metals and light metals at high current intensities. It is important to notice that a watercooled torch will quickly burn off if the supply of water fails.
- Ususally this type of torch is fitted with some sort of protection which prevents welding if the torch is overheated (overheating protection) or if the water pressure fails (pressure protection).

❑ WELDING WIRE:

- Welding wire is either delivered on wire reels or in coils for larger industrial installations.
- The wire must always be strictly concordant with the base material and the welding process.
- In MAG welding there is a reaction between the filler material, the shielding gas and the parent material.

- Usually, this reaction means that alloying elements are burned off in the arc. Wire for welding of e.g. steels are therefore overalloyed with Si and Mn which partly burn off, that is they oxydize in the arc, and precipitate in a very hard almost resin-like slag scattered alongside the weld seam.
- Regardless of the materials to be welded the basis of a good welding result is a clean wire free from grease and other polluting elements.

05 MATERIAL TRANSFER

- The welding wire can be melted and transferred to the base metal as droplets in three different modes:

  (1) **s**hort−circuiting transfer, (2) **G**lobule transfer and (3) **S**pray transfer.

- Depending upon the mode, the appearance and shape of weld bead, quantity of spatter, and penetration can vary.
- In CO_2 (MAG) arc welding, the short−circuiting transfer and the globule transfer can be observed.

1) **Short−circuiting transfer:**

- The welding method that uses the short−circuiting transfer is called the Short Arc Welding or the Dip Transfer Welding.
- When a comparatively low welding current (200A or lower) is used in CO_2 (MAG) arc welding, the droplet transfers to the base metal after short circuiting with it, as shown in Fig. 5.

- It is suited for welding of thin plates, sheet metals and in all−position welding including vertical up, vertical down and overhead welding.

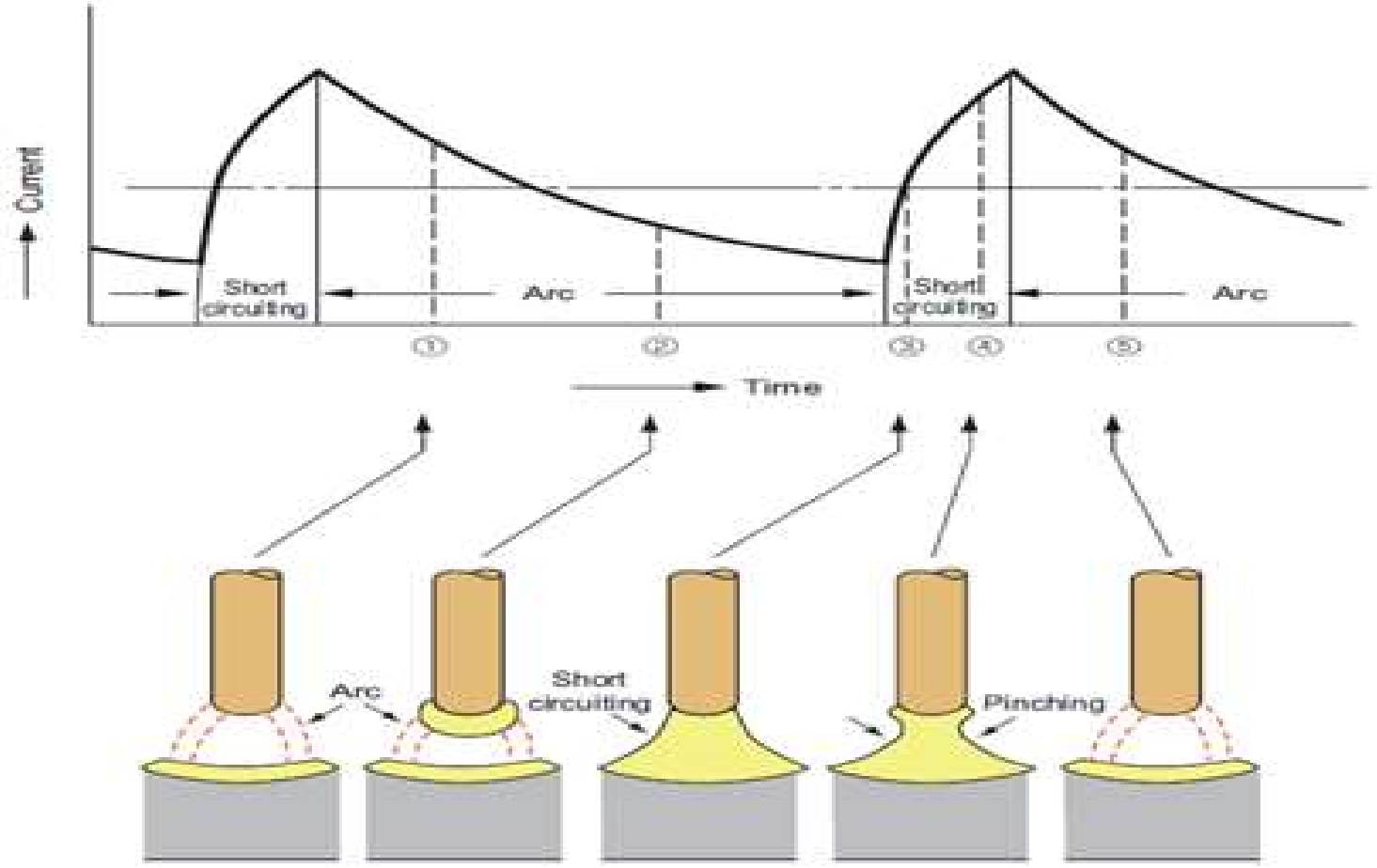


Fig. 5 Short−circuiting transfer vs. welding current.

2) Globule transfer:

- This transfer mode is also known as the globular droplet transfer, which is observed in welding with a comparatively high welding current and the droplet as big as the wire diameter or bigger transfers to the base metal.
- Because of this, a slightly higher amount of spatter is emitted than in other modes of transfer. But it is used often for it is highly efficient. In high current CO_2 arc welding, the mode of droplet transfer becomes this mode.

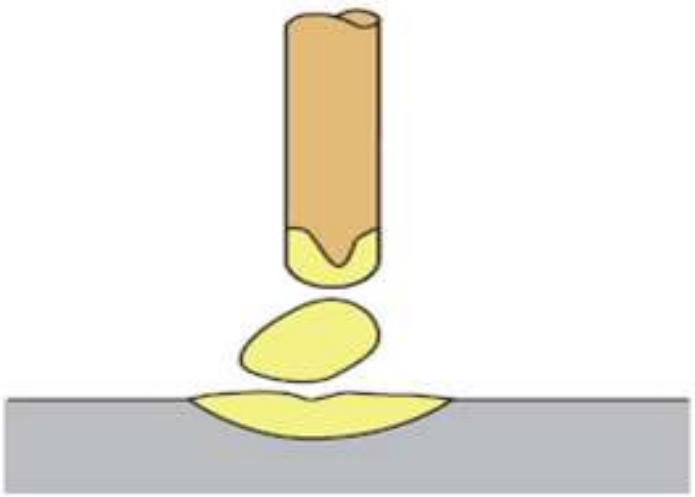


Fig. 6 Globule transfer.

3) SPRAY TRANSFER:

- In high current MAG welding with DC electrode positive polarity and inert shielding gas, the droplet becomes smaller than the wire diameter due to the effect of plasma flow on the arc column.
- This is why, the emission of spatter is little and the weld bead with good appearance can be obtained.

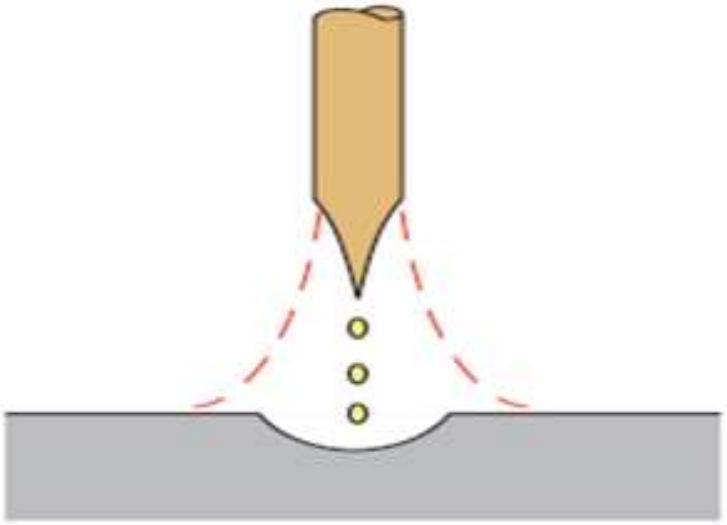


Fig. 7 Spray transfer.

06 FEATURES

- As compared with shielded metal arc welding, CO_2 arc welding has the following advantages and disadvantages.

ADVANTAGES

1. As the diameter of the wire is small, the welding current density is high and thus the deposition rate is big.
2. Good concentration of the arc realizes deep penetration.
3. The deposition efficiency is high and formation of slag is little, which makes it unnecessary to remove slag after each pass.
4. The arc generation rate is high, thereby lowering the welding cost and making the process to be more economical.
5. Hydrogen in the weld metal is low, which contributes to good crack resistance and mechanical properties.

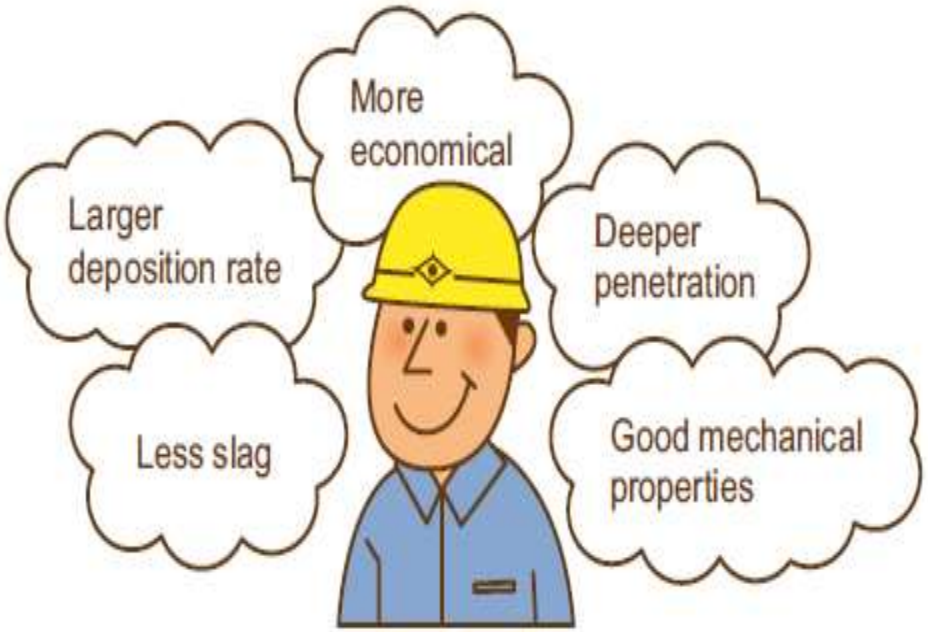


Fig.8 advantages

❑DISADVANTAGES

1. Windbreak screen is needed against high wind at a velocity of 2m/sec. or higher.
2. Even if a long conduit cable is used, welder's movable area is limited.
3. The price of the power source is high.

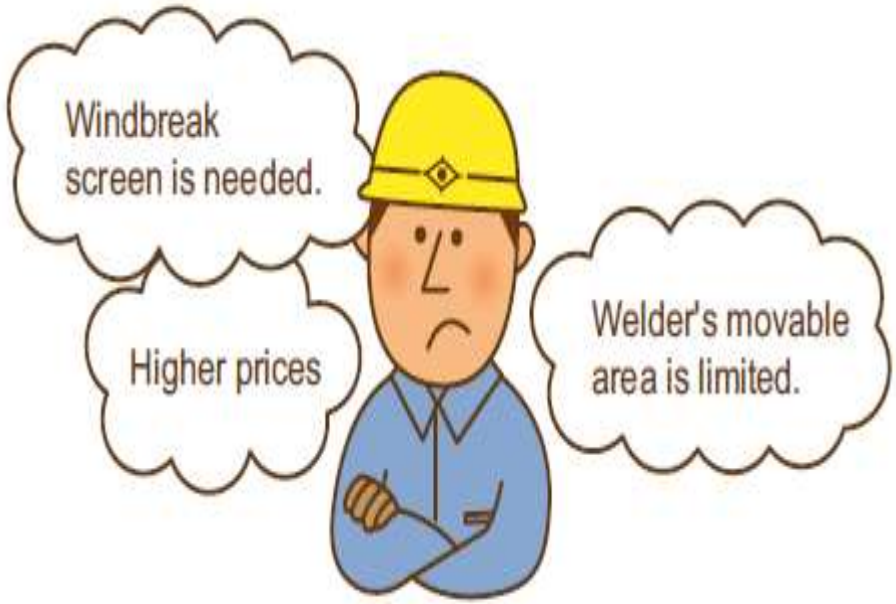


Fig.9 disadvantages

- If you compare such advantages and disadvantages with those of the shielded metal arc welding process, it is evident that CO2 arc welding offers higher efficiency, lower welding costs and better economy. Such advantageous effects can be maximized in automatic welding, particularly in robotic welding.

07 APPLICATION

- CO_2 welding is usually used with:
- Aluminium
- Ordinary mild steels
- Stainless steels
- Copper and copper alloys
- In addition to the above metals this method is suited for magnesium, nickel and a number of other metals and their alloys.

THANK YOU