CARBON DIOXIDE-SHIELDED WELDING

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UDC 621.791:661.97

Welding in an atmosphere of carbon dioxide, which is coming into wider use, makes it possible to mechanize the process, increase the output, weld in the flat and vertical positions, and weld thin metal. It becomes unnecessary to clean the rust off the edges or the slag in the case of multipass welds.

The use of carbon dioxide in arc welding is a very effective and economical method of protecting the weld pool against the influence of the air.

The technique of automatic gas-arc welding can be profitably used in mass production assembly lines in manufacturing fittings for chemical equipment. In the case of manufacturing individual machines, where there are short, discontinuous, and inaccessible welds to be made, the structure and separate units and parts can be assembled by semiautomatic welding.

The most widely used semiautomatic welders have been designed by the E. O. Paton Institute of Electric Welding – the A-547 for wire 0.8-1.2 mm in diameter, the A-537 and A-765 for wire 1.6-2.0 mm in diameter, the A-929 dual welder (with two interchangeable holders) for wire 0.8-1.2 and 1.6-2.0 mm in diameter. There are also semiautomatic machines designed by TsNIITMASh and PGSh-Z. Portable semiautomatic welders also exist.

For welding structures with linear seams the automatic welders ADPG-300 and ADPG-500, with USA-2 heads, are usually used, as well as the ADK-500 automatic welder with a rotating head. These are powered by heavy-duty transformers PSG-350, PSG-500, and the IPP type, with rectifiers VS-200 and VSK.

In welding shielded with carbon dioxide the current density is high (over 70 A/mm^2) and the arc is short, with the electrode touching the pool. With the short arc the porosity of the weld seam and spattering are substantially reduced.

Recently there has been a tendency to use current pulses according to a predetermined program. For this purpose the IIP apparatus (pulsed power supply) is connected to the electrical circuit.

Carbon dioxide-arc welding is characterized by considerable melting of the base metal in comparison with hand arc welding. For this reason plates up to 12-16 mm thick can be welded on one side without dressing the edges. Plates up to 20-24 mm thick can be welded on both sides without dressing the edges.

Dense seams with high strength can be produced only by using special wire. The wire must contain alloying elements ensuring the required chemical composition and adequate mechanical properties of the seam metal and deoxidizing elements to prevent pore formation. Special wire is produced for carbon dioxide-shielded welding of carbon and alloy steels: Sv-08GS, Sv-08G2S, Sv-10Kh2S, Sv-10GS, Sv-08Kh3G2SM, Sv-08KhG2SM, Sv-08KhGSMF, Sv-08Kh14GT, Sv-10Kh17T (GOST 2246-60).

The carbon dioxide used for welding is 99.5% pure. To reduce the amount of moisture entering the weld zone the carbon dioxide must be passed through a special dehumidifier. To prevent freezing of the moisture in the tank it is recommended that a heater (24-36 V) be placed in the line immediately following the tank. The greatest number of pores occurs at the beginning and the end of a tank of carbon dioxide. Therefore the gas is first allowed to escape into the air, and to improve the composition of the gas the tank is inverted for 1.5-2 h. Afterwards, some of the gas is released along with the water vapor. The moisture content of the gas is highest at tank pressures below 10 atm. Due to the increasing consumption of carbon dioxide, the supply of gas for welding has become of some importance. Many plants have converted to a central supply of carbon dioxide.

The All-Union Scientific Research Institute of Applied Technology of Petrochemical Apparatus recommends that a central supply of carbon dioxide be established for 10-12 welding stations. There are a number of methods of producing carbon dioxide – from dry ice (VNIKhI and TsNIITMASh), from liquid

Translated from Khimicheskoe i Neftyanoe Mashinostroenie, No. 7, pp. 24-25, July, 1969.

carbonic acid (UkrNIIPP). In machinebuilding plants it is possible to set up a supply from special containers previously filled in carbon dioxide plants from liquid or solid carbonic acid. The gas is piped from these tanks to the welding stations in the shop.

The All-Union Scientific Research Institute of Applied Technology of Chemical Machines (Penza) has developed a welding technique employing carbon dioxide and demonstrated its use in many plants. The ADK-500 machine has proved to be particularly effective and also the semiautomatic welders A-537, A-765, A-929m, and A-929s (crater welding is possible with the latter two machines). Machines based on modernized semiautomatic welders PSh-5 and PSh-54 are also used. The welds are made with direct current of reverse polarity, using 200-500 A. Due to the high melting rate, the feed rate of the welding wire reaches 620 m/h.

The introduction of carbon dioxide-shielded welding in plants manufacturing chemical machines in series or individual machines has had a substantial effect. Carbon dioxide-shielded welding has proved to be 25% more rapid than submerged-arc welding and three times more rapid than hand arc welding. The cost of 1 kg of metal deposited by carbon dioxide-shielded welding is 20% below that of hand arc welding with high-quality electrodes. It is particularly effective in welding thin plates (2-4 mm) with small seams. Good results have been obtained with dressed edges, with a considerable reduction of the bevel angle, for plates 40-100 mm thick (for T-shaped joints the bevel angle is 35° instead of 60°); the leg is reduced correspondingly (by 2-4 mm) and the difference in the thickness of the metal is retained (5-100 mm).

Semiautomatic welding with carbon dioxide shielding requires adherence to a strict technique. The surface of the welding wire must be clean. The presence of lubricants, anticorrosion coatings, oil, etc., on the welding wire can cause an unstable arc, considerable spattering, an increase of the hydrogen concentration in the weld seam, and the occurrence of pores. The presence of rust on the surface of the wire is inadmissible. The seams should be prepared for welding in conformity with GOST 5264-56. Various machines are used to clean and wind the wire in cassettes.

In carbon dioxide-shielded welding the gun is of major importance. In semiautomatic welding a curved head is used for welding in different positions and structural combinations. At the present time many different holders (guns) with nozzles are available. The spatter must be cleaned off the nozzle periodically and the nozzle coated with a chalk solution. With proper welding conditions the seams are flat with no spatter.

It is recommended that the welds be made toward the operator or from right to left to ensure good visibility and increase the accuracy in guiding the electrode along the seam. Depending on the profile and size of the seam, the transverse movement of the holder should be serpentine or spiral. In this case the seam becomes wider, the strength and penetration decreasing. This procedure is suitable for vertical welds, but welds with a wide gap, and for surfacing.

The slope of the electrode (the back angle or lead angle) can be 15-20°. For T welds in the vertical position it is recommended that the angle be 35-45°. Vertical welds should be made from bottom to top; in welding thin metal (thickness less than 4 mm) it is recommended that welds be made from top to bottom.

In welding stainless austenitic steels of the 18/8 type wire Sv-Kh18N9T is used (0.08% C) when the welded part is not subjected to intercrystalline corrosion. Welding wire Sv-06Kh19N9T ensures resistance of the seams to intercrystalline corrosion in the natural state, although the welds are susceptible to intercrystalline corrosion after tempering at 650°C for 2 h. The E. O. Paton Electric Welding Institute has developed a new wire (08Kh20N9S2BTYu) that ensures high resistance of the weld seams to intercrystalline corrosion even after provoking annealing, which is due to the complex alloying. Welding wires Sv-08GS and Sv-08G2S are used for welding critical parts of carbon steels under pressure. Weld seams made with these wires have high mechanical properties.

The introduction of semiautomatic welders and specialized automatic welders for carbon dioxide-shielded welding in Penzkhimmash, Borisoglebskkhimmash, Pervomaiskkhimmash, Melekesskhimmash, Ruzaevkhimmash, and other plants has resulted in large technological and economic advantages. The annual savings from the use of a single semiautomatic welder amount to 3000-3500 rubles. The capital outlay and installation cost for a semiautomatic welder and rectifier power source are recovered in 10-12 months.