ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 5, May 2024

Analysis of cast iron welding methods

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ABSTRACT: This article provides an analysis of cast iron welding methods

KEY WORDS: cast iron, welding, cementite, graphitizer, crack, welding thermal cycle

I. INTRODUCTION

The most radical remedy for eliminating bleaching and hardening, as well as cracks in the seam and heat-affected zone, is preheating the part (hot welding) with slow cooling. Favorable conditions are also created during processes that are carried out without melting the base metal (soldering, soldering). To reduce the likelihood of cracks, electrodes are used that ensure the production of a deposited metal other than cast iron.

II. LITERATURE SURVEY

The choice of welding method and technological methods for preparing parts for welding are determined by the size and location of the defect. Preliminary cutting of defects before welding can be carried out by mechanical methods and air-arc cutting, but with different welding methods, preparing the defect for welding has its own characteristics. [1].
Since in arc welding with preheating the process is usually carried out using a bath method at elevated conditions, after preliminary cutting, in order to prevent leakage of liquid metal, a mold is created from a refractory mixture around the defective area. [2].
In most cases, a frame made of steel wire with a diameter of 5-6 mm is welded in place of the mold. In case of through defects, the frame is installed on the lower side of the defect. The inside of the mold is smoothed with a trowel, after which the walls are reinforced with metal pins. The mold can be made from graphite plates or from blocks of various refractory materials. The form should provide a height of the deposited metal of up to 5 mm above the surface of the part. When repairing, it is preferable to cut by air-arc cutting or direct arc smelting. [3].

Preparation of edges for gas welding can be carried out using various mechanical methods, as well as by melting the metal in the welding zone and removing it with a filler rod. This cutting method is recommended when welding for repair purposes. [4].
Preheating the welded parts is the most important operation. The heating temperature is determined by the size of the part and its rigidity, the welding method, the volume of deposited metal, the chemical composition and structure of the cast iron and is in the range of 400-700°C. The most common heating is up to 400-550°C, and only for parts of increased

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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complexity and rigidity is heating up to 600-700°C allowed. A further increase in heating temperature can cause a sharp decrease in the strength properties of cast iron. for uniform heating of parts, especially those with walls of different thicknesses, the speed should not exceed 120-150°C/h. [5]

When arc welding without preheating, the mode and process technology must ensure the minimum possible depth of penetration of the base metal (0.5-2.0 mm). The order of seams is chosen in such a way that the heat is distributed over the entire surface to be deposited. The heating temperature of the part in the immediate vicinity of the seam should be no higher than 100 - 150°C. After applying each bead, time is given to cool the welding site to a temperature below 100°C. Forging of seams is recommended, which reduces internal stresses and increases the tightness of the welded joint. [6]

III. METODOLOGY

Manual welding with coated electrodes is used in small-scale production, when welding for repair purposes and welding large defects in hard-to-reach places in castings.

Welding with electrodes with cast iron rods is widely used, since in foundry conditions their production does not cause difficulties. Electrodes are made from cast iron rods with a diameter of at least 10 mm. Cast iron rods provide stable and high-quality welding. Components that stabilize the arc, form slag and alloy the metal with carbon and silicon are introduced into the coating composition. The thickness of the coating is no more than 0.5 mm per side.

Welding is carried out using alternating current or direct current of straight polarity. The electrode holder must provide good contact with the cast iron electrode, low heating and good protection of the welder's hand from thermal radiation. When welding, the welding current is 900-1300A. Before starting to fill the molded defect, it is recommended to splash out the first portion of molten metal to remove non-metallic inclusions and additionally heat the welding zone. During welding, slag is periodically removed from the surface of the weld pool.

The properties of the deposited metal largely depend on the cooling rate and, when slow cooling is provided, they are identical to the properties of the base metal. The chemical composition of the deposited metal, compared to the original composition, may differ in its increased silicon content.

When welding small defects, it is recommended to use TsCh-5 electrodes with a rod made of low-carbon steel and a coating containing graphitizing elements. Welding is carried out using direct current of straight polarity using standard equipment. The process is carried out with liquid metal in the weld pool, usually with electrodes with a diameter of 5 mm at a current of 200 - 250A. The mechanical properties of the welded joint are identical to the properties of the base metal.

Semi-automatic flux-cored wire welding is used to weld large defects in castings and is carried out with one or three wires simultaneously. In the latter case, the process productivity is 17–20 kg/h of deposited metal. Welding with a single wire with a diameter of 2.8–3.2 mm is inferior in productivity to manual welding with coated electrodes with a cast iron rod (10–15 kg/h); Therefore, welding with three wires is practically more often used. Welding with one wire is possible, but with a diameter of 4.5-5.2 mm, the productivity of which is not inferior to that of welding with three wires.

The process parameters depend on the wire feed speed (I_{sv} = 800 - 1300 A; U_d = 40 - 60 V).

Manual welding with copper-based non-ferrous metal electrodes has found wide application in industry. Copper does not form chemical compounds with carbon and is practically insoluble in iron. Therefore, when welding with electrodes with a rod made of a copper-based alloy, the seam is inhomogeneous. The copper base contains inclusions of a high-carbon iron phase, often having a martensitic structure. At the fusion boundary, a zone of increased hardness is created in the base metal due to the formation of ledeburite. Therefore, the machinability of welded joints is difficult. Copper-iron electrodes of various designs (with iron powder and coating, with tin braid, copper tube with a steel rod, etc.) are more often used for welding cracks (small and large) when welding broken parts, ensuring good strength characteristics of welded joints.

Welding with electrodes with a rod made of a nickel-based alloy is used to eliminate minor defects, primarily in cases where it is necessary to ensure the machinability of the welded joint, as well as its color identity with the base metal. Nickel is infinitely soluble in iron, and the resulting nickel austenite dissolves a large amount of carbon without the formation of carbides, has high ductility and low hardness. Copper-nickel and iron-nickel alloys are used for the manufacture of electrode rods. When performing particularly critical work, electrodes with a rod containing more than 90% Ni are used.

The disadvantage of these electrodes is significant shrinkage, which when welding with electrodes made of copper-nickel alloys (monel) leads to the formation of cracks in the deposited metal, and when welding with iron-nickel and nickel electrodes can lead to cracks in the transition zone due to the higher strength of the deposited metal compared to strength of cast iron. In this regard, welding is carried out in modes that ensure minimal penetration of the base metal with a short length of the rollers with mandatory forging.

Welding with electrodes with carbide-forming elements in the coating is used for welding small defects on the processed surfaces of castings (welding in places to be drilled is not recommended) instead of electrodes with a Monel rod. When using an electrode of this type, the carbon entering the weld from the base metal is bound by titanium or vanadium contained in the coating into finely dispersed carbides that are sparingly soluble in the metal, and therefore the carbon contained in them does not affect the phase transformations in the deposited metal. The structure of the weld is ferritic with inclusions of finely dispersed carbides. The machinability of the welded joint is satisfactory.

The most widely used electrodes are TsCh-4, which contain ferrovanadium in the coating. Welding is carried out at a minimum current (23-30A per 1 mm of electrode diameter) with electrodes with a diameter of no more than 4 mm. The current is constant, the polarity is reversed. Welding is recommended to be carried out by lining the edges with TsCh-4 electrodes in no more than two layers, followed by filling the defect volume with steel electrodes of type E42, E42A.

Welding of small and large parts with steel electrodes is carried out in cases where mechanical processing of the joints is not required and their strength is not specified. The process is carried out using electrodes for welding low-carbon steels (UONI-13/45) at minimum mode, in separate sections, with breaks for cooling the base metal.

Welding with “annealing” beads is also used, which is deposited onto already deposited beads without contact with the base metal. In this case, the structure of the transition zone is thin-plate pearlite with secondary cementite. The strength of the connection is higher than when welding without “annealing” beads.

Repair of failed equipment can be carried out without dismantling parts by welding with the installation of steel pins. This ensures the uniform strength of the welded joint. In this case, cutting the defect with a part thickness of up to 20 mm is not necessary. For larger thicknesses, the edges are beveled at an angle of 90–120°. With a part wall thickness of up to 10 mm, the diameter of the studs is 6 mm, with a thickness of up to 20 mm - 10 mm, and for larger thicknesses, studs with a diameter of 16 mm are used. The studs are installed in a checkerboard pattern. Welding is performed as follows. The studs are scalded and a steel coating is applied to the surface of the cast iron. These operations can be performed using TsCh-4 electrodes or electrodes with a rod made of nickel-based alloys. Welding is carried out with the minimum possible penetration depth, in sections of 48-50 mm, with breaks for cooling.

After filling the groove, the welded area is strengthened by welding steel rods. A layer of “annealing” beads is laid over the surfacing surface.

IV.CONCLUSION

The results of the research performed provided the necessary basis for choosing the optimal method for welding cast iron.

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ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 11, Issue 5, May 2024

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