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Calculation of automatic submerged arc welding

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ABSTRACT

This article provides an example of the calculation of automatic submerged arc welding modes. The main features of submerged arc welding are highlighted. The sequence of calculation of the technological parameters of the modes of automatic welding of low carbon steels is considered. The influence of changes in the main welding parameters on the weld dimensions is determined. Based on the calculation results, a conclusion is drawn on the calculation of the parameters of the automatic submerged arc welding modes.

Key words: Automatic welding, welding mode, electrode wire.

1. INTRODUCTION

Calculation of welding modes is always made for a specific case when the type of connection and the thickness of the metal being welded, the grade of wire, flux and method of protecting the weld pool from air and other data on the seam are known. Therefore, before starting the calculations, it is necessary to establish the structural elements of a given welded joint according to GOST8713-79 or according to the drawing and determine the area of the weld using a known method [2].

It should be borne in mind that the maximum cross-section of a single-pass seam made by an automatic machine should not exceed 100 mm^2. The sequence of calculation of the technological parameters of the modes of automatic welding of low carbon steels is as follows.1. Set the required penetration depth hm, mm. In single-sided welding, it is equal to the thickness S of the metal hm = S, and in bilateral and angular welding, hm = 0.6S.

2. Determine the diameter of the electrode wire

It is desirable to choose the diameter of the electrode wire de such that it ensures maximum welding (surfacing) performance at the required penetration depth. In most cases, it is chosen depending on the thickness of the metal being welded [3].

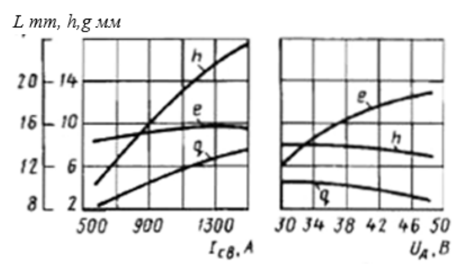
2. RESEARCH

Submerged arc welding modes have basic and additional parameters. The main ones include: current, its kind and polarity, arc voltage, electrode wire diameter, welding speed. Additional parameters of the mode - the departure of the electrode wire, the composition and structure of the flux (density, particle size), the position of the product and electrode during welding.

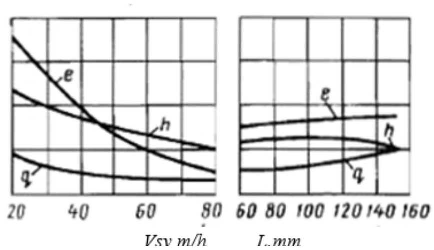
The parameters of the welding mode depend on the thickness and properties of the metal being welded and are usually given in the technical conditions for welding a particular product and are adjusted when welding prototypes. In the absence of such data, the modes are selected experimentally.

The main condition for the successful conduct of the welding process is to maintain stable arc burning. For this, a specific welding current feed rate must correspond to a specific current of the electrode wire. The feed rate should increase with the rise of the electrode. With its constant departure, an increase in the feed rate reduces the arc voltage. When using alloyed wires having high electrical resistance, the feed rate should increase.

Figure 1 shows the effect of changes in the main welding parameters on the weld dimensions. Patterns apply to the case of surfacing, when the penetration depth ≤0.8 of the thickness of the base metal. With a greater penetration depth, the deterioration of heat dissipation from the bottom of the seam leads to a sharp increase in penetration - up to burnout.



a) b)



v) g)

Figure 1: Change in the width e and the bulge q of the seam and the penetration depth h depending on the parameters of the mode(a - c) and electrode take-off (g):Ud - arc voltage; Isv - welding current; Vsv - welding speed.

The welding current has the greatest influence on the shape and dimensions of the weld. With its increase, Figure 1, a) the penetration depth and height of reinforcement of the seam increase intensively, and its width increases slightly.

An increase in the arc voltage increases the width of the weld, the penetration depth remains practically unchanged, the convexity decreases in Figure 1, b).

The effect of the welding speed on Figure 1, c) on the penetration depth and seam width is complex. First, with an increase in the welding speed, the arc pressure in ce displaces the liquid metal more, the thickness of the layer of liquid metal under the arc decreases, and the penetration depth increases. With a further increase in the welding speed (> 20 m / h), the linear energy decreases markedly and the penetration depth begins to decrease. In all cases, with increasing welding speed, the width of the seam decreases. At a welding speed > 70, 80 m / h on both sides of the weld, non-fusion with the edge or undercuts are possible. If it is necessary to conduct welding at high speeds, special methods are used (welding with a three-phase arc, two-arc, etc.) [6].

The diameter of the electrode wire significantly affects the shape and dimensions of the weld, especially the penetration depth. As can be seen from table 1, in the absence of sources that provide the necessary welding current, the required penetration depth can be achieved by reducing the diameter of the used electrode wire.

Table 1: Depth of penetration of the weld at different diameters of the electrode wire and the values of the welding current (A) (submerged arc welding).

Depth of penetration, mm	Diameter of electrode wire, mm	Welding current, A
3	5 4 3 2	450 375 300 200
4	5 4 3 2	500 425 350 300
5	5 4 3 2	550 500 400 350
6	5 4 3 2	600 550 500 400
8	5 4 3 2	725 675 625 500
10	5 4 3 2	925 900 750 600
12	5 4 3 2	930 925 875 700

Thus, the inclination of the electrode along the seam and the position of the part are also reflected in the shape of the seam. Usually, welding is performed with a vertically arranged electrode, but in some cases it can be performed with the electrode inclined forward or backward. When welding angle-ahead, the liquid metal leaks under the arc, the thickness of its layer increases, and the penetration depth decreases. Backward angle welding reduces the interlayer, and penetration increases. Welding on the rise increases the depth of penetration and the likelihood of burn-through [5].

3. RESULTANDDISCUSSION

The weld of the shell is cooked by automatic submerged arc welding, therefore, the following calculation procedure can be applied to it [1]:

Initial data: the main material is steel (10X17H13M2T); the thickness of the parts to be welded is S = 12 mm.

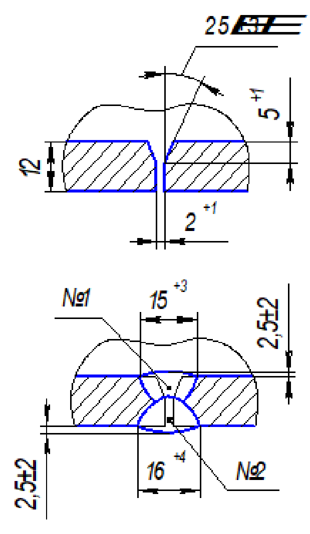


Figure 2: Weld in automatic welding under a flux layer

1. Choose the diameter of the electrode wire:
d = 3 mm for seam No. 1 and for de = 4 mm for seam No.
2. The choice of such a wire diameter is associated with a number of factors: reduced welding currents, minimal heat input, high quality of the weld pays for less productivity compared to wires of a larger diameter [7].
2. For the diameter of the electrode wire 3 mm in the calculations we will use the welded current Isv = 280 ...

300 A., and for the wire 4 mm we will use a current of 480 A.

3. We determine the magnitude of the voltage across the arc from an empirical relationship:

$$U_д = 20 + \frac{50 \cdot 10^{-3}}{d^{0.5}} \cdot I$$

$$U_д = 20 + \frac{50 \cdot 10^{-3}}{\sqrt{4}} \cdot 480 = 32B$$

$$U_д = 20 + \frac{50 \cdot 10^{-3}}{3^{0.5}} \cdot 280 = 28B$$

We take the voltage Usb = 32 V for 4 mm and Usb = 28 V for 3 mm.

4. Determine the cross-sectional area of the weld metal weld for a given passage based on Figure 2:

$$F_н = 2 \cdot 8 + (5 \cdot 5 \cdot tg25) + 1.5 \cdot 2.5 \cdot 0.75 =$$

Since the area of the deposited metal is less than the recommended area (no more than 100 mm2), we will conduct welding in one pass.

5. Determine the welding speed of one pass:

$$V = \frac{(16...20) \cdot 1000}{480} = 33{,}3 ... 41{,}6 \; m/h$$

$$V = \frac{(16...20) \cdot 1000}{480} = 33{,}3 ... 41{,}6 \; m/h$$

for d = 4 mm

$$V = \frac{(16...20) \cdot 1000}{280} = 57{,}1 ... 71{,}4 \; m/h$$

для $d_э$=3 мм

Accept 35 m / h

Determine the surfacing coefficient:

$$\alpha_р = (8{,}3 + 0{,}22\frac{450}{4}) = 35{,}75 г / А \cdot ч$$

where w is the loss of electrode metal due to evaporation of spraying and oxidation, %. Usually w = 7 ... 15%. For calculations, w take 10%.

$$V_{пр} - \frac{4\alpha_н \cdot I_{св}}{\pi \cdot d_{эл}^2 \cdot \gamma}$$

6. Determine the wire feed speed:

$$V_{пр} = \frac{4 \cdot 11{,}52 \cdot 450}{3{,}14 \cdot 16^2 \cdot 7{,}85} = 52{,}6 \; m/h$$

4. CONCLUSION

According to the calculation results, enter the data in table 2. Table 2 presents the calculated parameters of the welding modes.

Table 2: Parameters for automatic submerged arc welding

Diameter of electrode wire, mm	Welding current, A	Welding voltage, V	Welding speed, m / h	Wire feed speed, m / h.
3	480	30	35	68,5
4	280	32	57	62,5

Electric rivet welding is usually performed in lap joints, t-joints, as well as corner joints. The main difficulty in welding such joints is to ensure a snug fit on the surfaces of the parts being welded. To prevent leakage of molten flux and metal, the gap should not exceed 1 mm. Electric rivets can be welded by pre-prepared holes in the top sheet> 10 mm thick or with penetration of the top sheet up to 10 mm thick. When welding with a hole, the diameter of the electrode must be equal0.2..0.25 hole diameter [8].

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