Impulse Control Process Arc Welding Covered Electrode

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Abstract. A method and technological advantages of impulse control processes of arc welding electrodes coated further RD. Ways to overcome the shortcomings RD.

Introduction

When welding structures that are difficult to achieve due to rational automation methods, for example, when installing and repairing pipes for heating surfaces of high-pressure boilers, manual arc welding with coated electrodes (RD) is one of the leading technological processes. At the same time, it should be noted that the reserves for increasing the productivity and efficiency of the RD have been exhausted. One of the promising modifications taxiway, which makes it possible to increase the efficiency of this process, is the use of pulse modulation the welding current [1]. However, the existing methods and technical means of implementing this process realize the concept of "machine-technology" with programmatic control of the parameters welding current pulses giving the welder essentially the role of a mechanism that mechanically moves the electrode along the joint line and maintains a constant arc length. The welding rate is set by the technical means of modulation and remains unchanged during the welding process.

The concept of "machine-technology" is based on the desire to transfer the operation of dosing thermal energy to technical means of modulation, facilitating the work of the welder and reducing the requirements for his qualification [2, 3]. The technical means and methods of modulating the welding current that realize the concept of "machine-technology" can be attributed to the first generation of developments in this field.

The review of the state development methods and means of pulse modulation the first generation showed that the introduction them into the industry is hampered by a number of factors decisive importance, for example, ignoring:
- the phenomenon of mass transfer through the arc gap;
- the influence of current modulation on the physical stability of arc combustion and technological stability of the process;
- influence on the welder;
- the impossibility of active control the thermal power of the arc by the welder during the welding process.

The possibility of fulfilling all the requirements for the methods and technical means for RD with a modulated current represents the concept of "machine-man-technology" implemented in a second-generation pulse modulator created at the OTSP NI TPU department [4]. At the same time, automatic
control of the thermal power, and, consequently, the rate of welding, while simultaneously improving the quality of the welded joint during welding in all spatial positions and reducing the load on the eyesight is carried out.

**Results and Discussion**

In Fig. 1 shows the developed algorithms for automatic control of the thermal power arc with the adaptation of the welding current pulse parameters.

![Graph](image)

**Fig.1. Cyclogramm of the modulated current with additional pulses:** $I_i$ - impulse current; $I_b$ - base current (pause); $I_{d.i}$ - auxiliary pulse current; $t_{bas}$ - the duration of the main pulse; $t_{p.bas}$ - duration of the main pause; $t_{dop}$ - the duration of the additional pulse; $t_{p.dop}$ - duration of additional pause; $T_{c.bas}$ - duration of the main cycle of modulation of the welding current; $T_{c.dop}$ - the duration of an additional cycle of modulation of the welding current
In Fig. 1a shows the arc voltage plot;
In Fig. 1b shows the current cyclogram during modulation of the duration main pause;
In Fig. 1c is a current cyclogramm with simultaneous modulation of the durations main pulses and
pauses;
In Fig. 1d shows the current cyclogram with modulation according to the level of the deviation
average voltage arc gap from the set at the relay mode of regulation.

In the process of welding with pulse modulation welding current automatically as a function of the
development average voltage arc gap from the set value, the duration of the main pulses and pauses is
regulated by varying the arc length, and additional pulses are applied to the current during the main
pause with a repetition frequency of at least 50 Hz and a duration from 0.5 to 2 ms.

Control of the thermal power of the welding arc by changing the length of the arc (1.5 ÷ 2) V, which
does not violate the gas-slag protection of the welding zone - by extending or shortening the arc length
within these limits, the welder, taking into account the situation in the weld zone and his capabilities,
adapts the parameters of the regime to these conditions for Pulse modulation of pulse parameters.

Current modulation makes it possible to use the amplitude value of the current of the main and
additional pulses equal to the nominal value of the current each particular electrode, in which there is
no short circuit in the continuous mode and the drop of electrode metal is transferred to the weld pool
during the pulse also without short circuits with minimal spattering. Fig. 2 shows the oscillograms of
the welding current and the voltage of the RD using SSSI-13/55 electrodes with a diameter of 3 mm.
According to the oscillograms, the region of the rated current at which the best welding-technological
properties of these electrodes manifest themselves is in the range from 170 to 180 A [5].

![Oscillograms of currents and voltages recorded at different values of the current of the RD by SSSI-13/55 electrodes with a diameter of 3 mm](image)

Fig. 2. Oscillograms of currents and voltages recorded at different values of the current of the RD
by SSSI-13/55 electrodes with a diameter of 3 mm [4]

The use of a nominal current in the pulse (primary and secondary) allows to significantly increase
the modulation efficiency by increasing the depth of modulation and reducing the average value of the
welding current to (30 ÷ 40) A while maintaining the best welding and technological properties of the
coated electrodes. The transition of drops during a short circuit in the main pause is guaranteed by one
additional pulse with minimal spattering. In Fig. 3 shows the forced transfer of a drop by an additional
pulse during a pause period [2, 3, 5].

![Diagram showing forced transfer of a drop](image)
Fig. 3. Current and voltage oscillograms for modulated current welding, showing forced transfer of an electrode metal droplet during a pause by the energy of one additional pulse.

Figure 4 shows a part of the welded joint, as a practical result of using modulated current welding in the framework of the concept of "machine-man-technology" [5, 6, 7, 8].

![Diagram]

Fig. 4. Welded seam made by modulated current welding within the framework of the concept "machine-man-technology"; Electrodes SSSI-13/55 with a diameter of 3 mm; Plate 220x70x12mm (09GS); The spatial position when making the seam - ceiling; Modulation parameters: Ion and i = 1 and ≈ 170 A; Ip ≈ 30 A; T.n. and 55 ms; T.ns.p ≈ 200 ms; T.i = 6 ms; Thickness and ≈ 380 ms; T.d.i = 20 ms (50Hz).

a) configuration of cutting edges; b) macrosection of the root suture; c) the front side of the seam; d) reverse side of the seam.

Conclusions

1. The application of the pulse-controlled welding process according to the concept of "machine-man-technology" allows the welder to regulate the volume of the weld pool, and therefore perform welding in all spatial positions of the weld, including electrodes, welding in spatial positions other than the lower one, such as corrosion-resistant alloys on the basis of nickel, wear-resistant and other materials with special properties.

2. The regulation of the volume of the weld pool is performed by the welder by changing the arc length with respect to the specified voltage. Accordingly, the welder is able to control the welding speed by changing the pulse time of the main pulse, or the main pause, or by a joint change in the durations of the main pulse and pause.

3. Melting of coated electrodes at rated current makes it possible to provide their best welding and technological properties, namely, to influence the oxidation-reduction processes during electrode melting, during the transfer of electrode metal droplets and at the stage of the weld pool.

4. Ensure the stability of arc burning during the period of the pause current (Ip = 15 ÷ 30 A), by superimposing additional pulses with a frequency of at least 50 Hz and amplitude equal to the amplitude of the main pulses.
5. A concomitant effect of the application of additional pulses is the elimination of the effect of the variable light flux of the impulse process on the visual function of the welder.

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