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The “Engineer” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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- Architecture.

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CONTEXT / MUNDARIJA

Welding of metals with accompanying preheating

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Abstract: This article considers a technological method of influencing the thermomechanical state (with reduced plasticity) of the crystallizing metal of a welded joint when welding metals with accompanying preheating. It is noted that the effect of accompanying preheating is manifested when the preheating tool is optimally positioned relative to the welding arc. Methane, propane-butane gas can be used for plates thicker than 10 mm, and the electric arc without melting the base metal up to 10 mm thick. The preheating tool has a speed adequate to the welding speed.

Keywords: local preheating, preliminary, general, accompanying, welding transformer, welding generator, crystallization, crystallization cracks, tungsten electrode, gas burner, thermodeformation effect.

1. Introduction

Strength of connections plays an important role in welding metals. In welding conditions, it is practically impossible to eliminate the value of tensile stresses on the crystallizing metal of the welding pool; however, their level can be significantly reduced in the process of manufacturing structures.

In addition to metallurgical means of influencing the formation and properties of welds, there are also various technological means: controlling the shape of the welding pool and, consequently, the direction of crystal growth, regulating the thermodeformation conditions of welding, that is, the speed of crystallization and cooling of the weld, etc.

However, one of the effective technological methods is the accompanying preheating during metal welding. Despite the fact that preheating has been relatively long, its capabilities are far from exhausted.

Studies by domestic and foreign scientists have shown that when preheating the base metal, the level of welding stresses and deformations decreases significantly, the weldability of certain steels and alloys improves, and the quality of welded joints significantly increases.

2. Methodology

In some studies, it has been noted that preheating during welding does not completely prevent the formation of crystallization (hot) cracks, but can contribute to the improvement of some properties of welded joints. It is more rational to use accompanying preheating to prevent cracks during welding. However, the effectiveness of the influence and the effect of accompanying preheating on crack resistance during welding are not sufficiently studied. The abundance of various (sometimes contradictory) information often puts specialists in a difficult position. Thus, unsubstantiated choice of temperature, location, method, and scheme of accompanying preheating does not always lead to positive results.

There is almost no literature on the calculation methodology for determining the sizes of heated areas, the influence of accompanying preheating on the average temperature and dimensions of the welding pool, on the degassing of the weld metal. According to our view, accompanying mobile preheating can prevent the occurrence of tensile stresses and reduce their growth rate during the period when the weld metal has reduced plasticity. Research on these issues is relevant.

Industrial electric furnaces, gas furnaces, high-frequency currents - inductors are used as heating devices.

There are general, local 1, 3, 4 by the location of the heating zone - preliminary 6, 7, 8 and accompanying 2, 5, 11, by the time of action of the accompanying preheating during welding.

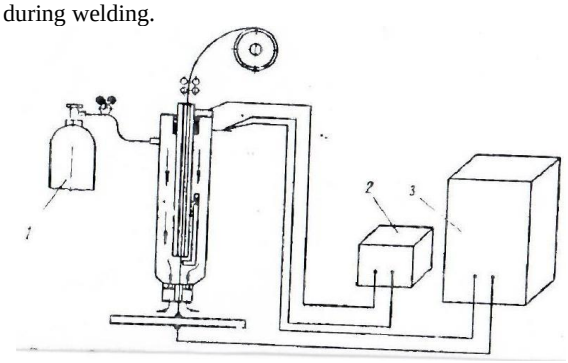

Fig. 1. Diagram of gas-electric welding with a consumable heated electrode: 1-protective gas; 2-heating source; 3-welding source.

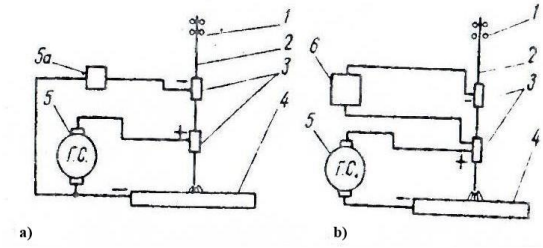

Fig. 2. Scheme of welding with preheated wire. a - preheating from the welding generator; b - preheating from the transformer. 1 - feed rollers; 2 - electrode wire; 3 - contact tip; 4 - workpiece; 5 - welding generator; 5a - ballast resistance; 6 - transformer

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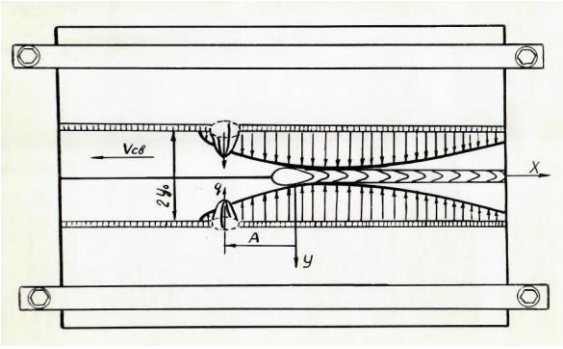

Fig. 3. Schematic assumption of thermo-deformational effect

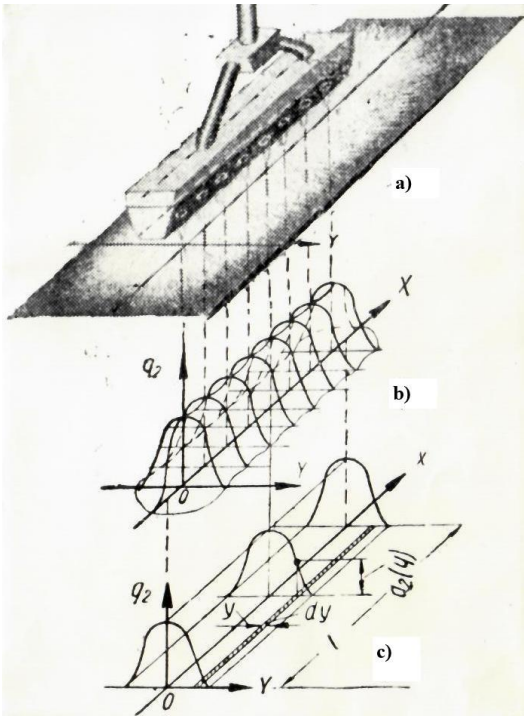

Fig. 4. Distribution of specific heat flow of the flame of a linear burner: a - linear multi-flame burner; b - actual distribution of specific heat flow q2; c - scheme of the normal-strip heat source of limited length L

There are also recommendations in the literature for additional preheating of the welding wire with currents from a low-voltage transformer 9, 10, fig. 1, 2. When welding steel 1H18N10T, an increase in productivity by 1.5 times, a decrease in welding current by 30%, stability of arc burning, reduced spattering of molten metal, increased melting of the wire, and absence of undercutting in the near-welding area were noted.

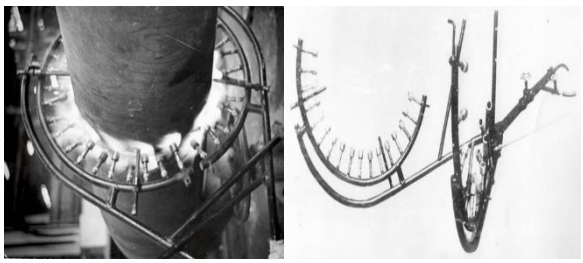

Fig. 5. Preheating with a ring burner of non-rotating joints of pipes made of steel 15Kh1M1F

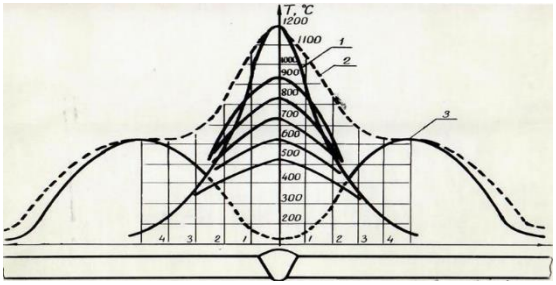

Fig. 6. Scheme of temperature distribution with additional preheating and without it. 1 - temperature distribution from arc heating; 2 - temperature equalization; 3 - temperature of additional preheating

Our proposed method differs from existing ones in its research methodology and problem setting when using additional preheating in welding of steel St. 45, 1H18N10T, 15H1M1F, and aluminum alloy D16AT. This method is based on the statement of the renowned scientist V.I. Dyatlov that with additional preheating during welding, a thermo-deformational effect can be created in the zone of the crystallizing weld (internal tensile state, partially compressive, see fig. 3), thereby preventing the formation of hot longitudinal cracks.

This effect can be observed at a certain preheating temperature (fig. 6), preheating location from the welding arc, and welding mode. Preheating without melting the base metal can be done with an electric arc (carbon or tungsten electrode), gas multi-jet (linear, ring) burners (fig. 4, 5). Acetylene, methane, and propane are recommended as the fuel for the flame.

3. Conclusion

1. It is established that a number of metals are welded with preheating.
2. It is shown that preheating during the welding of metals significantly improves the weldability of the metal and the weld properties.
3. It is noted that additional preheating of the welding wire with currents from a low-voltage transformer or generator cannot eliminate the formation of hot (crystallization) cracks in the weld, although it significantly improves the weldability of the metal.
4. It is established that only additional preheating is the most effective means in preventing hot cracks in the weld and improving the mechanical properties of the joint.

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