CONTROL OF STRUCTURE AND PROPERTIES OF WELDED CONNECTIONS OF MEDIUM ALLOY STEELS BY APPLICATION HIGHLY CONCENTRATED PULSE ENERGY ACTIONS

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Introduction

On-stream of equipment, machines and mechanisms their parts often work in conditions of contacting with various hostile environments and abrasive agents causing not only wear, but also intensive corrosion [1]. Depending on conditions of metal interaction with environment and their properties, some types of corrosion can proceed: uniform, pitting, intergranular and cracking. As a rule resistance of welded connections to corrosive attack is lowered due to thermalphysic and chemical-metallurgical influences of welding process, first of all on metal structure in a zone of formed permanent connection, and is related with chemistry of weld metal and heat affected zone.

The work purpose – carrying out assessment of welding conditions influence on corrosion resistance of welded connections of the alloyed steels.

Materials, equipment and experimental techniques

Samples have been welded by manual arc welding for carrying out of researches. Welding was performed on a direct current and also with application of adaptive pulse-arc welding method (APT) [2]. Samples of low-alloy steel 10Г2С have been welded by electrodes of type УОНИ-13/55, and samples of steel 12Х18Н10Т have been welded by electrodes of type ЦЛ-11. Mechanical tests of steel welded joints strength were carried out with using traditional techniques, at static loading by tensile. Studying the effect of power parameters of welding mode on corrosive attack pattern of steels welded joints were conducted on welded joints samples obtained by manual arc welding with covered electrodes on stationary modes, and also by the method (APT) realized on inverter power sources ФЕБ-315 «МАГМА» [3, 4]. Corrosion tests samples of welded joints of 10Г2С steel were conducted by an immersion method in a solution of the concentrated hydrochloric acid for 100 hours. Corrosion tests samples of welded joints of 12Х18Н10Т steel were conducted by accelerated method in a water solution of 10% HNO_3 + 3% HF. Test period was 48 hours. After the tests of welded joints researches of corrosive failure of weld and HAZ were carried out. Registration of observed microstructures of welded joints surface was performed on the PC using a special video camera installed on a microscope using the program «Multi Cap».

Results and discussion

At mechanical tests fracture of the samples received using both modes occurs on the basic metal, Fig.1, this indicates of fulfillment of main condition of obtaining welded joint material stronger than the base material. It is established that durability and plasticity of steels welded joints strongly depend on presence even single welding defects which can lead to decrease their plasticity in 1,5-2 times. Welded connection with more uniform structure has also more uniform distribution of mechanical properties, Fig.2.

Fig. 1. A photo of the fractured sample of welded joint of 15ХСНД steel.

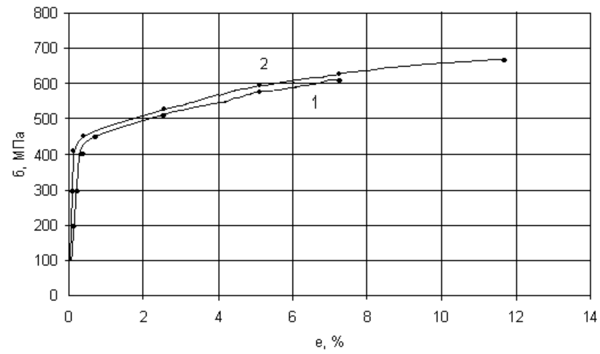

Fig. 2. Stress-strain diagrams of samples of 15ХСНД steel: 1 – with defect (pore), 2 – without defects.

It is known that structure and properties of welded joint strongly depend on power parameters of processing procedure of its obtaining [5]. Influence of frequency characteristics of the current on structure steels welded joints obtained by stationary modes and pulse change of their power parameters was investigated in this work, Fig.3. It is established that at reduction of current frequency the structure is crushed. The seam has ferrite-pearlite structure. After the stationary welding mode a large pearlite grains with ferrite grains on boundary are observed in the center of seam. In the transition zone structure crushing is observed. However, the sizes of grains of this zone strongly surpass structural constituents of weld steel. For the samples welded with pulse change of power parameters of a mode in the seam center as well as in the transition zone crushing of structural constituents is observed in 3-4 times. By grain sizes this zone approximates to structural constituents of weld steel.

Structure investigations of surface condition of samples after the stationary mode of welding have shown that metal has been prone both to dangerous intergranular

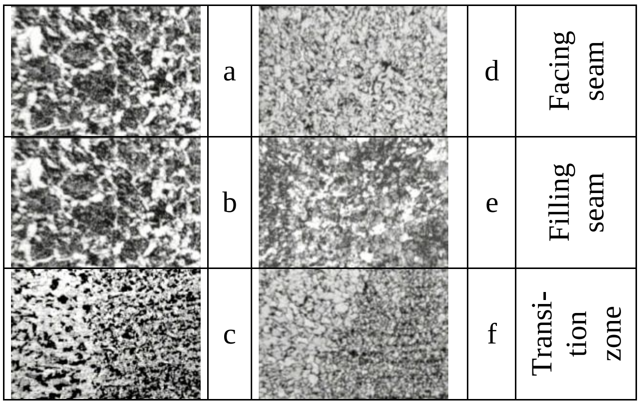

Fig. 3. Structure of welded joint of 10Г2С steel after a stationary mode of welding (a, b, c) and after APT mode (d, e, f).

corrosion, and pitting corrosion. The corrosion picture indicates that HAZ of welded joint of 10Г2С steel after stationary mode of welding has a high corrosive attack area, Fig.4, a, b. The analysis has shown that corrosion has attacked the base metal on the area to about 40 %. Structure investigations of surface condition of samples after the pulse mode of welding have shown that the given welded joints are prone to less dangerous pitting corrosion, Fig.4, c, d. Metal is attacked on the area about 25 %.

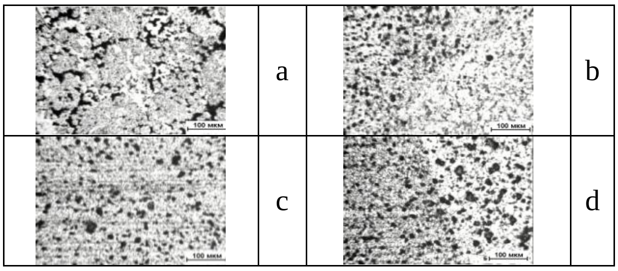

Fig. 4. The behavior of corrosion attack in a zone of welded joints received: on stationary modes (a – seam, b – transition zone); on APT mode (c – seam, d – transition zone).

In whole, the conducted researches have shown that at use of pulse welding mode the mechanism of corrosion interaction of welded joints of low-alloy steel 10Г2С in hydrochloric acid changes: instead of intergranular corrosion proper to joints after a stationary mode pitting corrosion occurs. This is associated with more uniform distribution of elements in the weld and decrease burnout in the APT process.

The greatest corrosion attacks of welded joints of 12Х18Н10Т steel localized in HAZ, Fig.5, a.

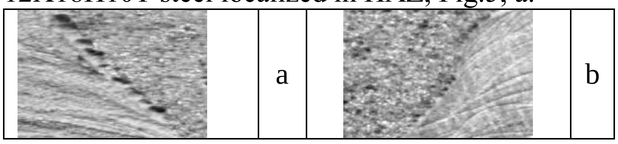

Fig. 5. The behavior of corrosion attack of welded joints of 12Х18Н10Т steel received: a – on stationary modes; b – on APT mode.

At applying the APT, resistance of welds to corrosive attack increases to 3 times. Meanwhile the corrosion attack picture of samples welded by adaptive pulse-arc welding is changing. The knife-line corrosion is absent. There is corrosion in the form of pitting localized in the HAZ, Fig.5, b.

Conclusion

Application of adaptive pulse-arc welding method allows receiving the weld joints that have fine-grained structure as in weld metal and HAZ. Resistance to corrosive attack of weld joints of 10Г2С and 12Х18Н10Т is increasing, including dangerous kind of intergranular corrosion – knife-line corrosion. Thus kinetics of corrosive attack of weld joints is changing. The initial stage of corrosion attack in a kind of pitting corrosion does not come to dangerous intergranular corrosion typical for joints obtained at stationary modes. As a result these welded joints have a higher durability at operation in corrosion conditions.

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