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# Specific Properties of Welding Chromium-Nickel Steels

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**Abstract:** This article provides ideas and comments on the specifics of welding chromium-nickel steels.

**Keywords:** chrome-nickel, welding, liquefied gas, agricultural machinery, automotive, heavy and transport machinery, light and food industries, instrumentation.

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**Introduction**

A recent article by the Uzbek National News Agency, entitled "Production of a new type of liquefied gas tanker began in Andijan," prompted him to write this scientific article. It states that currently 3.6 million consumers in the country use more than 4.5 million household gas cylinders. As the demand for liquefied gas increased, it began to be transported in tank cars. This makes it possible to transport up to 2,000 tons of liquefied gas using a single train, and the capacity will increase by 40%. Based on this, we would like to provide information on some specific aspects of the production of such tank cars.

It is known that such tank cars operate in a somewhat aggressive environment. Therefore, they are welded from special high-alloy steels.

Today, more than 1,500 brands of alloy steels and alloys of non-ferrous metals are produced in the world. About 80% of them are used in industrial production, 20% in capital construction. In machine-building, ready-rolled steels are widely used in tractor construction, agricultural machinery, automotive, heavy and transport machinery, light and food industries, instrumentation.

At the same time, special steels and alloys are widely used in industrial production, accounting for about 25% of metal material production. They have broad prospects for application in aerospace engineering, chemical engineering and nuclear power.

It is well known that today, machine building cannot be imagined without welding. The high efficiency of welding has made it an integral part of machine building. Welded structures made of special steels are used in a variety of specific conditions: very high and low temperatures, aggressive environments, heavy operating conditions with different properties.

One of them is tank cars for liquefied gas. If the volume of existing wagon tanks is 60 m3, the volume of new wagon tanks is 83 m3. This allows each wagon to fill 1,800 household gas cylinders instead of 1,500 domestic gas cylinders. These tank cars are made of high-alloy steels with chromium-nickel. However, mistakes made during the manufacturing process can cause cracks in the tanks and they can lead to accidents that can lead to serious consequences.

Figure 1. Wagon-tank for liquefied gas transportation.

Therefore, in the manufacture of such tank cars will have to comply with a number of additional requirements.

Typically, high-alloy steels contain more than 10% of several alloying elements or a single

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alloying element of more than 5%.

Chromium-nickel stainless steels have a special place among high-alloy steels. These steels are also often referred to as austenitic steels. They contain 18-25% chromium, which provides heat and corrosion resistance, 8 ... 35% nickel, which stabilizes the austenite structure and provides heat resistance, plasticity and technology. Austenitic steels may also contain other alloying elements such as carbon, nitrogen, manganese, titanium, neobium, molybdenum, tungsten, silicon, vanadium.

The chemical composition of stainless steels serves to increase their chemical and electrochemical corrosion resistance of two types. The specific difference of these steels is that the carbon content is less than 0.12%.

Based on the above, 12X18N10T austenitic alloy steel with a thickness of 22 mm is usually used for tank cars. Sheets made of this steel are cut to certain sizes, then bent and the pieces are welded together.

When welding tank cars, the method of automatic welding under flux, which meets the requirements for it, is used.

Automatic and semi-automatic welding of stainless steels under flux is used in the manufacture of large-sized vessels, tanks, various shells and similar structures. In this case, automatic welding under flux is especially effective when it is necessary to obtain a long weld seam with a metal thickness greater than 5 mm.

The welding technology of stainless steels is not much different from the welding of ordinary low carbon steels. However, in this case, the stainless steel wire melts faster than the carbon steel, so the wire transfer and welding speeds are also higher.

Automatic welding under the flux layer is the most productive welding method, which allows not only welding of ordinary structural steels, but also high-strength, stainless and heat-resistant steels with a thickness of 2-50 mm.

Taking into account these advantages of the method, the department of "Technological machines and equipment" of Namangan Engineering and Construction Institute was provided with automatic welding equipment under the flux layer.

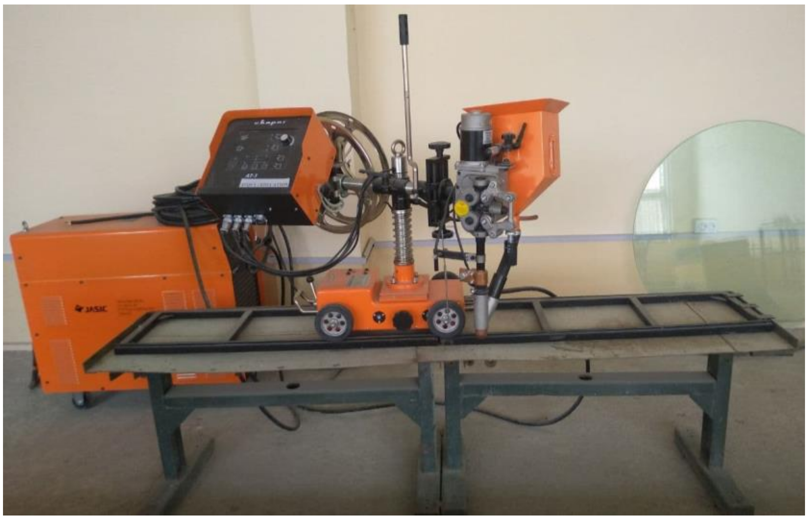

Figure 2. General view of automatic welding tractor under flux.

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The specific features of stainless steel welding are as follows. Stainless steels have mainly a stable single-phase structure, the carbide and intermetallic phases of which undergo significant changes during the welding process. They differ sharply from perlite steels in their thermophysical properties. They have a much lower liquidus temperature (above 1000S), 3 times less thermal conductivity, however, a large coefficient of thermal expansion, a much higher electrostatic resistance (up to 5 times), high strength, good relaxation stability at high temperatures. All this leads to an increase in residual stresses in the welded joint. These factors lead to the fact that these stainless steels have lower weldability than carbon steels, difficulties in maintaining the mechanical and chemical properties of the metal, the appearance of crystalline, solid, liquefied cracks of various shapes.

The low thermal conductivity and high coefficient of linear expansion, which are characteristic of high-alloy steels, lead to the appearance of cracks in and around the weld.

Based on the above, the following basic features of stainless steel welding can be demonstrated.

The formation of intergranular cracks occurs as a result of the formation of a pure austenite structure of the metal in the weld;

Excessive bending of welded structures relative to carbon steel structures;

The need to increase the length of the joints and reduce the distance between them by 1.5-2.0 times due to the large coefficient of linear expansion;

The main and common feature of welding of stainless steels is the formation of cracks with crystalline properties in the weld seam and in the weld zone. The formation of these cracks is associated with the formation of a coarse-grained macrostructure in the metal during welding.

Another requirement for welded joints is their resistance to various corrosion. In particular, intergranular corrosion can occur in both the weld metal and the thermal impact zone of the parent metal. The main reason for the occurrence of intergranular corrosion in such weld metal is the high amount of carbon and insufficient titanium and neobium. The resistance of the weld to intergranular corrosion is reduced due to prolonged exposure to heat.

The main means of eliminating cracks in the welding of chromium-nickel stainless steels is the additional alloying of the metal weld during the welding process and the use of fluxes without oxygen and low silicon content.

In practice, when it is not possible to select the flux and electrode wire, the technological way of combating cracks helps:

- Modification of base and electrode metal components in weld metal;
- Change the cross-section and shape of the seam;
- Preheating of the weld metal;
- Trimming the welded edge or the bottom layer of the weld;

The main advantage of automatic welding under the flux layer over manual welding is the constant uniformity of metal composition and properties along the entire length of the weld. The well-formed surface of the weld and its smooth transition to the base metal, the absence of metal splashes on the surface of the product significantly increases the corrosion resistance of welded joints.

It is recommended to perform welding with a small cross-section of the weld to prevent overheating of the metal and, consequently, enlargement of the structure, the appearance of cracks and, consequently, the deterioration of its operational properties. To do this, reduce the diameter of the welding wire to 2 ... 5 mm, the length of the output of the electrode wire from the tip of the nozzle to 1.5 ... 2 times.

Generally, it is recommended to use electrode wires of the following brands for welding stainless steels such as 12X18N9, 08X18N10, 12X18N10T, 12X18N9T: Sv-01X18N9, Sv-04X19N9, Sv-06X19N9T, Sv-07X18N9TYu, Sv-04N99S2.

The weld is alloyed by means of a flux or electrode wire. In this case, the second method is more convenient because it provides more stability of the weld metal composition.

For stainless steels, the use of low-silicon fluxes AN-26, 48-OF-6 and ANF-14 is recommended. Fluoride-boride ANF-22 flux is used to prevent cracks in welded joints. In this case, welding is carried out at alternating currents in reverse polarity. It is recommended to obtain the automatic welding mode under the flux layer when the metal thickness is 22 mm and more as follows: diameter of the welding electrode wire - 5 mm, welding current - 750 ... 775 A, welding arc voltage - 38 ... 42 V, welding speed 25 m / h, the transmission speed of the electrode wire is 81.0 ... 95.0 m / h, the output length of the wire from the tip of the nozzle is 40 ... 50 mm. Types of welded joints and welds obtained in automatic welding under the flux layer, structural elements and their dimensions are standardized by GOST 8713 and GOST 11533. In automatic welding under flux, it is recommended to hold the welded surface at a 30-degree angle in the longitudinal direction, either downwards or upwards.

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