УДК 621.791.75

FEATURES OF A355 GR P 91 STEEL WELDING AND HEAT TREATMENT

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In recent years, main steam pipelines made of chromium steel P91, which operate effectively at high temperatures, have found widespread use in the power engineering sector of many countries. The main problem preventing further operation of steam pipelines is the initiation and development of fourth-type cracks in the weld and the heat-affected zone of welded joints. Main types of cracks in steels are as follows: destruction by a wedge-shaped crack, which usually occurs at the intersection of three grains and then continuously spreads along their boundaries from the surface into the depth of the steam pipeline; fracture by formation of pores at grain boundaries, which increase in size over time, merge and form a continuous crack.

Wedge-shaped cracks are formed at lower temperatures, high stresses and high creep rates, whereas pore-generated cracks are formed at higher temperatures, low stresses, and low creep rates. A distinctive feature of wedge-shaped cracks is a smooth fracture surface, while a crack formed from pores has a rough surface.

Over the past three decades, scientists and specialists have made significant progress, which has made it possible, due to the introduction of some alloying elements (boron, vanadium, niobium, nitrogen) in small quantities into the base metal and weld metal, to create the microstructure of steel with finely dispersed hardening (carbides, carbonitrides, etc. .), as well as regulate grain sizes and thereby increase operating temperatures from 500 to 650 °C.

Thus, the key areas, which make it possible to increase the service life of P91, alloy steel are as follows:

– to find effective methods for creating the required stress state and chemical composition in the surface defective layers of existing steam pipelines;

– to develop shielded welding modes with minimal heat input, excluding the entry of hydrogen into the weld pool;

– to find the optimal composition and properties of the coating on the weld and heat-affected zone, excluding the process of internal oxidation during operation of the steam pipeline;

– to improve diagnostic methods and non-destructive testing of the condition of the base metal, weld metal and heat-affected zone during operation;

– to develop and find optimal modes of restorative heat treatment of the weld metal and heat-affected zone during operation of the steam pipeline, in case of deterioration of mechanical properties.