

FORMATION OF CREEP PORES IN WELDED JOINTS OF STEAM PIPELINES

Glushko A.V.

*National Technical University
«Kharkiv polytechnic institute», Kharkiv*

Damage of welded joints of steam pipelines made of heat-resistant pearlitic steels (12Kh1MF and 15Kh1M1F) during their long-term operation (operating time more than 270000 hours) under creep conditions and low-cycle fatigue (the presence of start and stop) proceeds by the mechanism of pore formation and creep cracks, as well as by the mechanism of formation cracking fatigue.

The implementation of the above mechanisms is characterized by the presence of fundamental differences, which necessitates their separate consideration. The nucleation of pores occurs predominantly at the grain boundaries of the α -phase. The degree of pore appearance depends on the structural state of the welded joints of steam pipelines.

The initial structure of welded joints of steam pipelines, the formation of which is provided by welding heating, has a certain inhomogeneity. The structural state of welded joints made of heat-resistant pearlitic steels 12Kh1MF and 15Kh1M1F is regulated by regulatory documents.

Chemical composition of heat-resistant pearlitic steel 12Kh1MF, %: C – 0.10...0.15; Si – 0.17...0.37; Mn – 0.40...0.70; Cr – 0.90...1.20; Mo – 0.25...0.35; V – 0.15...0.30; Ni no more than 0.25; Cu no more than 0.20; S no more than 0.025; P no more than 0.025.

Chemical composition of heat-resistant pearlitic steel 15Kh1M1F, %: C – 0.10...0.16; Si – 0.15...0.37; Mn – 0.40...0.70; Cr – 1.10...1.40; Mo – 0.90...1.10; V – 0.20...0.35; Ni no more than 0.25; Cu no more than 0.20; S no more than 0.025; P no more than 0.025. Accordingly, the operating temperature should not exceed 570...580°C.

In the course of long-term operation of welded joints, their structure degrades, the rate of which depends on the initial structural state of the joints. The level of structure degradation largely determines the formation of creep pores and their transformation into creep cracks, which significantly reduces the strength characteristics of welded joints.

Pore formation is provided by operating stresses and temperatures, and also depends on the structural condition and properties of welded joints. With their long-term operation, the structure of the areas of incomplete recrystallization, overheating and fusion of the HAZ to a relatively greater extent than the base metal and weld metal turns into a ferrite-carbide mixture.

It was found that the nucleation of pores in the metal of welded joints of steam pipelines, operated for a long time under creep conditions, initially occurs primarily at the boundaries of the contact of the α -phase grains with coagulating carbides of the first group.

It was found that with an increase in the deformation of the metal of welded joints, the formation of creep pores is accelerated.