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"Study of the Influence of Heat Treatment on the Properties of Chrome Steel"

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ANNOTATION

This article describes the process of researching the effect of thermal treatment on the properties of chromium steel to increase its effectiveness.

Introduction: Increasing labor efficiency in metallurgy and ensuring the competitiveness of the output product requires a serious increase in accuracy and quality in production processes and the introduction of new technological methods and automatic technological processes on a large scale.

At present, the construction of products produced in enterprises is continuously becoming more complex, the types are increasing, production facilities are changing frequently, and the time of mastering the production of new products is getting shorter and shorter. Of course, to work in such conditions, i.e. in an integrated environment, to work in a rapidly changing set of material and technical means, a specialist must be a master of his profession and technologically prepared for this activity.

Relevance of the topic. Currently, research on improving the corrosion resistance of 9-12% Cr martensitic steels at a working temperature of 650°C has shown the importance of taking into account microstructural changes during corrosion, such as carbonitrides and intermetallic compounds. Steels with a chromium content of 9-10%, in addition to V, Nb, and N form fine MX carbonitrides, the alloy shows high values of long-term transition at a temperature of 600 ° C up to 100,000 hours. However, 9-10% Cr steels increase the oxidation resistance to a limited extent, and to increase the steam working temperature above 600 ° C, it is a mandatory factor to increase the oxidation resistance of Cr to 11-12%. However, 11-12% Cr steels exhibit low values of long-term corrosion, due to the deposition of Z-phase (Cr(V, Nb)N nitrides) dissolving dispersed MX nitrides. Recent studies have shown that the precipitation of the Z phase is caused by the high content of Cr in these steels and is accelerated by the addition of cobalt to the chemical composition of the steel. By reducing the nitrogen content, the formation of the harmful Cr(V, Nb)N phase can be avoided, but this also reduces the proportion of MX carbonitrides. In this case, alternatively, the effect of other reinforcement steps on shear resistance should be investigated.

Chemical composition and influence of alloying elements and impurities

In the development of 9-12% Cr martensitic steels, it is important to maintain a balance between ferrite and austenite-stabilizing elements to obtain a 100% austenitic structure during austenitizing and a 100% martensitic structure after hardening (normalizing). However, in 10-12% Cr steels, the presence of <5% δ -ferrite in addition to martensite and large MX carbonitrides that do not melt at the austenizing temperature cannot be ruled out.

The main alloying elements for martensitic steels are carbon, nitrogen, chromium, tungsten, molybdenum, vanadium, niobium, boron, phosphorus, nickel, cobalt, and copper. Permanent impurities are manganese, silicon, sulfur, and phosphorus.

The properties and structure of steels are determined by their chemical composition. Table 1 shows the chemical composition of new-generation martensitic steels.

Table 1. Chemical composition of new generation martensitic steels (%).

Steel	**C, %**	**N, %**	**Cr, %**	**W, %**	**Mo, %**
P9	<0,15	-	8-10	-	0,9-1,1
P91	0,08-0,12	-	8-9,5	-	0,85-1,05
P911	0,09-0,13	0,04-0,09	8,5-9,5	0,9-1,1	0,9-1,1
P92	0,07-0,1	0,03-0,07	8,5-9,5	1,5-2	0,3-0,6
	V, %	**Nb, %**	**Si, %**	**Mn, %**	**B, %**
P9	-	-	0,25-1	0,3-0,6	-
P91	0,18-0,25	0,06-0,1	0,25-0,5	0,3-0,6	-
P911	0,18-0,25	0,04-0,09	0,1-0,5	0,3-0,6	0,0003-0,006
P92	0,15-0,25	0,03-0,07	0,5	0,3-0,6	0,001-0,006

Carbon (C) and nitrogen (N). The carbon content of martensitic steels ranges from 0.002% to 0.1%. As the carbon content of steel increases, its hardness and strength increase. The standard amount of nitrogen in martensitic steels is ~0.05%, which the steel "pulls" from the atmosphere during melting. Carbon and nitrogen are strong austenite stabilizers, and the degree of solubility in austenite is high. They have very low solubility in ferrite, which leads to the formation of MX carbonitrides, MN nitrides, and/or MC carbides, respectively.

Chromium (Cr) is a ferrite-stabilizing alloy element. It limits grain growth during heating of steel, improves mechanical and cutting properties, improves corrosion resistance and hardening, and helps to improve steaming. If the amount of chromium is more than 10%, then the steel will be stainless, but will lose the ability to harden. When chromium is added to α-iron, solid solution strengthening is low. Chromium interacts with carbon to form carbides; The most common carbides containing 2-12% Cr are Cr: M23C6 and M7C3 (where M is Cr and Fe). 9-12% of steels are dominated by the amount of Me23C6 Cr; stored at high temperatures. In low-chromium steels (<7% Cr), the formation of the last carbide occurs, but the formation of Me23C6 in these steels is not excluded at high temperatures and long-term exposure.

Manganese (Mn) is introduced during the steel melting process for deoxidation, if its content is less than 1%, it is called permanent impurities. More than 1% of manganese is an alloying component. Increases its strength, durability, and toughness, and improves the cutting properties of steel. Impact power is reduced. Manganese contributes to the strengthening of carbides, but unlike nickel, it is a stabilizer of austenite.

Silicon (Si) is a deoxidizer that cleans steel from excess oxygen and is also an alloying element when the silicon content is more than 0.8%. It increases elastic limit, corrosion resistance, and heat resistance, and reduces impact strength. Melting in ferrite increases the strength of silicon steel, especially the ductility, s0.2. At the same time, a certain decrease in ductility is observed, which in turn leads to a decrease in the tensile strength of steel.

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