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BOOK OF ABSTRACTS

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EFFECT OF CHEMICAL ELEMENTS ON THE PROPERTIES OF PIPE STEEL

The effect of titanium on the properties of steel is manifested depending on its state (in pure form or in the form of compounds). In hot-rolled steel, titanium with a total amount of 0,1% is oxidized in carbides (about 0,055%), nitrides (about 0.025%) and oxides (about 0,002%), as well as in partially solid solution (about 0,02%). After low temperature heating (negative hardening), the amount of titanium solid solution sharply decreases and usually does not exceed 0,003%

with the growth of titanium carbides. As a result, the impact toughness increases while reducing strength [1].

It should be noted that minor additives of titanium (0,01-0,03%) are effective in crushing the normal structure of the metal, as formed in liquid steel titanium nitrides serve as centers of crystallization.

The size of these particles of titanium nitride is about 0,02 microns. They serve as a barrier to grain growth and facilitate their fragmentation [2].

With small aluminum additives (up to ~0,1%), the critical brittleness temperature decreases, which is a result of the reduced content of dissolved nitrogen. After removal of nitrogen from the solution, the aluminum content practically does not have an effect on this indicator, but with its excessive amount of grain growth occurs, accompanied by an increase in the brittleness temperature.

Studies of the influence of various elements on the roperties of normalized low alloy steel type 16G2AF containing vanadium (0,10-0,15%), aluminum (0,02-0,04%) and nitrogen (0,013-0,024%), showed [2].

Increase in carbon content from 0.16 to 0.23% strengthens the properties, reduces the toughness at sub-zero temperatures and slightly affects the cold brittleness threshold (T50), which is explained by perlite share increase without changing the size of the ferrite grain.

Manganese with a content up to 1,7% moderately trengthens the steel, slightly increases the toughness and cold resistance, which is associated with the fragmentation of grain, so it is advisable to alloy steel of this type with manganese to 1,7%.

Silicon in the amount of 0,45 to 1,5% gradually increases the strength characteristics with a decrease in impact toughness and increased cold resistance, which is associated with some enlargement of the grain, a strong curvature of the crystal lattice and the elimination of this element.

Chromium up to 1,3% increases the strength, but decreases the yield strength, lowers toughness and increases the cold shortness threshold, which is associated with grain consolidation and increased perlite formation.

With an increase in the content of vanadium to 0,28%, there is a slight increase in strength properties with a decrease in impact toughness (when the content is more than 0,15%) and a slight increase of cold shortness threshold. Therefore, steel with carbonitride strengthening is advisable to microalloy vanadium to 0,15%.

Niobium in the amount up to 0,08% in steel with 0,09% V practically does not affect the mechanical properties, so the use of this element in normalized steel with carbonitride strengthening is impractical.

Nickel and copper in the amount of 0,5% each slightly increase the strength and impact toughness, but have virtually no effect on the cold shortness threshold, so it is possible to use these elements if necessary to further strengthen the steel with carbidonitride.

With increasing nitrogen content, the strength properties increase due to the fragmentation of grain. With a constant content of vanadium, the impact toughness decreases and increases the threshold of cold shortness. However, while increasing the content of vanadium, these indicators are improving, so to obtain optimal properties, it is necessary to ensure the complete binding of nitrogen with vanadium and aluminium.

Small molybdenum additives have little effect on the properties of such steel. Small titanium additives slightly reduce the yield stress due to the depletion of the metal with nitrogen, which goes into the formation of stable titanium nitride. Joint microalloying with nickel, copper and molybdenum is accompanied by a significant strengthening with the deterioration of cold shortness impacttoughness.

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