EFFECT OF PRELIMINARY REHEATING ON AUSTENITE TRANSFORMATION IN THE CORE AND HARDENED CASE OF STEEL 20Kh2N4A

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For the investigation we took specimens of steel 20Kh2N4A from two melts (see Table) having a different sensitivity to crack formation in the hardened case (melts I and II) [1], [2] and subjected them to preliminary reheating at 1300°C for 2 h with air or oil quenching. We studied noncarburized and homogeneous carburized specimens (in a solid carburizing compound at 910°C) before and after reheating.

Isothermal transformation of austenite was studied on a magnetometer, by M. S. Akulov's system on 3 x 5 x 25 mm specimens at 900°C. In addition, we recorded the dilatometric curves on a Chevenard dilatometer at different cooling rates of the specimens and then plotted thermokinetic diagrams for each type of heat treatment.

### Transformation of Austenite in Noncarburized Steel 20Kh2N4A

The diagrams of the isothermal transformation of steel in the initial state (Fig. 1a, b) show a different stability of austenite in the upper subcritical temperature range of the two investigated melts. As we see in the figure, the pearlite range of transformation for the steel of melt I is shifted to the right in comparison with melt II. The distribution of the pearlite zone of transformation along the temperature axis in melt II was greater than in melt I; in the latter, the pearlite region is separated from the intermediate zone of high stability of austenite. Such a difference in the kinetics of austenite transformation in the pearlite region is characteristic for melts with a different sensitivity to crack formation [1], [2].

The diagrams of the isothermal transformation of austenite of preliminarily reheated steel (Fig. 1c and d) show for both melts an appreciable acceleration of austenite transformation in the upper subcritical temperature range and an increase in the quantity of austenite being transformed (Fig. 2).

It follows from the obtained data that the stability of austenite of melt I after reheating is the same as of melt II in the initial state.

Thus, in the upper subcritical temperature range in the core of the specimens of steel 20Kh2N4A, the stability of austenite appreciably declines (about by an order) under the effect of preliminary reheating and the degree of its transformation increases. In this case the bainite region and martensite point do not change their position on the diagram of isothermal transformation of austenite under the effect of preliminary reheating.

The results of studying the transformation of austenite with continuous cooling confirmed the conclusions obtained in the investigation of isothermal transformation. The pearlite decomposition region in melt I is appreciably less than in melt II in initial and reheated states (Fig. 3 a, c) and the degree of transformation in this zone is correspondingly less in melt I. The austenite in the upper subcritical temperature range in melt I is transformed only upon slow cooling (at an average rate of 0.79 and 1.46 deg/min).* The quantity of the phase that was transformed in this melt was small. In melt II with the same cooling conditions, transformation in the pearlite zone occurred to an appreciably

* This rate is approximately equal to the cooling rate of a part in a carburizing container.
greater degree. Moreover, in melts II, unlike melts I, the austenite had time to be transformed in the subcritical region at high cooling rates (4.6 and 5 deg/min).

The effect of preliminary reheating on acceleration of austenite transformation in the pearlite range and on the increase in the quantity of the phase transformed in this zone are shown in Fig. 3. At high rates of transformation, preliminary reheating elevates the temperature of bainite transformation.

A metallographic investigation of magnetometric specimens that experienced transformation in the upper subcritical zone showed that their structure consists of ferrite and bainite and that there is appreciably more ferrite in melt II than in melt I.

The quantity of ferrite in the specimens approximately corresponded to the degree of transformation in the pearlite region, which was determined by the magnetometric curves. Thus, ferrite is formed during transformation in the upper subcritical temperature range.

As the metallographic investigation demonstrated, an increase in the degree and rate of transformation of austenite in the pearlite region under the effect of preliminary reheating is also associated with an increase in the quantity of ferrite and its distribution along the boundaries of the former austenitic grains. We can assume that separation of ferrite and an increase in its quantity as a result of preliminary reheating occurred under the effect of the same factor.

A comparison of our data on the effect of preliminary reheating on the increase in the quantity of ferrite with the data of work [3] permits the assumption that aluminum nitrides stimulate the formation of ferrite in the core structure. Actually, the temperature range and conditions under which the content of nitrides increases coincides with the temperatures and conditions of the increase in the quantity of ferrite. Localization of ferrite along the boundaries of the former austenitic grains coincides with the distribution of aluminum nitrides.

Transformation of Austenite of Steel 20Kh2N4A After Carburizing. An investigation of isothermal transformation of austenite in carburized steel (Fig. 4) showed that, as before carburizing, the stability of austenite of melt I in the pearlite region is greater than that of melt II: the incubation period of transformation is greater and the temperature range of this zone is smaller for melt I. These differences are characteristic for the transformation of austenite in the two types of melts [1], [2].

It was found that preliminary reheating does not affect the character, kinetics, or degree of transformation of austenite in carburized steel (Fig. 4 c, d). The indicated regularity holds true even with retention of the pattern.