CORRECTING THE COARSE-GRAINED STRUCTURE OF CAST HYPEREUTECTOID STEELS

A. A. Astaf'ev, M. S. Potapova, and I. A. Borisov

UDC 620.186.5:621.771.07

In recent years rolls for hot rolling have been manufactured from cast hypereutectoid steels, which have a higher wear resistance (200-300%) at 500°C than the widely used steel 60KhN.

However, the presence of about 1.5% C in cast hypereutectoid steels makes it difficult to obtain high strength properties along with satisfactory impact characteristics. The heat treatment of cast hypereutectoid steels must meet the following requirements:

1. Refining of the original austenite grains.

2. Breaking up the coarse aggregates of carbides around primary austenite grains and prevention of the formation of a carbide network.

3. Reduction of the dendritic heterogeneity.

We investigated steels 100KhGMF and 150Kh2MF, for which Ac_1 is 740-760°C. The optimal heat treatment to remove the coarse-grained structure for rolls used in cold rolling (steel with 0.9% C) is double recrystallization [1]. In the first recrystallization the temperature must be high enough for recrystallization of the austenite.

We investigated the possibility of using double recrystallization in the heat treatment of cast hypereutectoid steels.

The ingots for the laboratory tests weighed 12 kg. After solidification they were heated to 1200°C, held 1 h, and quenched in oil. They were then tempered at 650°C for 2 h to reduce the hardness.

The temperature required to correct the coarse-grained structure was determined with impact test samples cut in the transverse direction with respect to the ingot. The samples were heated to 850-1150°C at rates of 2000 and 50 deg/h in an inert atmosphere and quenched in oil. The holding time at these temperatures was varied from 4 to 16 h. After this treatment the structure was martensitic.

Fractographic analysis of the samples showed that heating 30-100°C above A_1 does not correct the coarse-grained structure. The facets of the old large grains and the dendritic structure were clearly visible in the fracture. After heating to higher temperatures the dendritic structure was less noticeable and the facets became finer. The temperature for correcting the coarse-grained structure (holding 4 h in the austenitic region) increased when the heating rate was reduced from 2000 to 50 deg/h – from 1030-1070°C to 1080-1120°C for steel 150Kh2MF and from 980-1020°C to 1030-1070°C for steel 100KhGMF. An increase of the holding time in the austenitic region from 4 to 16 h reduced the temperature for correction of the coarse-grained structure by 80-100°C.

TABLE 1

First recrystallization temp., °C	a_n, kg-m/cm², after holding in austenitic region for	
	4 h	16 h
950	1,0; 1,1; 1,2	2,0; 2,2; 2,3
1000	2,0; 2,1; 2,4	2,7; 3,0; 3,2
1050	2,3; 2,4; 2,6	3,0; 3,5; 3,8
1100	2,5; 2,7; 2,8	2,0; 2,3; 2,5
1150	1,8; 2,0; 2,0	1,6; 1,7; 2,0

Microstructural and x-ray structural analyses confirmed the results of the fractographic analysis. The carbide phase is not completely dissolved in the austenite during heating to the temperature for correction of the coarse-grained structure. Complete solution of the carbide phase in steel 150Kh2MF occurs only after holding 2 h at 1200°C. This indicates that recrystallization of austenite is the controlling process during heating of cast hypereutectoid steels with 1.5% C in order to correct the coarse-grained structure.

TsNIITMASh. Translated from Metallovedenie i Termicheskaya Obrabotka Metallov, No. 3, pp. 64-65, March, 1969.

Samples cooled to room temperature at the rate of 100 deg/h were used to determine the mechanical properties of steels 100KhGMF and 150Kh2MF after double recrystallization. The samples were heated to normalization temperatures of 950-1150°C at the rate of 50 deg/h and held from 4 to 16 h. The second normalization temperature was 850-880°C. Following normalization the samples were tempered at 650-680°C for 8 h to a hardness HB 269-280.

Analysis of the mechanical properties of the steels shows that the properties depend on the first normalization temperature. The best combination of strength and impact characteristics resulted from heating to the austenite recrystallization temperature. This was confirmed by impact tests of cylindrical samples of steel 150Kh2MF (10 mm in diameter, 55 mm long) without notches (see Table 1).

It can be seen from the table that it is expedient to use a longer holding time and a lower temperature in the austenitic region for the first normalization.

Microstructural analysis showed that this heat treatment produces fine-grained austenite and eliminates the carbide heterogeneity.

Steels 100KhGMF and 150Kh2MF were used to manufacture experimental groups of rolls for the 250 mill at the Hammer and Sickle Plant. Operating tests of these rolls showed that their durability is 125-143% higher than that of rolls hard faced with 3Kh2V8 powdered wire.

CONCLUSIONS

1. In correcting the coarse-grained structure of cast hypereutectoid steels 100KhGMF and 150Kh2MF the recrystallization of austenite is the controlling process.

2. A heat treatment consisting of double normalization was developed for cast rolls of hypereutectoid steels used for hot rolling. For the first normalization we recommend a temperature at which austenite recrystallizes, and for the second normalization 850-880°C. Operating tests of rolls treated by this method have given positive results.

LITERATURE CITED

1. A. A. Astaf'ev and I. A. Borisov, Metal. i Term. Obrabotka Metal., No. 1 (1968).