Thus, mechanical twinning is the most important mechanism of deformation and hardening of steel 110G13 at large deformations, when the dislocation density reaches the maximum values (~ 10^{12} cm^{-2}) and slip becomes almost impossible.

ACCELERATION OF NITRIDING OF STEEL 12Kh18N10T

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Practical experience has shown that a case depth of 0.15-0.20 mm can be obtained in ~ 70 h.

We attempted to accelerate the nitriding process by optimizing nitriding conditions with use of equipment commonly used in heat treatment shops.

Nitriding was conducted in the PN-34 shaft furnace (Fig. 1), with cylindrical samples 10 mm in diameter of steel 12Kh18N10T.

Generally, the gas is supplied to the furnace through a pipe ending in a bottom ring with openings in it. The parts are loaded in a basket which is placed in the center of the ring. This method of supplying the saturating gas does not provide a high-quality case and the process takes a long time (72 h).

We used a basket of a new design (Fig. 1) consisting of an open cylindrical container with a welded bottom and a hole in the center 40 mm in diameter. The saturating gas passes through this opening into the container. Thus, two zones are created in the furnace – inside the container and outside the container (the furnace proper). Ammonia, passing through the container, dissociates and fills the furnace chamber. As new portions of ammonia pass into the furnace, there is an injection effect with formation of a mixture of ammonia with the dissociated gas, which accelerates the saturation process. In this case the furnace serves as the dissociator and mixer at the same time. By changing the ratio of the diameter of the hole in the bottom of the container and the diameter of the pipe it is possible to control the composition of the mixture (ammonia–dissociated gas).

Measurements of the rate of the process with use of the container shown in Fig. 2a indicated that with an input of 17 liter/min of ammonia the input of saturating gas is insufficient and nitriding occurs only in the lower part of the basket (after 3 h of nitriding a case 0.08 mm deep was formed on the lower part and 0.03 mm deep on the upper part, with no case formed at the very top). Reducing the distance between the inner wall of the cylinder and the part (Fig. 2b) produced a case 0.08 mm deep throughout the load (700 mm) in 3 h, i.e., the rate of the gas input was commensurate with the dissociation rate of ammonia.

It was found that no saturation occurs between the cylinder and the wall of the container.

After nitriding at 650°C (Fig. 2b) with an ammonia input of 40 liter/min in place of the 17 liter/min generally used the case depth remained unchanged (0.08 mm), i.e., increasing the ammonia input above the optimal had no effect on the case depth.

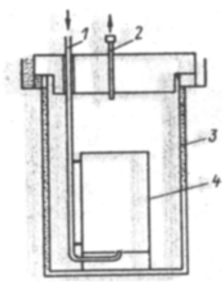

Fig. 1. Diagram of furnace PN-34 with container. 1) Gas inlet; 2) gas outlet; 3) body of furnace; 4) container.

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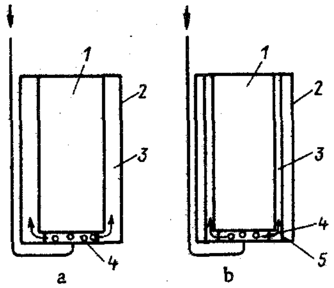

Fig. 2. Diagram of the nitriding device. 1) Cylinder with a solid bottom simulating the volume of nitrided parts; 2) container; 3) location of samples; 4) gas distribution ring with openings; 5) deflecting cylinder.

All tests were made with depassivation of the surface with carbon tetrachloride, the increase of the depassivation time from 8 to 30 min having no effect on the case depth.

The optimal nitriding process was conducted by the scheme shown in Fig. 2b – temperature 650°C, ammonia input 17 liter/min, treatment with carbon tetrachloride for 8 min.

After nitriding for 20 h under optimal conditions (Fig. 2) the case depth on disk valves was 0.15 mm, i.e., the rate of the nitriding process increased more than three times. No peeling of the disks was observed; the hardness was HV 758–HV 824. Control samples must be placed near machine parts. It is expedient to use disks as control samples and place them at the very top. This will guarantee an adequate case depth on treated parts.

CONCLUSIONS

Nitriding of austenitic steel of the 12Kh18N10T type can be speeded up by using ordinary furnaces. The main condition for increasing the rate of the process is to ensure the proper flow of the saturating gas around the machine part, which can be achieved by using a deflector.