2. The wear resistance of nitrided liners is a factor of 1.5 greater than for those produced with a Niresist insert.

LITERATURE CITED


CARBONITRIDING OF IRON-BASE POWDER MATERIALS

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Gas carbonitriding is one of the methods of strengthening sintered iron-base constructional materials.

However, the results of carbonitriding of powder materials are frequently unstable. Existing literature data [1] does not make it possible to reliably predict the service properties of parts of carbonitrided powder materials.

The purpose of this work is an investigation of the influence of chemical composition and porosity on the properties of sintered powder materials after carbonitriding using various cycles.

The 20-mm-diameter cylindrical samples with a height of up to 40 mm were prepared from an iron powder base charge with additions of up to 2.5 wt. % Cu. The samples were carbonitried at 840°C for 4-18 h in open furnaces built by I. A. Likhachev Moscow Automobile Plant in an endogas atmosphere with additions of natural gas and ammonia. The consumption of gases was 30, 2.5, and 1.5 m³/h, respectively. The carbon potential of the atmosphere, regulated on the basis of the CO₂ content, was 0.8%. One portion of the samples was cooled in the vestibule with a protective atmosphere and the other was oil hardened and tempered at 200°C for 1 h.

Before carbonitriding the ends of the samples were protected with AZLK paste.

The density of the samples was determined by the hydrostatic weighing method, the microstructure was investigated on samples cut perpendicular to the direction of pressing, and the microhardness was measured on a PMT-3 tester with a load of 0.5 N. The carbon profile across the cross section of the unhardened samples was determined by the method of layer-by-layer chemical analysis.

The character of distribution and the depth of penetration of the carbon is determined primarily by the properties of the samples after sintering (Fig. 1). With carbonitriding for 4 h the thickness of the diffusion layer of samples with a porosity of 12-16% is an order of magnitude greater than of samples of 20 steel. The surface carbon content is significantly greater than the carbon potential of the atmosphere. Soot was observed on the surface and in the voids of the samples. An increase in the porosity of the samples to 18-22% leads
Fig. 1. Carbon distribution in powder materials after carbonitriding at 840°C for 4.5 h in relation to porosity and copper content: h) distance from the surface; 1, 2) 18-22% porosity; 3, 4) 12-16%; 1, 3) 2.5% Cu; 2, 4) without copper; 5) 20 steel (control sample).

Fig. 2. Hardness profile across the thickness of the hardened case of powder material after carbonitriding at 840°C and hardening with different carbonitriding times (shown at the curves) (a) and material porosities (shown at the curves) (b): h) distance from the surface; a) powder material without copper and a porosity of 12-16%; b) powder material with 2.5% Cu.

to through impregnation of them and the carbon content in the core reaches 0.7%. With the addition of copper to the charge the general level of impregnation increases.

The microstructure of samples with a porosity of 18-22% was a ferrite-pearlite mixture with inclusions of excess cementite. With distance from the surface of the sample the quantity of pearlite decreases. In the 0.2-0.3 μm thick surface zone an increased content of voids and a more fine-grained structure are observed than in the core.

After carbonitriding and subsequent hardening regardless of the carbonitriding time and the charge composition the surface-layer structure of the samples with an increased porosity consists of martensite, excess carbides, carbonitrides, and a significant quantity of residual austenite.

The boundary of the hardened layer is not revealed metallographically and therefore the thickness of the hardened case was determined from the results of microhardness measurements across the cross section of the samples.

The highest surface hardness is observed after carbonitriding with short holds (Fig. 2a). With an original material porosity of 12-16% the microhardness is H 360-370 and with a porosity of 18-22% H 220-260. With an increase in the hold the microhardness of the surface layer drops to H 150-200 (with a porosity of 12-16%). This is caused by an increase in the porosity of the surface zone and propagation of it into the depth of the sample. With a similar original porosity of the compacts the depth of the hardened case does not depend upon the length of carbonitriding and is an order of magnitude greater than the depth of the hardened case.