The authors studied the effectiveness of strengthening free-cutting steel tools and moulds for pressing of technical rubber components, made from steels 9KhS, 38Kh2MYuA and 40Kh. Microstructural x-ray analysis of the hardened surface after nitriding could not detect any surface hardening by carbonitride phases, but detected some martensite with a more-than-normal tetragonal structure due to nitrogen dissolution. Apparently nitriding in a mixture of 70% NH₃ and 30% CH₄ causes complete disappearance of the high-nitrogen component on the surface of the specimens.

CONCLUSIONS

1. Carburizing and carbonitriding endothermic atmospheres with additions of natural gas and ammonia produce the optimum amounts of carbon and nitrogen in the diffusion layer, thus improving the wear and fatigue resistance of the steels studied by 30% as compared to thermochemical treatment by the application of liquid carburizers.

2. Nitriding in a complex atmosphere (70% natural gas + 30% ammonia) instead of a pure ammonia atmosphere shortens the duration of the process by 20% and causes complete disappearance of the high-nitrogen component on the surface.

LITERATURE CITED


STRUCTURE AND CHARACTERISTIC FEATURES OF IMPACT-FATIGUE FAILURE OF FORGED CAST IRONS

I. N. Bondarenko, S. N. Biler-Sirotkina, and G. Yu. Shul'te

We investigated the characteristic features of the impact-fatigue failure of forged cast irons with a ferritic, ferritic-pearlitic, and pearlitic base, as well as cast irons with a finely disperse matrix structure (troostite, sorbite, and granular pearlite) produced as a result of quenching cast iron in oil with subsequent high tempering.

The initial material used to obtain cast irons having a metallic matrix with a different structure was a white cast iron of the following composition: 2.70-2.80% C, 1.10-1.20% Si, 0.45-0.55% Mn, ≤ 0.13% S, ≤ 0.07% P, and ≤ 0.07% Cr.

Impact-fatigue testing was carried out on standard notchless impact specimens with the dimensions 10 × 10 × 55 mm, which were cut by a milling cutter from heat-treated tensile-test specimens 16 mm in diameter (GOST 1215-79). The surface of the impact specimens was ground, and the longitudinal face polished for the preparation of a microsection.

The impact specimens were subjected to one-sided bending with a concentrated impact in the center at a frequency of 600 blows per minute with an assigned fixed impact energy on a special apparatus [1].

Basic metallographic investigations were conducted on an optical microscope with a magnification of 1000.

We examined the topography of microcracks and main cracks on a 100-power MTM-7 microscope.
The effect of the primary structure of white cast iron, and the form, quantity, and distribution of the nonmetallic phase in the iron, as well as the structure after final heat treatment on the formation of the specimen's substructure and the character of the formation and propagation of submicrocracks and the main crack during impact-fatigue failure was determined.

Scannings characterizing the topography of fatigue cracks in specimens of forged cast irons with metallic matrices of the following structures are presented in Fig. 1: ferritic, ferritic-pearlitic, and temper sorbite, the hardness of which was HB 130, HB 187, and HB 229, respectively. It is apparent that the volume percentage of material participating in failure is determined by its structure and decreases significantly with increasing hardness of the cast iron.

It is demonstrated that the path of the cracks depends to a considerable degree on the block pattern of the primary structure of the white cast irons. The primary structure plays an important role in the initiation and further development of fatigue cracks. Submicrocracks usually open on the boundaries or the boundary joints between primary austenite grains, which can be exposed in forged cast irons by special etching. In this case, not all cracks take part in the formation of the main crack. In ferritic forged cast irons, a network of cracks is formed during fatigue failure (Fig. 2), while the main crack forms as a relatively broad crease with low crests parallel to the direction of impact (Fig. 3a).

In the case of ferritic-pearlitic cast irons and cast irons with a finely disperse structure (granular pearlite and temper sorbite), fatigue failure occurs with the formation of a clearly expressed main crack parallel to the direction of impact with bends dictated by the block pattern of the primary structure (Fig. 3b).

Metallographic analysis of the impact-fatigue specimens with a different matrix structure in stages of testing indicated that the negative effect of annealing-carbon inclusions and oxysulfide inclusions on the initiation process and propagation path of the fatigue cracks is manifested only when these particles are located on the block boundaries of the primary structure. Optimization of the composition and modification and heat-treatment regimes of cast irons, which have the capability to pulverize its primary structure and nodularize the nonmetallic inclusions and annealing carbon to a prescribed degree and to distribute them uniformly in the metal matrix will therefore lead, as a rule, to a significant increase in the level of impact-fatigue life. Heat-improved pearlitic forged cast irons with a sorbitic structure and hardness HB 207-229 exhibit the greatest impact-fatigue life.