EXCHANGE OF EXPERIENCE

EFFECT OF ALLOYING ELEMENTS ON MECHANICAL PROPERTIES, MICROSTRUCTURE, AND WEAR RESISTANCE OF CAST IRON

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Liteinoe Proizvodstvo, No. 9, pp. 26-27, 1987

UDC 621.74:669.13.018.256

To increasing the mechanical properties and wear resistance of iron castings the melt was alloyed with additives of B, Ti, and V. The iron was melted in the cupola with two rows of tuyeres with an output 2 t/hr and in an induction furnace IoT-016. During melting in the cupola a charge consisting of cast iron L2 or L3 (270 kg) was used along with steel scrap (30 kg). 0.3% Ferroboron FS3 was added to the charge (according to calculation). Assimilation of boron reaches 30-50%. In the induction furnace the iron was melted from a charge consisting of 25 kg cast iron L2, 15 kg returned from the plant itself, 10 kg of steel scrap and 0.5 kg of spiegelisen Z1. The alloying elements were incorporated in the charge in the form of ferrotitanium and ferrovanadium. Cyclone components were cast from the boron-alloyed cast iron into heated (453-473 K) and coated shells (weight 100 kg with a variable wall thickness of 10-60 mm), installed on sintering machines for purification of the waste gases from mineral dust. The strength and hardness of the cast iron were determined on standard specimens cut out from the body of the cyclone component. To investigate the effect of titanium and vanadium on mechanical properties in the sand-clay molds and shells the standard specimens with a diameter of 30 mm and a length of 350 mm were produced.

It was experimentally established that the strength and hardness of the iron increases with introduction of the selected alloying additives to the metal. For example, in unalloyed iron NV 139, and during alloying with 0.02-0.045% B, the hardness increases to HB 212-269. The results of 12 experimental meltings were mathematically processed on a Nairi computer and the hardness of the iron in the casting 25-30 mm thick as a function of the amount of boron incorporated in the iron and its degree of eutectic properties were derived as: $H_B = 1144 \, B + 170$ and $H_B = 317.322 - 163.066 \, S_e + 1622.22 \, B$.

The structure of the iron unalloyed with boron consisted of 25-30% Fe, 70-75% P, and lamellar graphite with a length of 250-500 μm, and in the iron alloyed with boron a perlite structure formed with lamellar graphite 25-80 μm long.

The hardness of the iron alloyed with titanium increases with increasing titanium content. The hardness of the unalloyed iron HB 220 in the sand-clay mold (SCM) and HRC 45 in the shell mold, and the hardness of the alloyed iron (0.45% Ti) was HB 302 and HRC 47, respectively. The hardness of castings produced in SCM increased in particular, which is very important for producing shaped parts that operate under conditions of wear. In investigating the microstructure of the iron alloyed with titanium the following was found. In the castings produced in SCM a fine lamellar graphite Gd6, Gd7 is formed with a length of the inclusions of 125-250 μm. Over the entire cross section of a polished section a perlite structure is observed within individual inclusions.
of rhombic titanium carbides. In casting with 1.7% Ti, inclusions of alloyed cementite were observed. In the shell castings alloyed with titanium a structure somewhat different from the structure of the iron cast in the SCM is formed. When 0.45% Ti is introduced, the structure of the iron consists of cementite- and troostite and in the castings with 0.9-1.7% Ti a structure consisting of cementite alloyed with titanium is formed and troostite with individual ledeburite colonies. In all the shell castings a finely dispersed graphite is distinguished.

Alloying of the alloy with vanadium also promotes an increase in mechanical properties and wear resistance. It was experimentally established that the hardness of the unalloyed iron equals HB 189, and the alloyed iron (0.45 V) - HB 228. The structure of the unalloyed iron consists of perlite, up to 30% ferrite and inclusions of coarse-flaty graphite 500-1000 μm long. Incorporation of 0.45% V in the iron promotes fiding of the graphite inclusions to 180 μm and the formation of a 95% perlite structure and 5% ferrite. In the iron with 0.65 and 1.25% V the structure consists of 75-100% ledeburite and fine graphite 0.05, 0.06 with a length of the inclusions of 40-125 μm. Formation of the ledeburite structure is explained by the active carbide-forming action of vanadium.

The lifetime of castings alloy with boron, titanium, and vanadium with resistance to abrasive wear was investigated on a grinding machine designed by the Kramatorsk Industrial Institute. Flux AN-348, which functions as an abrasive medium, is charged to the rotating basin with an autonomous drive and a speed of 0.25 m/sec. The tested specimen with a diameter of 10, 16, or 26 mm and a length of 120 mm is lowered into the basin containing the flux and made to rotate in a direction opposite to the spindle of the machine at a frequency of 0.71-0.25 m/sec. Owing to rotation of the specimen and the basin with flux in the opposite directions considerable friction is created of the grains of flux against the surface of the specimen which characterizes the wear resistance of the iron. The test time is 6 and 20 hr.

The absolute wear of the iron was determined according to the weight of the specimen before and after the test. The relative wear was calculated as the ratio of absolute wear to original weight of the specimen. The relative wear of experimental shell castings from iron unalloyed with boron was adopted as the unit of wear and the resistance of iron alloyed with boron to wear averages two times higher. The higher wear resistance was exhibited by specimens of iron alloyed with titanium and vanadium; after 6 hr of testing the specimens with titanium and vanadium showed 5-6 times greater wear resistance.

At the Ufaleisk Plant for repair of metallurgical equipment 2000 tonnes of cyclone components are cast from iron alloyed with boron; their wear resistance is 40-50% higher than the wear resistance of the same parts made from unalloyed iron. The increase in operating times of the cyclone components in one sintering machine ensures an economy of <20 thousand rubles/year.

To manufacture wear resistant parts that operate in abrasive media iron alloyed with titanium and vanadium can be used.