CHEMICO THERMAL TREATMENT OF GEARS IN FLUIDIZED BED

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Carburizing of alloy structural steels in fluidized bed is greatly accelerated with two-stage combustion of natural gas [1, 2]. We present new experimental data (Fig. 1 and 2) confirming the fact that the rate of carburizing in fluidized bed is three to five times higher than in the Ts-105 furnace.

With carburizing in fluidized bed the carbon concentration in the surface reaches values corresponding to the carbon activity of the gaseous atmosphere in 1 h, but only in 7-10 h with carburizing in the Ts-105 furnace (Fig. 2). The calculated mass transfer coefficient of carbon from the gaseous atmosphere to the surface of the steel is five to six times higher in the fluidized bed than in the Ts-105 furnace (270–290 $10^{-7}$ and 45–60 $10^{-7}$ cm/sec respectively). This is explained by the higher rate of withdrawal of reaction products (H$_2$O, CO$_2$, and H$_2$) due to the high velocity of the gas and the constant circulation of corundum particles around the part in the fluidized bed. Under these conditions a large concentration gradient from the surface to the core of the sample is established immediately, which accelerates carbon diffusion. The possibility of using a gaseous atmosphere of higher activity along with the absence of any inhibiting effect of soot [1] and rapid heating of the part [3] also accelerates carburizing.

Tempering of carburizing steel 18Kh2N4VA at 650 $^\circ$C requires only half the time in a fluidized bed as in the electric furnace, which is due to rapid decomposition of retained austenite [4]. Evidently this is explained by the higher stresses and retention of lattice defects from preliminary heat treatment with rapid heating in fluidized bed. As the result, carbides are precipitated at a higher rate during tempering in a fluidized bed, which raises $M_S$ and induces more complete decomposition of retained austenite during subsequent cooling.

Fig. 1. Case depth in steel 12KhN3A in relation to carburizing time at 950°C in fluidized bed with $\alpha$ = 0.26 and an addition of 20% gas (a) and in the Ts-105 furnace (b). 1) Hypoeutectoid; 2) eutectoid; 3) hypereutectoid.
Fig. 2. Carbon concentration through the depth of the case after carburizing of steel 18Kh2N4VA at 950°C in fluidized bed (a) and in the Ts-105 furnace (b). The carburizing time is indicated on the curves.

The cooling capacity of a fluidized bed is close to that of oil.* This is confirmed by our experimental data. Figure 3 shows cooling curves for thermoprobe gears with a difference in the outer (teeth) and inner (hub) diameters of 18 and 30 mm in a fluidized bed and in oil at 20°C. It can be seen that the cooling rate in oil is higher than in fluidized bed down to 280–250°C, but at lower temperatures (in the martensitic transformation range) the cooling rate is higher in fluidized bed than in oil. The mechanical properties of gears made of steels 12KhN3A and 18Kh2N4VA are almost identical after quenching in fluidized bed and in oil.

*Author's certificate No. 111, 541.