The composition of the atmosphere in the carburizing and carbnitriding units is regulated using multipoint gas analyzers (for methane and carbon dioxide).

To improve the working conditions of the gas-preparation units and increase the stability of the catalysts, apparatus to purify natural gas of sulfur compounds is placed prior to each generator.

Together with endogas, nitrogen (99.9%), which is fed to the units by a centralized system, and also from individual nitrogen generators, is used as a protective atmosphere during bulk heating.

Improved quality of production is assuming a major role in subdivisions and at union plants. Thus, the implementation of optimal heat-treatment regimes in production has made it possible to increase the structural strength of the front-axle beam fabricated from steel 45, the fatigue strength of the torsion bars used to level the cab, springs, divided axle, etc.

Special attention at the Kamaz Truck Plant is focused on nondestructive methods of control. Quality control of the heat treatment of the front-axle beam, the camshafts, connecting rods, and other truck components is carried out in accordance with structure and hardness on "Magnetest" and "Vitometer" type instruments that are built into the automatic lines and that are individually positioned.

The combined scientific research of more than 40 academic, educational, and scientific institutes is directed toward increasing production output, improving its quality, and enhancing truck reliability. A large number of studies are being conducted on metal economy and savings of fuel and energy resources. Thus, work involving the testing and use of steels with a reduced molybdenum content for crankshafts (steel 42KhMFA) and pinions (steel 20KhGNMTA) is being conducted in cooperation with the NITavtopromom. The expected savings due to the cutback in scarce alloying elements in just those steels used at the Kamaz Truck Plant is approximately 1 million rubles. Studies involving improvement in machinability of forgings of type 25KhGNMT carburizing steels with microadditives are being conducted in conjunction with the Scientific-Research Institute of Technology of the Truck Industry. Use of this steel will make it possible to increase the productivity of automatic machining lines and the stability of the cutting tools and to realize an annual savings of ~500,000 rubles.

USE OF THE "TOSOL-K" QUENCHED FLUID FOR THE BULK QUENCHED OF STEELS

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The oils used for bulk quenching, including highly purified oils, exhibit an inadequate cooling capacity in the temperature interval of the pearlite transformation. Quenching media based on water-soluble polymers do not possess this drawback, and, moreover, their use ensures excellent fire safety [2, 3].

In our study, we investigated the possibility of using the "TOSOL-K" fluid for bulk quenching of steels. The "TOSOL-K" fluid (TU 6-02-3-144-78) is a 50% aqueous solution of oxyethylized alkylphenol containing anti-foam and anticorrosion additives.

We investigated the cooling capacity of 10-65% aqueous solutions of "TOSOL-K" by the method of recording the cooling processes at the center of a copper sphere 20 mm in diameter. The cooling rate was computed from oscillographs by the method of graphic differentiation in accordance with the method of normals [1]. To prevent the specimen from oxidizing, its surface was prechromium-plated. Moreover, we compared the cooling capacity of the "TOSOL-K" fluid of a different concentration, MZM-16 quenching oil, and water from curves depicting the dependence of cooling rate on specimen temperature.

An increase in the concentration of the solution from 10 to 65% gives rise to a reduction in its cooling rate from 300 to 190 deg/sec in the 800-600°C interval of diffusion transformation (Fig. 1). In this case, the maximum cooling rate is depressed in the region of higher temperatures - from 530°C for oil to 600 and 630°C for the 10% and 65% "TOSOL-K" solutions, respectively. In the 450-20°C interval, the "TOSOL-K" solutions...
occupy an intermediate position between water and oil in terms of cooling capacity. In this interval, the cooling rate decreases with increasing concentration of the "TOSOL-K" solution. At temperatures above 450 °C, the 65% "TOSOL-K" solution approximates the oil most closely in terms of cooling capacity. At temperatures below 400 °C, this solution ensures moderate cooling at a rate of 200 deg/sec (cooling rate of water is 700 deg/sec).

For a more precise evaluation of the effectiveness of the quenching medium, we investigated the hardness of steels 45, 40Kh, and 40KhN2MA after quenching from 860°C. Specimens 30 mm in diameter and 10 mm thick were quenched in water, oil, and "TOSOL-K" solutions of different concentration.

The specimens exhibited lower hardness after quenching in the aqueous "TOSOL-K" solutions than after cooling in water, and higher hardness than after quenching in oil (Fig. 2). The hardness of steel 45 dropped markedly as compared with that of the alloy steels 40Kh and 40KhN2MA with increasing concentration and temperature of the "TOSOL-K" solution (Fig. 2).

The results of hardness measurements on the surface and core of specimens 30 mm in diameter and 120 mm long indicated that sufficiently high hardness is attained for steel 40Kh on cooling in 10-65% "TOSOL-K" solutions, and for steel 45 on cooling in 10-30% solutions of the same material (Table 1).

Conditions favorable to crack formation during quenching in the "TOSOL-K" solutions were determined on special steel U10 specimens in accordance with the method outlined by Gulyaev and Yakushev [4]. We investigated the effect of the temperature of the quenching heat and concentration of the solution on the formation of cracks in the specimens. Ten specimens were quenched from each temperature. To expose cracks, we etched the quenched specimens in a 10% solution of nitric acid at 50-70°C. After quenching from 760-800°C in the 10% "TOSOL-K" solution to a hardness HRC 62-64, no cracks were observed in the specimens (Fig. 3). The number of specimens with cracks increased sharply with decreasing concentration of the solution; all ten specimens exhibited cracks after quenched from 860°C in the 10% solution. Experimental-production testing of a quench from 860°C in a 65% "TOSOL-K" solution was conducted on 3000 crankshafts fabricated from steel 42KhMFA. The steel exhibited good complex mechanical properties after quenching from 860°C and tempering at 680°C: $\sigma_u = 970-980$ MPa, $\sigma_y = 870-880$ MPa, $\delta = 17-20\%$, $\psi = 59-60\%$, $a_n = 2.1-2.3$ MJ/m$^2$, and hardness HB 277-285; no crack formation was observed in the shafts.

![Fig. 1. Curves showing cooling of copper sphere 20 mm in diameter in distilled water (1), MZM-16 oil (2), and 10% (3) and 65% (4) "TOSOL-K" solutions.](image)

![Fig. 2. Hardenability of steels 40KhN2MA (a), 40Kh (b), and 45 (c) as function of temperature of different quenching media: 1) water; 2) oil; 3, 4, and 5) 10%, 30%, and 65% "TOSOL-K" solutions, respectively.](image)