together with the prepared components, were set in an electric furnace and held for 2-3 h at 650-840°C. A control specimen of workable steel was used for accurate control of the holding time. After heating, the contents of the box were rapidly transferred into cold water, where the components were released from the mixture, cooled and washed, and then dried with hot air.

After quenching from the maximum temperature, tempering must be carried out to remove stresses and prevent cracking of the components. A holding time of 60-90 min at 200-300°C is sufficient for this purpose.

It was established by x-ray structural analysis that the components acquire a speckled coloration after this case hardening as a result of the formation of a film of iron and calcium oxides up to 0.09 μm thick. Dark and light cinnamon tones predominate in the surface coloration. To prevent attrition and retain the pattern, the surface of the components can be coated with a lacquer, for example, EP-541.

The following optimum mixture composition was established in the process of experimental sampling: 50-80% of binary granular superphosphate, 20-35% of silica, and up to 11% of carbon.

We tested the process of color hardening using the proposed mixture on an experimental segment under plant conditions, and obtained positive results in this case. This method of case hardening makes it possible to increase labor productivity by a factor of 1.5 and eliminate the use of organic raw material. The expected savings realized from implementation of the proposed method for the components of guns used in sport hunting is ~50,000 rubles.

NONOXIDATIVE HEAT TREATMENT OF STAINLESS STEEL PIPES WITH PROCESS OIL RESIDUES

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At present nonoxidative heat treatment of stainless steel pipes in hydrogen and in vacuum [1] finds ever increasing use. Such treatment ensures improved quality of the pipes and lower production costs because oxidation of the treated metal is prevented, its surface is cleaner, its anticorrosion properties are improved, and the number and duration of laborious operations of pickling, grinding, and polishing of the pipes are reduced.

The reduced number of operations and the use of continuous furnaces for nonoxidative heat treatment open up prospects of producing long pipes (20-30 m) in automated production lines [2].

Before pipes are subjected to nonoxidative heat treatment, residues of process oil are, as a rule, removed from their surface by treating them with degreasing and acid solutions or molten alkalis. However, complete removal of the oil is not always ensured (especially from the inner surfaces of long pipes with small diameter). Sometimes this corrodes the surface, and after the heat treatment the anticorrosion properties and the quality of the surface of the pipes are impaired.

Methods exist which envisage the combination of nonoxidative heat treatment in vacuum or in hydrogen with the removal of oil residues from the surface of rolled products without special complicated chemical treatment in acid solutions and molten alkalis.

Moreover, such heat treatment helps obtain the required quality of the pipes even in cases where special chemical preparation does not ensure sufficiently complete removal of
oil residues (e.g., in the treatment of long pipes with small inner diameter) which impairs their quality in the subsequent heat treatment.

The residues of process oil can be removed from the surface of pipes in the process of heat treatment by burning out, when oxygen has the necessary access, or by thermal decomposition of these residues to the gaseous state with subsequent evacuation of the furnace chamber or its scavenging with protective gas.

To remove oil residues by one of these methods, it is recommended to burn out stainless steel pipes in several stages: preliminary heating to 400-500°C at atmospheric pressure, heating to 700-800°C with pressure reduced to \(133 \times 10^{-4}\) Pa and subsequent heating to the recrystallization temperature of 1000-1100°C at the same pressure.

At the beginning of heating, with free access of air to the pipes, intensive oxidation of the bulk of the oil residues and removal of the gaseous oxidation products is ensured. When the pipes are further heated in vacuum, the oil residues are completely removed by their decomposition and volatilization. Final heating of the metal to the recrystallization temperatures, to obtain pipes with specified properties, is carried out in a nonoxidative atmosphere in a continuous multichamber vacuum furnace in a vacuum of \(133 \times 10^{-4}\) Pa. For treating pipes 20-30 m long, it is recommended not to use a multichamber vacuum furnace because it would be very cumbersome and difficult to control.

For the heat treatment of long pipes it is preferable to use continuous furnaces with protective hydrogen atmosphere [3]. To improve the quality of the removal of residual process oil from the pipe surface, it is recommended to burn out the pipes in a hydrogen atmosphere with decreasing moisture.\(^\dagger\) In that case the amount of hydrogen supplied and its moisture content have to be chosen in dependence on the kind and the amount of oil residues.

The moisture content of the hydrogen has to be reduced in proportion to the removal of the forming carbon-containing compounds from the furnace chamber in order to reduce the concentration of free oxygen above the metal surface.

In view of the inaccuracy of the physicochemical calculations of the regime of supplying hydrogen with decreasing moisture content in consequence of the complex nature of the multicomponent interaction of the furnace medium with the oil residues, the optimum parameters of the processing regime were determined experimentally on an experimental device (see Fig. 1) which consisted of the furnace 15, cooler 12, and the system of preparing and supplying hydrogen to the muffle furnace 23 containing the processed specimen 14.

The system of preparing and supplying hydrogen includes the device 1 for cleaning the hydrogen UOV-4 and the device 4 for moistening hydrogen UUV by the method of passing it through hot water. The system is equipped with valves 2, 3, 6, 7, shut-off valves 10, 11, mixer 5, direct reading flow meters 8, 9 type RS-3, and moisture meter of the gas mixture 13 type KIVG.

*Inventor's certificate No. 428023.
\(\dagger\)Inventor's certificate No. 432211.