EFFECT OF CHEMICOTHERMAL TREATMENT ON THE SERVICE LIFE OF PRD-38-3000 ROLLER CHAINS

S. S. Iskhakov, V. B. Fridman, V. D. Vorob'eva, and I. S. Koifman

The service life of most farm machinery depends mainly on the durability of roller chains.

This work concerns the effect of chemicothermal treatment of bushings and PRD-38-3000 roller chains on the service life.

Under automatic production conditions, with strict control of the technological process, the quality of the chemicothermal treatment of bushings and roller chains depends on the condition of the semifinished product.

We investigated bands from three heats in the original condition and after sizing before coiling of the bushings and rollers. The quality of the carbonitride case was determined on commercially produced parts. Comparative laboratory and bench tests were made on chains.

The chemical composition and mechanical properties of the bands are given in Tables 1 and 2.

The broadening of reflection \( \beta_{220} \) is given below:

<table>
<thead>
<tr>
<th>Group No.</th>
<th>( \beta_{220}, \text{mrad} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.4/10.2</td>
</tr>
<tr>
<td>2</td>
<td>4.9/7.9</td>
</tr>
<tr>
<td>3</td>
<td>6.6/9.7</td>
</tr>
</tbody>
</table>

Note. Numerators refer to the original condition and denominators to steels after the sizing pass.

It can be seen from the data in the tables that groups 1 and 3 in the original condition are characterized by larger microdistortions of the crystal lattice of ferrite than group 2; this relationship is retained after sizing.

Chemicothermal treatment (carbonitriding and quenching) of bushings and rollers of different steels was conducted at the same time in an automatic apparatus with a rotating muffle designed at NIItraktorosel'khozmash. Carbonitriding was conducted in endothermal gas (2.2 m\(^3\)/h), natural gas (0.6 m\(^3\)/h), and ammonia.

*Deceased.
†I. A. Chervinskii took part in this work.

TABLE 1

<table>
<thead>
<tr>
<th>Steel, GOST and TU Spec., mm cold rolled band 2.1 × 3000</th>
<th>Group No.</th>
<th>C</th>
<th>Mn</th>
<th>Cr</th>
<th>Ni</th>
<th>Si</th>
<th>S</th>
<th>P</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-NT-3-NO GOST 503-67</td>
<td>1</td>
<td>0.11</td>
<td>0.46</td>
<td>0.04</td>
<td>0.03</td>
<td>0.20</td>
<td>0.002</td>
<td>0.018</td>
<td>0.013</td>
</tr>
<tr>
<td>Steel MSt46k32</td>
<td>2</td>
<td>0.07</td>
<td>0.31</td>
<td>0.02</td>
<td>&lt;0.02</td>
<td>0.02</td>
<td>0.017</td>
<td>0.013</td>
<td>0.018</td>
</tr>
<tr>
<td>1624 (West German standard)</td>
<td>3</td>
<td>0.12</td>
<td>0.40</td>
<td>0.05</td>
<td>0.20</td>
<td>0.18</td>
<td>0.005</td>
<td>0.024</td>
<td>Not</td>
</tr>
</tbody>
</table>

NIItraktorosel'khozmash. Translated from Metallovedenie i Termicheskaya Obrabotka Metallov, No. 12, pp. 30-33, December, 1975.
Figure 1 shows the distribution of the microhardness through the depth of the carbonitride layer and the microhardness of the core of bushings and rollers.

The carbonitride layer 0.35-0.4 mm thick on bushings and rollers (group 1) consisted of martensite with HRC = 60-62 (Fig. 2a); the core consisted of acicular decomposition products of austenite with ferrite.

The microstructure of the hardened layer on bushings and rollers of group 2 consists of martensite to a depth of 0.1 mm with HIRC = 62-63 and below that to a depth of 0.3 mm from the surface it consists of martensite with troostite (Fig. 2b). The core consists of ferrite with a small amount of austenite decomposition products.

The microstructure of the hardened layer 0.40-0.45 mm thick on bushings and rollers of group 3 consisted of martensite with retained austenite, with HRC = 61-62. The core consisted of acicular decomposition products of austenite with ferrite.

Extending the carbonitriding time to 150 min and changing the temperature and composition of the gas carburizer did not produce the required thickness of the carbonitride layer on bushings and rollers of group 2; the thickness of the layer was 0.05-0.20 mm.

To determine the reason for the lower saturation of bushings and rollers of group 2 with carbon and nitrogen the steels were heated at high temperatures. Bushings and rollers were annealed in vacuum at 600° for 1 h, while those from group 2 were subjected to blank carbonitriding and quenching.

Annealing led to coarsening of the structure* in a surface layer 0.15 mm thick on bushings and rollers of group 2 (Fig. 3a). No coarsening was observed in bushings of group 1.

The degree of deformation of the surface layers of bands from group 2 is evidently critical (5-10%).

Another reason for grain growth could be the decarburizing of the surface layer. It was impossible to distinguish any difference in the carbon content of the surface layer or the core by microstructural and chemical analyses. The results obtained after annealing with preliminary upsetting of 17-20% (groups 1 and 2 were fine-grained through the entire section – see Fig. 3b) confirmed the first suggestion – the degree of deformation is critical for group 1 and deformation is uneven through the section.

Investigation of the microstructure of quenched samples (after blank carbonitriding) showed coarsening of the structure in rollers of group 2 at a distance of 0.1 mm from the surface; the microstructure consisted of ferrite with a small amount of austenite decomposition products. No coarsening of the structure was observed in rollers of group 1; the microstructure consisted of austenite decomposition products with ferrite, with more ferrite in the core than in the surface layer but considerably less than in rollers of group 2.

* Metallographic analysis was conducted by T. I. Kasatkina and E. V. Kochetkova.