content in the steel, %).

2. The mass transfer coefficient during carburizing in $\text{H}_2-\text{CH}_4-\text{H}_2\text{O}$ mixtures diluted with nitrogen decreases with an increase in carbon content in the foil.

3. The specific flow of carbon into the metal depends to a considerable degree on carburizing temperature, methane content in the mixture, and carbon content in the steel.

4. A reduction in carburizing intensity with an increase in carbon content in the steel may be connected with development of pyrocarbon nuclei and a reduction in the number of active centers of the foil surface.

LITERATURE CITED


EFFECT OF METHODS USED TO ARRANGE COMPONENTS FOR CARBURIZING AND QUENCH COOLING ON THE DEFORMATION OF GEARS

V. A. Murzin, S. B. Kurilova, L. I. Koshkareva, and N. G. Polumordvinova

Heavily loaded gears for coal-mining combines are produced from chromium-nickel steel hardened by gas carburizing and quenching. In this case, it is necessary to obtain the maximum strength properties with minimal quenching deformation of the components and to prohibit the formation of quenching cracks.

Provision for minimal deformations during thermal hardening is particularly important when the gear teeth are not ground.

Gears with unground teeth are used in the coal industry. A reduction in quenching deformations of coarse gears is a mandatory condition for improvement of the production technology of coal-mining practice.

It is established that a pronounced effect in the reduction of gear deformations can be
TABLE 1

<table>
<thead>
<tr>
<th>Experiment No.</th>
<th>X₁</th>
<th>X₂</th>
<th>X₃</th>
<th>Specimen deformation, mm, from resultant criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>47.2/27.74  34.0/23.97  26.0/26.46  38.7/12.46  10.3/12.23  5.6/8.42</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>11.3/16.85  27.3/23.19  32.0/12.07  32.7/9.61  12.0/20.77  22.7/9.84</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4.6/13.81  -33.3/25.20  22.0/17.40  -30.6/10.60  18.0/36.43  19.1/11.23</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4.9/18.80  -38.0/18.13  30.6/17.10  -40.0/11.95  12.0/29.81  20.9/15.35</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5.3/23.64  -65.8/26.03  44.6/52.26  -47.3/10.33  -7.3/13.38  -7.7/17.50</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>26.6/22.16  34.6/36.81  60.3/24.34  17.4/13.80  -94.0/27.98  -52.9/16.57</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>12.0/25.41  -33.6/39.90  53.0/27.31  -19.3/16.2  -41.3/31.14  -13.2/15.04</td>
</tr>
</tbody>
</table>

Note. Average values and standard deviations of specimen deformations are given in numerator and denominator, respectively.

Fig. 1. Drawing of specimen (module - 4 mm, number of teeth - 36, material - steel 20Kh2N4A). I-III and x) sections in which specimen dimensions were measured; length of overall normal was measured along teeth Nos. 1-4, 13-16, and 25-28.

attained as a result of optimization of carburizing conditions characterized by the method of charging the components, the temperature of the process, the composition of the gaseous atmosphere, and by the cooling conditions of the components after carburizing. The need for strict regulation of all parameters of the quenching process, for example, the method used to charge the components into the cooler, the temperature and properties of the cooling liquid, etc., is noted in this case. This follows from experimental data, and the optimum effect can be provided in practice.

The purpose of our study was to investigate the effect of the method used to arrange the components during gas carburizing and their charging in the quenching medium and the selection of the optimal variant that provides for a reduction in the quenching deformation of the coarse gears of cleaning combines.

For the investigation, we used specially fabricated cylindrical gears with straight teeth (Fig. 1), which are physical models, the dimensions of which were three times smaller than those of large module steel 20Kh2N4A gears (module of 12 mm, number of teeth - 35). The results of experiments on the heat treatment of model specimens can be used in the production of disc gears with a module ranging from 4 to 12 mm. We investigated 15 specimens for each treatment variant.

The fabrication technology and the stages of measurement of the geometric parameters of the specimens were as follows:

- normalisation of forgings from 950°C, and tempering at 620-640°C for 4 h;
- preliminary machining;
- tempering at 560-580°C for 4 h;