RAPID CARBURIZING WITH NATURAL GAS IN A FLUIDIZED BED

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This work was undertaken to determine the possibility of accelerating gas carburizing by use of a fluidized bed. Carburizing was conducted with two-stage combustion of natural gas in a furnace with a fluidized bed [1] based on the OKB-724A furnace (Fig. 1).

The fluidized bed material was electrocorundum (250μ fraction), with a height of 600 mm above the catalyst.

The coefficient of primary air input \( \alpha \) was kept constant automatically with the RU-4-16A regulator, with pulses from the MGK-348 oxygen meter placed in the gas-air intake. The composition of the gas was determined with the VTI-2 apparatus. The carbon potential of the gas mixture was determined from the carbon content in foil of steel St. 10 with a thickness of 0.2 mm. The foil was placed in the furnace at the gas intake and heated 1 h at carburizing temperature, followed by quenching in water. The carbon content of the foil was determined by chemical analysis with an accuracy of 0.01%. Since the carbon content of the foil depends on the carburizing time, the nominal carbon potential of the furnace atmosphere was determined after holding for 1 h.

Figure 2 shows the composition of the gaseous atmosphere and the carbon potential in relation to the air input coefficient \( \alpha \) in tests without additional input of carburizer. The concentrations of the components

![Fig. 1. Carburizing furnace with a fluidized bed. 1) Heating chamber; 2) secondary air inlet; 3) gas carburizer inlet; 4) gas ring and cassette with catalyst; 5) furnace lining.](image-url)
The carbon content of the case at a depth of 0.1 mm (samples 40 mm in diameter) was 0.50-0.56%, which is too low. At the same time, the case depth was greater than in standard gas carburizing at 950° for 1.5 h without use of a fluidized bed.

The carbon content of the case can be increased substantially by reducing α to 0.20-0.22 (Fig. 2). This cannot be accomplished in practice with all the gas flowing through a stationary layer of catalyst, since passing the gas – air mixture through the GIAP-3 catalyst with α < 0.25 results in thermal decomposition of methane and deposition of soot [1, 2], poisoning the catalyst. Thus, the carburizing conditions recommended in [3] with α = 0.2 cannot be used. Carburizing can be conducted under these conditions for only a few hours, until the catalyst is poisoned.

The variation of the carbon potential of the atmosphere with the air input coefficient makes it necessary to control α very precisely; when α changes from 0.25 to 0.26 the oxygen content of the gas – air mixture changes from 15.0 to 15.1%.

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**TABLE 1**

<table>
<thead>
<tr>
<th>Steel</th>
<th>Case depth, mm</th>
<th>Carbon content at depth of 0.1 mm, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>12KhN3A</td>
<td>0.60–0.65</td>
<td>0.56</td>
</tr>
<tr>
<td>18Kh2N4VA</td>
<td>0.56–0.68</td>
<td>0.54</td>
</tr>
<tr>
<td>40Kh1NVA</td>
<td>0.40–0.42</td>
<td>0.50</td>
</tr>
<tr>
<td>St. 10</td>
<td>0.60–0.65</td>
<td>0.55</td>
</tr>
<tr>
<td>20</td>
<td>0.48–0.50</td>
<td>0.52</td>
</tr>
</tbody>
</table>

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Fig. 2. Carbon potential of the atmosphere and its composition in relation to the air input coefficient α.

Fig. 3. Carbon content and microhardness through the case depth of steels carburized at 950°C for 1.5 h, α = 0.27. 1) Microhardness of steel 12KhN3A; 2) carbon content of case, steel 12KhN3A; 3) carbon content of case, steel 20. The percentages on the graphs refer to the amount of gas–carburizer added. δ is the case depth for steel 12-KhN3A.

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