EFFECT OF THE STRUCTURE AND PROCESSING CHARACTERISTICS OF CAST IRON POWDER ON THE COMPRESSIONIBILITY OF ITS MIXTURES WITH IRON POWDER


In recent years, in the manufacture of sintered constructional components increasing use has been made of white cast iron powder, a byproduct obtained during the production of cast iron shot. Such powder contains about 3.8–3.9% of combined carbon and has an angular particle shape (Fig. 1a) and a ledeburitic structure (Fig. 1b). This structure and particle shape and the high proportion of carbon present in white cast iron in the form of cementite impart to the powder particles a high hardness (HV 940 kg/mm²) and brittleness, as a result of which the powder, in the absence of plastic strain, can quite easily be comminuted in a ball mill. On the other hand, however, compacts produced by the usual pressing techniques exhibit no mechanical strength whatsoever. This powder is used in the manufacture of various sintered

Fig. 1. Microstructure and shape of cast iron powder particles, × 340; a) unannealed, unetched; b) unannealed, etched; c) annealed (950°C, 2 h), unetched; d) annealed (950°C, 2 h), etched.
### TABLE 1. Properties of Iron and Cast Iron Powders Used in Experiments

<table>
<thead>
<tr>
<th>Powder</th>
<th>Amount, %</th>
<th>App. density, g/cm³</th>
<th>Flow rate, g/sec</th>
<th>Formability limits, g/cm³</th>
<th>Density (g/cm³) at pressures (tons/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting cast iron powder (−016 fraction)</td>
<td>3.8</td>
<td>2.6</td>
<td>8.1</td>
<td>Cannot be compacted</td>
<td>2 4 7</td>
</tr>
<tr>
<td>Cast iron powder after annealing (−016 fraction)</td>
<td>3.8 2.35</td>
<td>2.64</td>
<td>8.3</td>
<td>5-7.2</td>
<td>4.6 5.1 5.6</td>
</tr>
<tr>
<td>Cast iron powder after grinding of coarse fraction (−016 fraction)</td>
<td>3.9</td>
<td>3.8</td>
<td>8.33</td>
<td>Cannot be compacted</td>
<td></td>
</tr>
<tr>
<td>PZh2M2 iron powder</td>
<td>0.11</td>
<td>2.22</td>
<td>5.5</td>
<td>Not determined</td>
<td>4.6 5.5 6.1</td>
</tr>
</tbody>
</table>

Steels, such as ZhCh20, ZhCh25, ZhCh30,* and ZhCh20Kh3† grades.

It has been reported [1] that increasing the proportion of white cast iron powder adversely affects the compressibility of Fe—cast iron powder mixtures, but no detailed studies of this relationship over a wide range of concentrations have been carried out. In addition, it was considered of interest to study the possibility of improving the compressibility of Fe—cast iron powder mixtures by increasing the apparent density of the white cast iron powder used in mixes.

Moreover, to compare the compressibility characteristics of mixtures composed of ductile or brittle particles, the cast iron powder employed was subjected to graphitizing annealing. The present paper is concerned with this particular study.

White cast iron powder was annealed for 2 h at a temperature of 950°C in a converted-gas atmosphere to which 6-8% of natural gas had been added to protect the cast iron against decarburization. During the annealing, the starting ledeburite in the powder particle structure was found to decompose with the precipitation of free graphite (Fig. 1c) and formation of a perlitic-ferritic constituent (Fig. 1d). The microhardness of the cast iron powder particles after annealing fell to 170 kg/mm². Three groups of Fe—cast iron powder mixtures were prepared, using cast iron powder in the following three conditions: a) as supplied and sieved through a No. 016 screen (apparent density 2.6 g/cm³); b) as supplied, sieved through a No. 016 screen, subjected to graphitizing annealing, and sieved again through the same screen (apparent density 2.64 g/cm³); c) a coarse (+016) fraction subjected to additional comminution in a ball mill and sieved through a No. 016 screen (apparent density 3.8 g/cm³). The iron powder, of grade PZh2M2,‡ was taken from a single batch of 2.22 g/cm³ apparent density.

The chemical compositions and processing characteristics of the components of the powder mixtures studied are listed in Table 1. The apparent density of the powders was measured by means of a volumeter, while their flow characteristics were determined by measuring the time required for 100 g of powder to flow out of a funnel with a cone angle of 60°, a stem length of 10 mm, and a discharge orifice diameter of 4 mm. The compressibility of the powders was measured by the technique laid down by GOST 10937-64 standard. It will be seen from the data in Table 1 that annealing has very little effect on the apparent density and flow properties of white cast iron powder, but ledeburite decomposition reduces its microhardness by a factor of 5.5 and markedly increases its ductility, as a result of which compacts of adequate mechanical strength can be obtained from annealed powder.

Using the powder components listed in Table 1, Fe—cast iron mixtures with different cast iron contents (from 0 to 100%) were prepared and then subjected to compressibility tests in accordance with GOST 10937-64 standard at a compaction pressure of 7 tons/cm².

The test results obtained (Fig. 2) show that:

*Fe with, respectively, 20, 25, and 30% of cast iron powder—Transl.
†Fe with 20% of cast iron powder and 3% chromium—Transl.
‡A fine grade of powder prepared by the reduction process—Transl.