A Study on the Improvement of Characteristics of AC Contactor by Addition of Rare Earth Element

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ABSTRACT

In the prior literature, to improve the characteristics of the AC contactor, the structural dimension of the contact point was changed or the type of contact material was changed.

This section introduces a method of improving the characteristics of contact including contact resistance and electrical wear by adding a rare earth element to the Ag-Cd0 contact point, which is currently used as an AC contactor.

1. MAIN CONTENT

Contact specimens for AC contactors were prepared using Ag powder, Cd powder, and rare earth intermediate alloy powder.

The properties of the powders used as raw materials are given in Tables 1 to 3.

Table1. Properties of Ag Powder

<table>
<thead>
<tr>
<th>Signification</th>
<th>Ag, % or more</th>
<th>Impurities, % below</th>
<th>Average particle size, μm</th>
<th>Surface density, 10^3 kg/m^3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag-1</td>
<td>99.5</td>
<td>0.12 0.01 0.2 0.02 0.02</td>
<td>4</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Table2. Properties of Cd Powder

<table>
<thead>
<tr>
<th>Signification</th>
<th>Cd, % or more</th>
<th>Impurities, % below</th>
<th>Average particle size, μm</th>
<th>Surface density, 10^3 kg/m^3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>99.5</td>
<td>0.2 0.05 0.08 0.02 0.01 0.03</td>
<td>5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Table3. Characteristics of rare earth intermediate alloy powder

<table>
<thead>
<tr>
<th>Signification</th>
<th>Alloy composition, %</th>
<th>Average particle size, μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>rare earth intermediate alloy</td>
<td>Ce 38 Cu 61.5 Fe 0.03 Pb 0.04 As 0.005 Sb 0.01</td>
<td>4</td>
</tr>
</tbody>
</table>
The mixing of the powder materials was conducted in an alcohol medium for 10 hours, dried and then molded at a pressure of 500 MPa to a diameter of 6mm and a thickness of 3mm.

The rare earth element for the contact alloy is pulverized and the rare earth intermediate alloy is added so that the rare earth element amount is 0.01, 0.02, 0.03, 0.04, 0.05%, and the mixing and molding process is performed. As the electrical contact sintering device, the switch type AC resistance welding machine of the electromagnet pressurizing device is used.

The technological characteristics of the electrical contact sintering device are shown in table 4.

Table 4. Technical Characteristics of Electrical Contact Sintering Equipment

<table>
<thead>
<tr>
<th>Transformer capacity</th>
<th>Pressure control ranges</th>
<th>Current control range</th>
<th>Time range</th>
</tr>
</thead>
<tbody>
<tr>
<td>70kVA</td>
<td>10~30MPa</td>
<td>8~14kA</td>
<td>30~50</td>
</tr>
</tbody>
</table>

The internal oxidation temperature is guaranteed at 750 ± 10 ℃ and oxidized for 72 hours in the electric furnace.

In the spot welder, the silver solder dissolved toward the Ag surface solders the contact eggs uniformly at the bottom of the contact and the plate water.

The compositions of silver and silver-lead solvents are given in Tables 5 and 6.

Table 5. Composition of Silver Lead Materials

<table>
<thead>
<tr>
<th>Silver Lead Materials</th>
<th>Ag</th>
<th>Cu</th>
<th>Zn</th>
<th>Cd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>35</td>
<td>35</td>
<td>25</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 6. Composition of Silver lead solvent

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Content %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous borax</td>
<td>35</td>
</tr>
<tr>
<td>Anhydrous fluoridation kalium</td>
<td>42</td>
</tr>
<tr>
<td>Boron Folic Acid</td>
<td>23</td>
</tr>
</tbody>
</table>

The amount of electrical wear was measured with an electrical wear meter under the conditions of voltage 220V, current 10~25A, opening time 104 time, and contact pressure 1 000N (Table 7).

Table 7 Measurement results of electrical wear according to the amount of rare earth element added

<table>
<thead>
<tr>
<th>MR additive amount, %</th>
<th>0.01</th>
<th>0.02</th>
<th>0.03</th>
<th>0.04</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical abrasion amount</td>
<td>10A</td>
<td>0.8</td>
<td>0.65</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>15A</td>
<td>1.1</td>
<td>0.75</td>
<td>0.65</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>20A</td>
<td>1.3</td>
<td>0.9</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 7 shows the measurement results of the electrical wear according to the amount of rare earth element added under the sintering current I = 10 kA, the electrode pressure P = 25 MPa, and the electrical contact sintering condition with the current passing time T = 45 cycles.
As shown in Table 7, the addition of rare earth elements greatly reduces the electrical wear of the contacts.

In other words, when the rare earth element is added up to 0.03% at a current of 10A, electrical wear decreases from 1.0mg to 0.5mg.

References


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AUTHOR CONTRIBUTIONS

Authors equally contributed.

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