More and more, water-cooled cables are now being used for various furnaces, in particular for the melting arc furnace and the melting induction furnace. SWCC, as a leading manufacturer in this field, is supplying reliable and high quality water-cooled cables, utilizing to the full its vast experience and research, and is achieving highly satisfactory results.

SWCC Water-Cooled Cables are in great demand not only in Japan, but also from overseas, and are contributing to the optimum operation of electric furnaces all over the world.

SWCC SHOWA CABLE SYSTEMS CO., LTD.
www.swcc.co.jp/
SWCC Water-Cooled Cables may be classified in two types according to their construction, the hose type cable using a rubber hose and the wire type cable which is similar to the general rubber insulated cable. The hose type is applicable for the working voltage of up to 1,000V and is suitable where the mechanical load on the cable is large. The wire type on the other hand, is applicable for the working voltage of up to 3,000V and is suitable where the mechanical load is small. The application fields for each type of cable are:
Hose type cable: Primarily, melting arc furnace, vacuum degassing unit, vacuum arc furnace, electroslag remelting furnace, etc.
Wire type cable: Primarily, melting induction furnace, induction heating unit, resistance heating furnace, electrolytic machining unit, etc.

### Hose Type Water-Cooled Cable for Arc Furnace

The hose type water-cooled cable for melting arc furnace is SWCC’s highly esteemed product developed on the basis of vast experience and consequent success.

#### ADVANTAGES

1. **High Flexibility**
   Use of the surface corrugated hose and either non-separate type or separate type conductor allows smaller bending radius even in a large size cable, and prevents kinking of a hose with a conductor even when the cable is strongly twisted, thus greatly improving flexibility compared with conventional SWCC products. The improved flexibility enables the reduction of the cable required length as well as the furnace installation area.

2. **Low impedance, Low Energy Loss**
   Low impedance and low energy loss are achieved by reducing the cable required length and by improving the conductor construction so that larger geometric mean radius (G.M.R.) and smaller skin effect are assured.

3. **Excellent Durability**
   SWCC Water-Cooled Cable is constructed using the surface corrugated hose and either separate type or non-separate type conductor so that loads by bending, twisting, and impact can be satisfactorily relieved. The conductor is so constructed as to minimize the mechanical wear, thus improving the durability.

4. **Easy maintenance**
   The Cable can be easily disassembled without being damaged, by simply removing the stainless steel bands and pins for the check and cleaning of the conductor. Reassembling is also easy.
CONSTRUCTION

1. Conductor
   a. Non-separate type
      High-conductive annealed copper wires are stranded over the star-shaped hexagonal rubber core made of highly-elastic water-proof and wear-resisting rubber (see fig.1).
   b. Separate type
      Surfaces at both ends of the hose core are finished flat, while remaining surface is finished corrugated. The individual conductor is covered with a perforated rubber tube and reinforced against wear (see fig.2).

2. Terminal
   High-conductive tough-pitch copper is used after being machined and plated. Thus the contact resistance is reduced and the current density on the contacting surface is increased. The cooling water is separately circulated within the terminal in order to cool the inside and outside surface of the conductor.

3. Hose
   Hose if made of wear-resisting and water-proof rubber. Surfaces at both ends of the hose are finished flat, while remaining surface is finished corrugated. The flat-finished surfaces relieve the repeated bending stress applied to the conductor ends. On the surface of the hose, splash-proof material is adhered during the vulcanization process.

4. Protection hose
   The protection rubber hoses, on which outer surface the material is applied by vulcanization, are fixed on the both ends of the hose by means of stainless steel bands, in order to relieve the repeated bending stress on the conductor ends.

5. Stainless steel band
   As corrosion-resisting, non-magnetic stainless steel is used, water leakage and corrosion breaking of the band are completely eliminated.
   Note) For articles from 2 to 5, refer also to Table 2.

![Fig.1 Section of the non-separate type](image1)
![Fig.2 Section of the separate type](image2)
COVERING

The rubber-made covering is attached to lower the cable impedance during the furnace operation. This ring also protects the hose.

OTHER HOSE TYPES FOR THE WATER-COOLED CABLE

Hose type water-cooled cables, other than that used for the melting arc furnace, are designed according to the application field. They are used, for example, for the vacuum degassing unit, vacuum arc furnace, electroslag remelting furnace, slag melting furnace and high frequency generator.

WIRE TYPE WATER-COOLED CABLE

The wire type water-cooled cable is widely used for the melting induction furnace, induction heating unit, resistance heating furnace, electrolytic machining unit, while the type of electric current which can be used ranges from direct current to high frequency alternating current (10kHz).

The standard size is 125, 200 and 400mm².

SPECIFICATIONS

Table 1 shows the specifications of the standard size water-cooled cable

<table>
<thead>
<tr>
<th>Conductor cross-sectional area mm²</th>
<th>Rated current A</th>
<th>Conductor type</th>
<th>D.C. resistance (20°C) 10^6Ω/m</th>
<th>Skin effect coefficient 50Hz</th>
<th>Skin effect coefficient 60Hz</th>
<th>G.M.R mm</th>
<th>Cooling water flow rate l/min</th>
<th>Approx. weight kg</th>
<th>Min. bending radius mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>4800</td>
<td>Non-separate</td>
<td>25.5</td>
<td>0.03</td>
<td>0.04</td>
<td>23.2</td>
<td>10</td>
<td>180+17</td>
<td>1000</td>
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<tr>
<td>1000</td>
<td>6000</td>
<td>Non-separate</td>
<td>20.4</td>
<td>0.04</td>
<td>0.06</td>
<td>25.8</td>
<td>13</td>
<td>250+23</td>
<td>1000</td>
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<tr>
<td>1500</td>
<td>9000</td>
<td>Non-separate</td>
<td>12.8</td>
<td>0.08</td>
<td>0.11</td>
<td>33.6</td>
<td>19</td>
<td>330+31</td>
<td>1000</td>
</tr>
<tr>
<td>2000</td>
<td>12000</td>
<td>Non-separate</td>
<td>7.70</td>
<td>0.13</td>
<td>0.18</td>
<td>49.5</td>
<td>33</td>
<td>495+46</td>
<td>700</td>
</tr>
<tr>
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<td>15000</td>
<td>Non-separate</td>
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<td>0.13</td>
<td>0.18</td>
<td>57.9</td>
<td>40</td>
<td>660+57</td>
<td>900</td>
</tr>
<tr>
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<td>18000</td>
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<td>0.21</td>
<td>51.0</td>
<td>47</td>
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<td>5.00</td>
<td>0.18</td>
<td>0.25</td>
<td>51.5</td>
<td>57</td>
<td>710+65</td>
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<td>72</td>
<td>970+90</td>
<td>900</td>
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<tr>
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<td>3.72</td>
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<td>0.42</td>
<td>58.3</td>
<td>72</td>
<td>970+90</td>
<td>900</td>
</tr>
</tbody>
</table>

Note)  1: At commercial frequency
   2: Rated current, cooling length = 10m
   3: Including cooling water, L (m) means overall length of the cable

DIMENSIONS

Table 2 shows the overall dimensions of the standard size water-cooled cable

<table>
<thead>
<tr>
<th>Conductor cross-sectional area mm²</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
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<td>500</td>
<td>600</td>
<td>6</td>
<td>13</td>
<td>35</td>
<td>Ⅲ</td>
</tr>
<tr>
<td>1000</td>
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<td>47</td>
<td>30</td>
<td>45</td>
<td>145</td>
<td>115</td>
<td>121</td>
<td>136</td>
<td>500</td>
<td>600</td>
<td>6</td>
<td>13</td>
<td>40</td>
<td>Ⅲ</td>
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<td>700</td>
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<tr>
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<td>120</td>
<td>106</td>
<td>70</td>
<td>40</td>
<td>55</td>
<td>235</td>
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<td>600</td>
<td>700</td>
<td>8</td>
<td>17</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>3000</td>
<td>144</td>
<td>130</td>
<td>80</td>
<td>40</td>
<td>60</td>
<td>255</td>
<td>184</td>
<td>190</td>
<td>210</td>
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<td>1</td>
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<tr>
<td>3500</td>
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<td>1</td>
</tr>
<tr>
<td>4500</td>
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<td>125</td>
<td>80</td>
<td>40</td>
<td>65</td>
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<td>700</td>
<td>800</td>
<td>8</td>
<td>22</td>
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<td>1</td>
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<td>700</td>
<td>800</td>
<td>8</td>
<td>22</td>
<td>60</td>
<td>1</td>
</tr>
</tbody>
</table>

Note)  1: Non-separate type up to 3000mm², 3500mm² and above is separate type
   2: Terminal size is based on Copper type
**COVERING**
The rubber-made covering is attached to lower the cable impedance during the furnace operation. This ring also protects the hose.

**Other Hose Types for the water-cooled cable**
Hose type water-cooled cables, other than that used for the melting arc furnace, are designed according to the application field. They are used, for example, for the vacuum degassing unit, vacuum arc furnace, electroslag remelting furnace, slag melting furnace and high frequency generator.

---

**Wire Type Water-Cooled Cable**
The wire type water-cooled cable is widely used for the melting induction furnace, induction heating unit, resistance heating furnace, electrolytic machining unit, while the type of electric current which can be used ranges from direct current to high frequency alternating current (10kHz). The standard size is 125, 200 and 400mm².
CONSTRUCTION

1. Cable
Annealed copper wires are wrapped over the rectangular hard drawn copper spiral, binder tape, insulating ethylene propylene rubber, strengthening braid (to ensure the water pressure resistivity), and the sheath of chloroprene rubber is applied in this order over the wrapped wires (see Fig.3).

2. Terminal
The terminal is made up of machined and plated copper castings. Two types are available, battledore type and flange type. In case of the battledore type, the connecting tubes are provided for feeding and discharging the cooling water (see table 4).

SPECIFICATIONS

Table 3 shows the specifications of the standard size wire type water-cooled cable. The rated current shown in Table 3 is at the commercial frequency (50, 60Hz). Where higher frequencies are used, the rated current decreased accordingly. Fig.4 shows the ratio of rated current at the commercial frequency to that at other frequencies.

Table 3 Specifications of the standard size water-cooled cable

<table>
<thead>
<tr>
<th>Conductor cross-sectional area mm²</th>
<th>Rated current ¹ A</th>
<th>D.C. Resistance (20°C) 10⁻⁶Ω/m</th>
<th>Cooling water flowrate ² l/min</th>
<th>Overall diameter (Approx.) mm</th>
<th>Min. bending radius mm</th>
<th>Approx. weight ³ kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>1875</td>
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<td>4</td>
<td>37.5</td>
<td>200</td>
<td>2.27</td>
</tr>
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<td>3000</td>
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<td>7</td>
<td>51.0</td>
<td>350</td>
<td>3.9</td>
</tr>
<tr>
<td>400</td>
<td>6000</td>
<td>47.6</td>
<td>14</td>
<td>58.3</td>
<td>400</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Note) ¹: At commercial frequency
²: At rated current and cooling length of 10m
³: Including cooling water
At commercial frequency

At rated current and cooling length of 10m

Including cooling water

CONSTRUCTION

1. Cable

Annealed copper wires are wrapped over the rectangular hard drawn copper spiral, binder tape, insulating ethylene propylene rubber, strengthening braid (to ensure the water pressure resistivity), and the sheath of chloroprene rubber is applied in this order over the wrapped wires (see Fig.3).

2. Terminal

The terminal is made up of machined and plated copper castings. Two types are available, battledore type and flange type.

In case of the battledore type, the connecting tubes are provided for feeding and discharging the cooling water (see table 4)

SPECIFICATIONS

Table 3 shows the specifications of the standard size wire type water-cooled cable.

The rated current shown in Table 3 is at the commercial frequency (50, 60Hz). Where higher frequencies are used, the rated current decreased accordingly. Fig.4 shows the ratio of rated current at the commercial frequency to that at other frequencies.

![Fig.3 Cross sectional drawing of cable](image1)

![Fig.4 Frequency - Ratio of rated current](image2)

### Table 3 Specifications of the standard size water-cooled cable

| Conductor cross-sectional area | Wp | Lp | P1 | P2 | P3 | P4 | N  | A  | B  | TP | LA | LB | LC | LH | LT | LSP | D1 | D2 | D3 |
|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| mm²                           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 125                           | 50 | 110| 25 | 25 | 40 | 2  | 14 | 28 | ( 7)| 65 | 16 | 80 | 43 | 60 | 215| 47 | 37.5| 14.5|
| 200                           | 65 | 110| 32.5| 25 | 40 | 2  | 14 | 32 | (12)| 95 | 25 | 90 | 41 | 75 | 250| 60 | 51 | 21  |
| 400                           | 100| 140| 50 | 25 | 30 | 50 | 4  | 14 | 28 | (12)| 125| 30 | 98 | 46 | 90 | 300| 70 | 58.3| 27.5|

### Battledore type terminal

![Battledore type terminal](image3)

- **N-φA** Spotface depth 1 (mm)
- **N-φB** Spotface depth 1 (mm)

### Flange type terminal

![Flange type terminal](image4)

- **4-φC** Spotface depth 1 (mm)
- **4-φE** Spotface depth 1 (mm)

---

**DIMENSIONS**

Table 4-1 shows the dimensions of the battledore type terminal

(Units: mm)

<table>
<thead>
<tr>
<th>Conductor cross-sectional area</th>
<th>Wf</th>
<th>Wc</th>
<th>C</th>
<th>E</th>
<th>P.C.D.</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>TF</th>
<th>Lt</th>
<th>LSP</th>
<th>D1</th>
<th>D2</th>
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</thead>
<tbody>
<tr>
<td>mm²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>50</td>
<td>4.1</td>
<td>7</td>
<td>13</td>
<td>50</td>
<td>47</td>
<td>37.5</td>
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</tr>
<tr>
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<td>70</td>
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<td>9</td>
<td>18</td>
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<td>13</td>
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<td>150</td>
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</tbody>
</table>
More and more, water-cooled cables are now being used for various furnaces, in particular for the melting arc furnace and the melting induction furnace. SWCC, as a leading manufacturer in this field, is supplying reliable and high quality water-cooled cables, utilizing to the full its vast experience and research, and is achieving highly satisfactory results. SWCC Water-Cooled Cables are in great demand not only in Japan, but also from overseas, and are contributing to the optimum operation of electric furnaces all over the world.