High Functional Hot Work Die Steel with 1.6 times higher thermal conductivity than SKD61 contributing to rapid cooling of die casting and low pressure casting tools such as core pins and spool cores.

- High thermal conductivity contributes to rapid solidification and results in refined and improved cast structure with less defects.
- Reduced thermal load leads to longer life by lessening galling, soldering and heat checking behavior.
- Applying to the tools around gate helps to shorten cycle time due to faster solidification of casts.

<table>
<thead>
<tr>
<th>Recommended positions or parts</th>
<th>Applied tools</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where cast quality is required to be improved</td>
<td>Insert</td>
<td>40～47HRC</td>
</tr>
<tr>
<td>Where severely galled and heat checked</td>
<td>Core pins</td>
<td>42～47HRC</td>
</tr>
<tr>
<td>Around gate such as biscuits when especially when shorter cycle time is aimed</td>
<td>Spool bush • Spool core Plunger chip</td>
<td>40～47HRC</td>
</tr>
</tbody>
</table>

Notes:
- Sufficient inner cooling is required to exercise the characteristic of high thermal conductivity
- Available for small tools lighter than 40kg due to hardenability

Chemistries
- Patent pending

Heat treatment

<table>
<thead>
<tr>
<th>Forging Temperature (℃)</th>
<th>Heat treatment (℃)</th>
<th>Hardness</th>
<th>Transformation Temp(℃)</th>
</tr>
</thead>
<tbody>
<tr>
<td>900 ～ 1200</td>
<td>Annealing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow cooling</td>
<td>Quenching</td>
<td>Tempering</td>
<td>Annealing</td>
</tr>
<tr>
<td></td>
<td>Vacuum (≥4bar)</td>
<td></td>
<td>Quenching Tempering</td>
</tr>
<tr>
<td></td>
<td>820 ～ 870</td>
<td>550 ～ 670</td>
<td>～229HB</td>
</tr>
<tr>
<td></td>
<td>1000 ～ 1030</td>
<td>550 ～ 670</td>
<td>38 ～ 49 HRC</td>
</tr>
<tr>
<td></td>
<td>Air cooling</td>
<td></td>
<td>727 ～ 806</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>295(Austenitized at 1030℃)</td>
</tr>
</tbody>
</table>
### Softening resistance

Specimen: 10mm x 15mm x 20mm  
Quenching : 1030°C, Gas cooling (6bar)

![Softening resistance graph](image)

### Nitriding characteristic

Quenching : 1030°C, Gas cooling (6bar)  
Nitriding : PS treatment / Salt bath nitriding

![Nitriding characteristic graph](image)

### Mechanical properties

Specimen : φ 8mm x 100mm, L direction  
Quenching : 1030°C, Gas cooling (6bar)

![Mechanical properties graph](image)

### Heat checking resistance

Mold size : 62mm x 200mm x 205mm (42HRC)  
Quenching : 1030°C, Gas cooling (6bar)  
Die casting : 135t machine, ADC12 (700°C)  
Observed at 10,000 runs

![Heat checking resistance image](image)

### Al erosion resistance

Specimen : 10mm dia. x 30mm  
Quenching : 1030°C, Gas cooling (6bar)

![Al erosion resistance image](image)

### Table: Charpy impact values (J/cm²)

<table>
<thead>
<tr>
<th>Temperature(℃)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHA-Thermo</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>DHA1</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
</tr>
</tbody>
</table>

### Table: Thermal conductivity (W/m·K)

<table>
<thead>
<tr>
<th>Temperature(℃)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHA-Thermo</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>DHA1</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

### Table: Hardness (HRC)

<table>
<thead>
<tr>
<th>Temperature(℃)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHA-Thermo</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>DHA1</td>
<td>55</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
</tr>
</tbody>
</table>

### Table: Weight loss ratio (%)

<table>
<thead>
<tr>
<th>Temperature(℃)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHA-Thermo</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DHA1</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>
Machinability

**Endmilling**

- Tool: UTi20T (No-coated)
- Speed: 150m/min
- Depth of cut: 1 x 4mm
- Coolant: Air blow
- Feed: 0.15mm/rev
- Milling: Down Cut

**Drilling**

- Tool: SKH51, φ 5, Straight shank
- Feed: 0.15mm/rev
- Depth of hole: 20mm
- Lubricant: Yushiro-ken EZ30 (5% Soln.)
- Criteria: Breakage or corrosion

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**Application to spool core**

- Surface temperature of spool core
  - 220°C
  - 340°C

- Cast structure of the biscuit contacted with DHA-Thermo

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**Physical properties**

- **Thermal expansion rate**
  - Temp. 20°C to 100°C: 12.0 12.3 13.3 13.8 14.4
  - Temp. 20°C to 300°C: 23.0 24.2 25.3 27.0 28.5
  - Temp. 20°C to 500°C: 50.1 51.7 53.8 56.1 59.4
  - Temp. 20°C to 700°C: 98.5 101.4 104.5 108.2 112.5

- **Thermal conductivity**
  - Temp. 20°C to 100°C: 3.1 3.7 3.8 3.7 2.9
  - Temp. 20°C to 300°C: 3.1 3.7 3.8 3.7 2.9
  - Temp. 20°C to 500°C: 3.1 3.7 3.8 3.7 2.9
  - Temp. 20°C to 700°C: 3.1 3.7 3.8 3.7 2.9

- **Specific heat**
  - Temp. 20°C to 100°C: [0.106] [0.112] [0.121] [0.131] [0.143]
  - Temp. 20°C to 300°C: [0.106] [0.112] [0.121] [0.131] [0.143]
  - Temp. 20°C to 500°C: [0.106] [0.112] [0.121] [0.131] [0.143]
  - Temp. 20°C to 700°C: [0.106] [0.112] [0.121] [0.131] [0.143]

**Notes**

- High functional hot work die steel with 1.6 times higher thermal conductivity than SKD61,
- Rapid cooling, Tempered to the hardness 45.7HRC.
- Sufficient inner cooling is required to exercise the characteristic of high thermal conductivity.
- Available for small tools lighter than 40kg due to hardenability.
- For cast products like spool cores, pins and spool cores.
- Contributing to rapid cooling of die casting and low pressure casting tools such as core and mold.

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