YSS
Die Steels For Die Casting
DAC Series
Characteristics of Diecasting Die Steels

In compliance with diversification of diecasting technology, variety of steel grades is prepared in order to best fit for each individual application.

Applications of YSS Die-casting Die Steels and Their Features

<table>
<thead>
<tr>
<th>Applications</th>
<th>YSS Grade</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Die for Aluminium/Zinc Alloy in general use</td>
<td>DAC, DAC-S</td>
<td>Strength at elevated temperature and toughness are well balanced. Good machinability and less deformation after heat treatment</td>
</tr>
<tr>
<td>Advanced Die Steel for Die Casting</td>
<td>DAC-MAGIC</td>
<td>High performance die steel which balanced high strength at elevated temperature and high toughness. Excellent heat crack resistance, stress corrosion cracking resistance and better machinability</td>
</tr>
<tr>
<td>High performance die, Squeeze die</td>
<td>DAC55</td>
<td>Good heat crack resistance Higher toughness enables initial hardness of dies much higher.</td>
</tr>
<tr>
<td>For Precision Die Casting</td>
<td>DAC10</td>
<td>Higher strength at elevated temperature and excellent heat crack resistance</td>
</tr>
<tr>
<td>Longer pin life, insert die parts</td>
<td>YXR33</td>
<td>Highest strength at elevated temperature Excellent erosion resistance</td>
</tr>
<tr>
<td>Die for small lot production, low cost die</td>
<td>FDAC</td>
<td>Prehardened to 32HRC(HI-PM7), 40HRC(HI-PM MAGIC). Good machinability and toughness. Least difference of hardness between surface and center of large die.</td>
</tr>
</tbody>
</table>
## Heat Crack Appearance

<table>
<thead>
<tr>
<th>Heat crack</th>
<th>Appearance</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diecast in general use</strong></td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>On the surface of dies</td>
<td>Network</td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>Temperature of molten material 680°C</td>
<td>0.1mm</td>
</tr>
<tr>
<td><strong>Precision/Hi-Si Al-alloy Diecast</strong></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>On the edge of dies</td>
<td>Stress concentration</td>
<td>5mm</td>
</tr>
<tr>
<td>Stress concentration</td>
<td>Temperature of molten material 760°C</td>
<td>0.1mm</td>
</tr>
<tr>
<td><strong>Diecast in SQ use</strong></td>
<td><img src="image5" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td>At the corner of dies</td>
<td>Crack opening</td>
<td>0.4mm</td>
</tr>
<tr>
<td>Stress concentration</td>
<td>Temperature of molten material 720°C</td>
<td>0.5mm</td>
</tr>
</tbody>
</table>

## Results of Heat Crack Generation Test

*Number of cycles of heat crack generation and cross section*

Specimen: φ 90 mm  
Test procedure: repeated induction heating and cooling by spray water on end face

<table>
<thead>
<tr>
<th>No. of test cycle</th>
<th>YSS Grade</th>
<th>HRC</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>Cross section after test cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DAC</td>
<td>43</td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>DAC</td>
<td>47</td>
<td><img src="image10" alt="Image" /></td>
<td><img src="image11" alt="Image" /></td>
<td><img src="image12" alt="Image" /></td>
<td><img src="image13" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>DAC</td>
<td>51</td>
<td><img src="image14" alt="Image" /></td>
<td><img src="image15" alt="Image" /></td>
<td><img src="image16" alt="Image" /></td>
<td><img src="image17" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>DAC55</td>
<td>50</td>
<td><img src="image18" alt="Image" /></td>
<td><img src="image19" alt="Image" /></td>
<td><img src="image20" alt="Image" /></td>
<td><img src="image21" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>DAC55</td>
<td>53</td>
<td><img src="image22" alt="Image" /></td>
<td><img src="image23" alt="Image" /></td>
<td><img src="image24" alt="Image" /></td>
<td><img src="image25" alt="Image" /></td>
</tr>
</tbody>
</table>

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YSS Die Steels For Die Casting DAC Series

Mechanical Properties

Physical Properties

<table>
<thead>
<tr>
<th>YSS Grade</th>
<th>Thermal expansion coefficient ($\times 10^{-6}/^\circ C$)</th>
<th>Thermal conductivity (W/m·K)</th>
<th>Young's modulus (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average value from 20°C to each temperature</td>
<td>20°C</td>
<td>200°C</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------</td>
<td>-----------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>DAC</td>
<td>11.3</td>
<td>12.2</td>
<td>12.8</td>
</tr>
<tr>
<td>DAC-MAGIC</td>
<td>11.3</td>
<td>12.3</td>
<td>13.1</td>
</tr>
<tr>
<td>DAC55</td>
<td>11.3</td>
<td>12.1</td>
<td>12.8</td>
</tr>
<tr>
<td>DAC10</td>
<td>11.2</td>
<td>12.0</td>
<td>12.7</td>
</tr>
<tr>
<td>YXR33</td>
<td>11.3</td>
<td>12.2</td>
<td>12.9</td>
</tr>
</tbody>
</table>
DAC (JIS SKD61)

DAC is most widely used as Die for Aluminium and Zinc Diecasting. DAC is hot working tool steel with good balance of strength, toughness and heat resistance.
With introduction of Isotropy technology DAC has become tougher and more isotropic to help life of dies longer and stable.

Features
* Good balance of both strength at elevated temperature and toughness
* Good machinability with less distortion after heat treatment

Applications
* General die for Aluminium Diecasting
* Die for Zinc Diecasting
* Die for low pressure casting
(Remarks)
Both forged and cast steel available for low pressure casting die in prehardened condition of 30-40HRC.

Hardened hardness
* 45-48HRC general size dies
* 43-46HRC big size dies

Quenching:
- 1020℃

Hardness
- 44HRC

Tempering:
- 400℃
- 500℃
- 550℃
- 600℃
- 650℃
- 700℃

Hardness (HRC)

Tempering Temperature (℃)

Quenched and tempered hardness

Tempered hardness vs Charpy I-Value

Toughness of Isotropy DAC

L: Longitudinal direction
T: Transverse direction

Index of 2mm U-notch Charpy impact value

Hardness: 47HRC

Standard Quality for Aluminium Diecasting
YSS Die Steels For Die Casting DAC Series

The range of applications of diecast products for weight saving and recycling is expanding while awareness of environmental protection is increasing. This fact requires bigger diecast products to be produced with higher quality in short cycle. In order to meet such needs, DAC-MAGIC is one of the best materials for diecasting which has not only good heat crack resistance but also good toughness and machinability.

**Features**
- High strength at elevated temperature and excellent heat crack resistance
- High toughness prevents gross crack of die
- Improved stress corrosion cracking resistance reduces crack problem from cooling channel
- Better machinability than conventional SKD61 improved steel (high toughness type) possible to reduce manufacturing time and total cost

**Applications**
- Die casting in general use
- Squeeze die casting
- Precision die casting

**Standard Heat Treatment**
- Quench: 1010-1030°C rapid cooling
- Temper: 550°C-640°C

**Recommended hardness**
- 45-52HRC small/medium size dies
- 42-46HRC large size dies

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DAC55 has been developed in responding to the needs for a longer die life or a steel with good hardenability as well as heat crack resistance and toughness for large and medium size dies.

**Features**
- Good heat crack resistance
- Higher service hardness of 50-53HRC
- Higher resistant to crack propagation
- Higher strength at elevated temperature
- Good hardenability

**Applications**
- Precision die casting
- Large and medium size dies for die casting
- Squeeze die casting

**Standard Heat Treatment**
- Quench 1010-1030°C rapid cooling
- Temper 550°C - 640°C
- Hardness 43-53HRC

**Recommended hardness**

<table>
<thead>
<tr>
<th>Hardness (HRC)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-53</td>
<td>Small Die, Squeeze Die (Anti-Heat Crack)</td>
</tr>
<tr>
<td>46-50</td>
<td>General Use Die</td>
</tr>
<tr>
<td>43-46</td>
<td>Large Die (Priority:Toughness)</td>
</tr>
</tbody>
</table>

(Remarks) Recommended hardness may not apply depending on projection or casting conditions

**Tempered hardness vs Charpy I-Value**

**Quench Cooling Speed vs Charpy I-Value**
(Test Result of 250mm Cubic Block)
**YSS Die Steels For Die Casting DAC Series**

**For Precision Diecasting**

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**DAC10**

As material of die for diecast products which requires higher level of surface, heat crack resistance has been intensified. Most useful for small and medium size dies of their longer life.

**Features**

* Higher strength at elevated temperature and excellent heat crack resistance
* Good erosion resistance

**Applications**

* Small / Medium size dies of which O-ring grooves require heat crack resistance
* Medium dies for products like headcover which requires good appearance
* Small dies for OA components which require erosion resistance

**Standard Heat Treatment**

* Quench 1,010-1,030°C rapid cooling
* Temper 570°C-610°C
* Hardness 44-51HRC

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**Quench cooling speed and Microstructure (×400)**

- Oil cool
- Half Temperature Time (15min)
- Half Temperature Time (30min)
- Quenching Temperature 1020°C
- Hardness 44HRC

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**Tempered hardness vs Charpy I-Value**

- (J/cm²) (kgf・m/cm²) (1,020°C Quenching)
- Oil cool
- Half Temperature Time
- 30min
- 45min
- 60min

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**Quench Cooling Speed vs Charpy I-Value**

- (J/cm²) (kgf・m/cm²) (1,020°C Quenching)
- 40HRC
- 44HRC
- 48HRC
- 52HRC

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*Oil Cool Test Piece Size: 10 × 10 × 55mm*

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**DAC-S**

DAC-S has higher toughness than general-purpose diecasting die steel DAC, which has excellent resistance to gross crack generation of die.

**Features**
- Higher toughness than general-purpose diecasting die steel DAC
- DAC-S meets a minimum Charpy impact value specification of the NADCA 207-2003 Superior.
- DAC contributes to the stability of die life

**Applications**
- Large and medium dies for die casting

**Standard Heat Treatment**
- Quench 1,000°C - 1,050°C rapid cooling
- Temper 550°C - 680°C
- Hardness 45-48HRC (general size dies), 43-46HRC (large size dies)

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**YXR33**

YXR33 is a HSS with higher toughness which solved breakage problem often existed in SKH51. Fitted for insert pin or other inserts exposed to critical wear due to erosion.

**Features**
- Highest strength at elevated temperature among HSS and Alloy Tool Steel.
- Toughness is more than 5 times as big as SKH51
- Excellent nitridability

**Applications**
- Erosion resistant insert pin
- Insert die parts

**Standard Heat Treatment**
- Quench 1080°C - 1140°C oil cool
- Temper 550°C - 600°C
- Hardness 52 - 58HRC

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FDAC, HI-PM7, HI-PM MAGIC

These materials whose strength and toughness are less than those of general die-casting die steels (ex. DAC) can be used for dies for small lot production or holding blocks.

FDAC is based on chemical composition of DAC with the addition of some Sulfur for machinability. As delivered pre-hardened to 38-42HRC, direct cavity making is possible.

HI-PM7 is prehardened to 29-33HRC and has good machinability.

HI-PM MAGIC is prehardened to 37-41HRC and has good machinability and toughness.

Features
*Good machinability
*As delivered prehardened, farther heat treatment is necessary
—Possible to reduce manufacturing time and total cost

Applications
Die for small lot production, low cost die, holding block
FDAC: priority heat resistance
HI-PM7 and HI-PM MAGIC: high toughness and good machinability

Heat Crack Test (0.5R ditch)

<table>
<thead>
<tr>
<th>Tool</th>
<th>Cutting condition</th>
<th>Coolant</th>
<th>Life</th>
<th>Cutting speed</th>
<th>Feed</th>
<th>Depth</th>
<th>Coolant</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSS Co φ4</td>
<td>Cutter</td>
<td>Ø63</td>
<td>Insert</td>
<td>Coated cemented carbide</td>
<td>Number of inserts</td>
<td>1</td>
<td>130m/min</td>
</tr>
</tbody>
</table>

Mechanical Properties (Reference)

<table>
<thead>
<tr>
<th>YSS Grade</th>
<th>Hardness (HRC)</th>
<th>0.2% Yielding Strength (MPa)</th>
<th>Tensile Strength (MPa)</th>
<th>Elongation (%)</th>
<th>Reduction of Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAC</td>
<td>40</td>
<td>1,070</td>
<td>1,250</td>
<td>12</td>
<td>58</td>
</tr>
<tr>
<td>FDAC</td>
<td>40</td>
<td>1,060</td>
<td>1,240</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>HI-PM7</td>
<td>32</td>
<td>860</td>
<td>980</td>
<td>20</td>
<td>55</td>
</tr>
<tr>
<td>HI-PM MAGIC</td>
<td>40</td>
<td>1,020</td>
<td>1,200</td>
<td>18</td>
<td>45</td>
</tr>
</tbody>
</table>

2mm U-notch Charpy I-Value (Reference)

<table>
<thead>
<tr>
<th>YSS Grade</th>
<th>Hardness (HRC)</th>
<th>Longitudinal direction (J/cm²)</th>
<th>Transverse direction (J/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAC</td>
<td>40</td>
<td>58</td>
<td>39</td>
</tr>
<tr>
<td>FDAC</td>
<td>40</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>HI-PM7</td>
<td>32</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td>HI-PM MAGIC</td>
<td>40</td>
<td>60</td>
<td>35</td>
</tr>
</tbody>
</table>

Size of Raw Material: 280×640
Position of Specimen: w/2×t/4

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## Actual Performance

<table>
<thead>
<tr>
<th>Diecast Products YSS Grade</th>
<th>Die Clamping Force (die size mm)</th>
<th>Comparison of Actual Performance</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autoparts surface priority</td>
<td>800 ton 120 × 210 × 300</td>
<td>DAC (44HRC)  Primary heat crack at 37K shots</td>
<td>DAC (48HRC)  Primary heat crack at 50K shots</td>
</tr>
<tr>
<td>Autoparts DAC-MAGIC</td>
<td>2,500 ton Insert</td>
<td>DAC (43HRC) heat cracks</td>
<td>DAC-MAGIC (44HRC)  Less heat cracks</td>
</tr>
<tr>
<td>Autoparts DAC-MAGIC</td>
<td>1,250 ton WJ Insert</td>
<td>Life span of DAC55, DAC10, material A and material B are 20K-50K shots</td>
<td>DAC-MAGIC (46HRC)  Still on service after 100K shots</td>
</tr>
<tr>
<td>Autoparts DAC-MAGIC</td>
<td>1,600 ton</td>
<td>Life span of other company material (46-47HRC) is 29K shots</td>
<td>DAC-MAGIC (47-48HRC)  Still on service after 62K shots</td>
</tr>
<tr>
<td>Autoparts surface priority DAC55</td>
<td>2,000 ton</td>
<td>DAC (47HRC)  Heat crack at 60K shots</td>
<td>DAC55 (50HRC)  Still on service after 100K shots</td>
</tr>
<tr>
<td>Autoparts (thin insert) DAC55</td>
<td>n.a.</td>
<td>DAC  Breakage at 20K shots</td>
<td>DAC55  More than 40K shots</td>
</tr>
<tr>
<td>OA Components (precision die) DAC10</td>
<td>250 ton 80 × 200 × 300</td>
<td>DAC  Primary heat crack at 15K shots, repair at 30K shots, scrap at 80K shots</td>
<td>DAC10  Primary heat crack at 24K shots, no griding repair, scrap at 120K shots</td>
</tr>
<tr>
<td>OA Components (precision die) DAC10</td>
<td>650 ton 90 × 215 × 380</td>
<td>DAC  Primary bite at 1K shots, scrap at 30K shots</td>
<td>DAC10  No bite at 10K shots</td>
</tr>
<tr>
<td>Autoparts YXR33</td>
<td>Insert Pin</td>
<td>DAC  Meltdown and galling at 3K shots</td>
<td>YXR33  Still on service after 10K shot</td>
</tr>
<tr>
<td>High melting point Al-alloy autoparts YXR33</td>
<td>Insert Pin</td>
<td>SKH51 (60HRC)  Breakage at 2K shots</td>
<td>YXR33 (54HRC) + TiN  Meltdown at 20K shots</td>
</tr>
</tbody>
</table>

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Machinability

Comparison of machinability by High feed radius milling (annealed)

<table>
<thead>
<tr>
<th>Work</th>
<th>State of tool wear</th>
<th>Cutting speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAC-MAGIC</td>
<td>Wear width: 0.13 mm</td>
<td>180m/min, 90m/min</td>
</tr>
<tr>
<td>DAC55</td>
<td>Wear width: 0.25 mm</td>
<td>180m/min, 90m/min</td>
</tr>
</tbody>
</table>

<Cutting conditions>
- φ63 High feed radius mill
- Cutting speed = 90, 180m/min
- Feed = 2.0mm/tooth
- Cutting depth = 1.0mm
- Cutting width = 42mm

Comparison of machinability by Ball end milling (45HRC)

<Cutting conditions>
- φ6-R3 Coated carbide ball end mill
- Cutting speed = 200m/min
- Feed = 0.1mm/tooth
- Cutting depth = 0.6mm
- Cutting width = 0.6mm

Simulated Die Machining Example

High feed radius milling

<table>
<thead>
<tr>
<th>Work</th>
<th>State of tool wear</th>
<th>Cutting speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAC-MAGIC</td>
<td>Wear width: 0.13 mm</td>
<td>180m/min, 90m/min</td>
</tr>
<tr>
<td>DAC55</td>
<td>Wear width: 0.25 mm</td>
<td>180m/min, 90m/min</td>
</tr>
</tbody>
</table>

<Cutting conditions>
- φ63 High feed radius mill
- Cutting speed = 90, 180m/min
- Feed = 2.0mm/tooth
- Cutting depth = 1.0mm
- Cutting width = 42mm

Ball end milling

<table>
<thead>
<tr>
<th>Work</th>
<th>DAC-MAGIC</th>
<th>DAC55</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of tool wear</td>
<td>Wear width: 0.03 mm</td>
<td>Wear width: 0.05mm</td>
</tr>
</tbody>
</table>

<Cutting conditions>
- φ6-R3 Coated carbide ball end mill
- Cutting speed = 200m/min
- Feed = 0.1mm/tooth
- Cutting depth = 0.5mm
- Cutting width = 0.5mm
- Air blow
- Work = Heat treated condition (45HRC)

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Repair Welding

Followings show standard repair welding method in build-up welding due to design change or repair welding due to heat crack.

Material involved: DAC, DAC-MAGIC, DAC55, DAC10, FDAC.

<table>
<thead>
<tr>
<th>State of Die</th>
<th>Welding</th>
<th>Welding Method</th>
<th>Welding Condition</th>
<th>Welding Process Chart</th>
<th>Temp. between weld layers</th>
</tr>
</thead>
</table>
| Annealed State | DAC or same steel | TIG | ○ Welding bar 1.6 - 4.0φ  
○ Current 80 - 200A  
○ Flux of Ar gas 8 - 15ℓ/min | Welding 300 - 400℃  
After-heating 350 - 400℃  
Pre-heating 100 - 150℃  
Annealing 680 - 730℃  
Furnace Cooling or Ash Cooling  |
| 250℃ Above | |
| Hardened State | YAG |  |
| 250℃ Above | |

(Remarks)

1. YAG is a brand name of Hitachi Maraging Steel used for various applications including high grade welding rod. Using YAG welding rod remarkably decreases such welding defects as "bead crack" or "pin holes".

2. TIG Welding Method (Tangsten Inert Gas Welding Method) is to make arc between tangsten electrode covered by argon gas and objects to be welded, and then wire is inserted into the heat pool generated by the arc.

3. Use lower current and finer welding wire in order to get better efficiency of welding metal. In order to prevent crater cracks, avoid an overlap of the crater of backward pass on the crater of foregoing pass. To avoid an overheat of mother material, conduct an interrupted welding with short bead.

4. Keeping time of Temper and Anneal after welding should be 1h/25mm in thickness.

5. A careful attention is to be paid of crack during grinding.
Heat Treatment

Standard Heat Treatment Process

Quenching

Temperature

- 500-550°C
- 750-800°C
- 1,000-1,050°C

Methods

- Forced Air Cooling, High Pressure Gas, Cooling, etc.

Tempering

Temperature

- 300-350°C
- 550-680°C

Methods

- Air Cooling, Room Temperature

Holding time for quenching

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>≤15</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>200</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding time (min)</td>
<td>15</td>
<td>25</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>65</td>
<td>70</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

Holding time for tempering

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>26-35</th>
<th>36-64</th>
<th>65-84</th>
<th>85-124</th>
<th>125-174</th>
<th>175-248</th>
<th>255-348</th>
<th>350-499</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding time (h)</td>
<td>1.5</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Quenching Method to Reduce Distortion

As the cooling rate of quenching becomes faster, the heat-treated microstructure becomes finer and the toughness is improved. However, the distortion after heat treatment increases. By optimizing the quenching pattern, Hitachi Metals Group has established heat treatment method which not only reduce distortion but also improve toughness.

Examples of measuring impact values of heat-treated products (DAC10/160 × 400 × 500)

<table>
<thead>
<tr>
<th>Method</th>
<th>Quenching method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td></td>
</tr>
<tr>
<td>Method 1</td>
<td></td>
</tr>
<tr>
<td>Method 2</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td></td>
</tr>
</tbody>
</table>

Examples of distortion of heat-treated products

<table>
<thead>
<tr>
<th>Distortion rate (“bend” versus “length”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.05</td>
</tr>
<tr>
<td>&lt;0.10</td>
</tr>
<tr>
<td>&lt;0.15</td>
</tr>
<tr>
<td>&lt;0.20</td>
</tr>
<tr>
<td>&lt;0.25</td>
</tr>
<tr>
<td>&lt;0.30</td>
</tr>
</tbody>
</table>

Nitriding

Properties and characteristics of the nitried layer vary depending on nitriding methods and conditions. Please choose the type of nitriding according to the right figure.

Comparison of various nitried layers

<table>
<thead>
<tr>
<th></th>
<th>TYPE A</th>
<th>TYPE B</th>
<th>TYPE C</th>
<th>TYPE D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitriding depth and form (in the case of nitried SKD61)</td>
<td>ε phase (white layer)</td>
<td>Grain boundaries in the nitride layer</td>
<td>Sulfide, oxide layer</td>
<td>No compound layer</td>
</tr>
<tr>
<td>0.1mm &gt;1000HV</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>0.2mm &gt;1000HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting Resistance</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Type of Nitriding</td>
<td>General nitriding</td>
<td>Deep nitriding</td>
<td>Sulfurizing and nitriding</td>
<td>Shallow nitriding</td>
</tr>
</tbody>
</table>

Exellent “A” → Good “B” → Ordinary “C”
The characteristics listed on this catalog are representative values and they do not guarantee the quality of the product.

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Please contact a representative of our Specialty Steel Division if there are any questions or problems.

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