

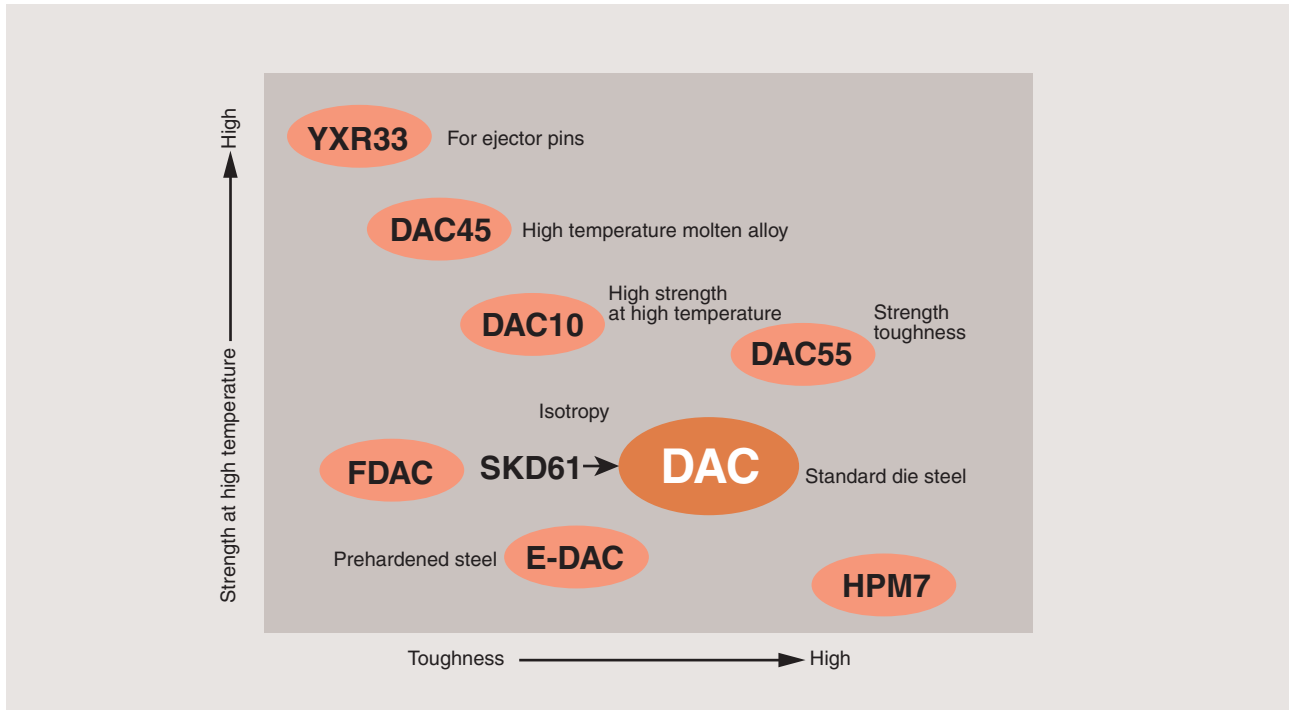
# YSS DIE STEELS FOR DIE CASTING DAC Series

In compliance with changes of die casting technology



## YSS Correlation for Diecasting Die steels

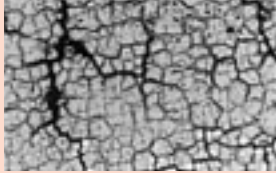



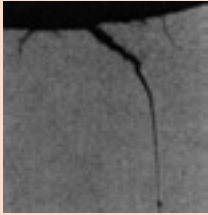
In compliance with diversification of diecasting technology, variety of steel grade is prepared in order to best fit for each individual application.



## Die Steel for Diecasting Die-Kind and Features





Applications	Steel Brand	Features
Die for Aluminium/Zinc Alloy in general use	<b>DAC</b> equivalent to JIS SKD61 0.38C-5Cr-1.3Mo-1V	Strength at elevated temperature and toughness are well balanced. Good machinability and less deformation after heat treatment.
High efficiency die, Squeeze die	<b>DAC55</b> 5Cr-Mo-V-Ni-Co	Superior heat crack resistance. Higher toughness enables initial hardness of dies much higher.
Precision Die Cast Die	<b>DAC10</b> 5Cr-2.5Mo-V	Higher strength at elevated temperature and good heat crack resistance.
Die for high melting point aluminium alloy and copper alloy	<b>DAC45</b> 3.5Cr-W-Mo-V	Higher strength at elevated temperature. Good crack development resistance.
Longer life pin, insert die parts	<b>YXR33</b> Matrix HSS	Highest strength at elevated temperature. Best erosion resistance.
Die for small lot, Simple die	<b>FDAC</b> SKD61+S Sulphurized DAC	Standard hardness is 40HRC. Delivered prehardened.
Simple die Core, Backblock	<b>HPM7</b> Mn-Cr-Mo	Prehardened to 32HRC. Good machinability & Toughness. Least difference of hardness between surface and center of large mold.

# Appearance of Heat Crack and Test Result

Heat crack	Appearance	Cross Section
<p><b>Diecast in general use</b></p> <p>On the flat surface of dies Network Temperature of molten material</p>	 <p>0.1mm</p>	 <p>0.1mm</p>
<p><b>Precision/Hi-Si Al-alloy Diecast</b></p> <p>On the edge of dies Crack opening Temperature of molten material</p>	 <p>50mm</p>	 <p>0.1mm</p>
<p><b>Diecast in SQ use</b></p> <p>At the corner of dies Stress concentration Temperature of molten material</p>		 <p>0.4mm</p>

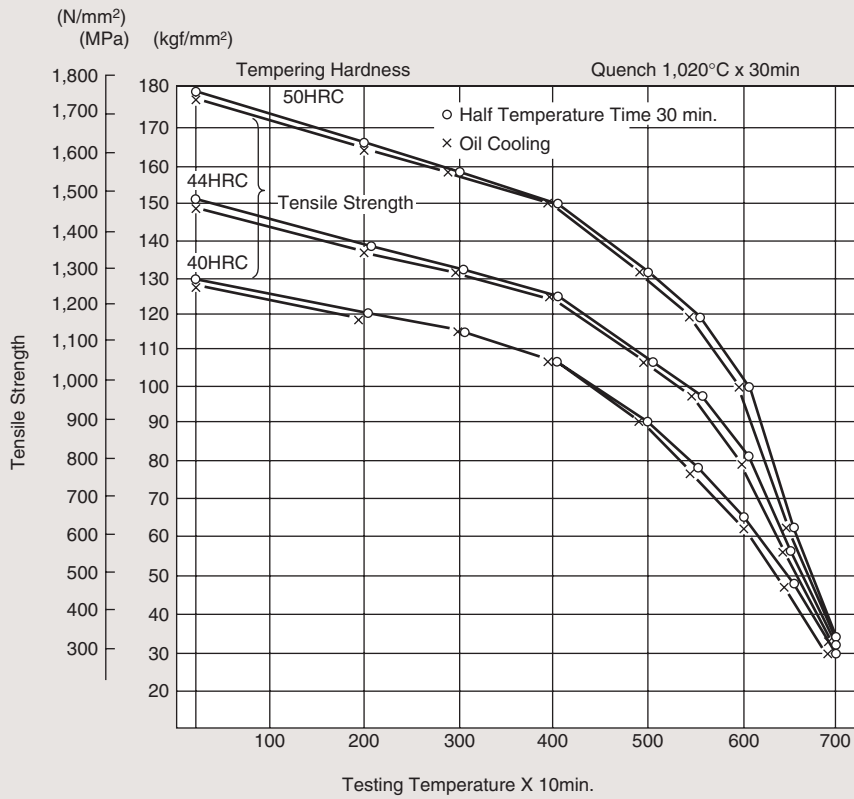
## Number of cycles of heat crack initiation and cross sectional appearance

Test: Repetition of Heating upto 600°C by high frequency and Cooling by spray water. Specimen used is one end of dia 90mm bar.

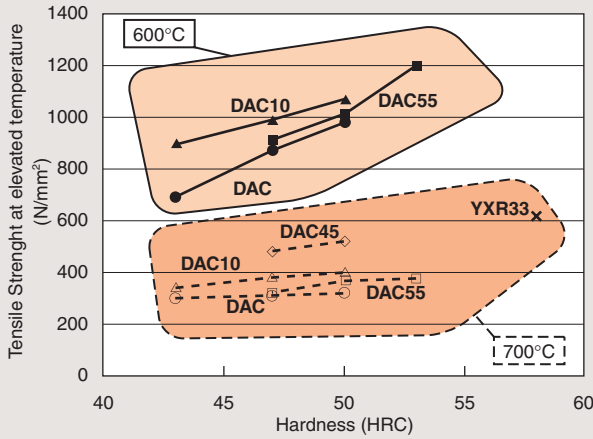
Steel Brand	HRC	No. of test cycle			Cross sectional appearance
		1000	2000	3000	
DAC	43	Occurance of heat crack			
DAC	47	Occurance of heat crack	Observation of heat crack		
DAC	51	Occurance of heat crack			
DAC10	47	Occurance of heat crack	Observation of heat crack		
DAC55	50	Occurance of heat crack	Observation of heat crack		
DAC55	53	Occurance of heat crack	Observation of heat crack		

# Mechanical Properties

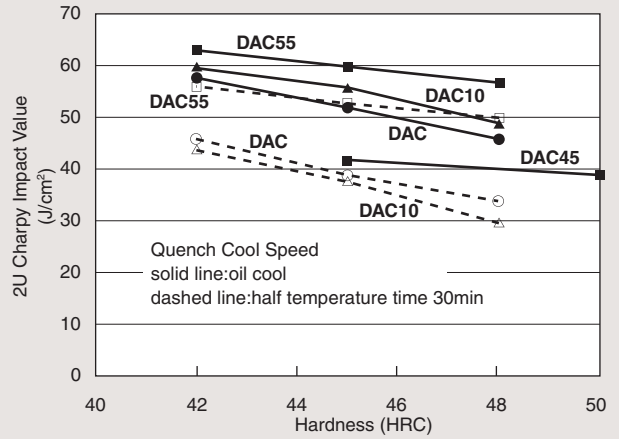
Tensile Strength at elevated temperature



Tempered hardness vs Tensile Strength at elevated temperature



Tempered hardness vs Charpy I - Value



## Physical Properties

	Temperature	DAC	DAC10	DAC55	DAC45	YXR33
Thermal Expansion Coefficient X 10 <sup>-6</sup> /°C	100°C	11.7	10.7	11.6	10.5	11.6
	700°C	14.0	13.2	13.7	13.6	13.2
Thermal Conductivity W/m·K[cal/cm·s·°C]	20°C	30.5 [0.073]	32.2 [0.077]	34.5 [0.082]	26.4 [0.063]	27.2 [0.065]
	700°C	28.0 [0.067]	28.5 [0.068]	28.0 [0.067]	27.6 [0.066]	29.7 [0.071]

# DAC

## DAC Standard Quality for Aluminium Diecasting

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 deformation 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 with prehardened condition of 30-40HRC.

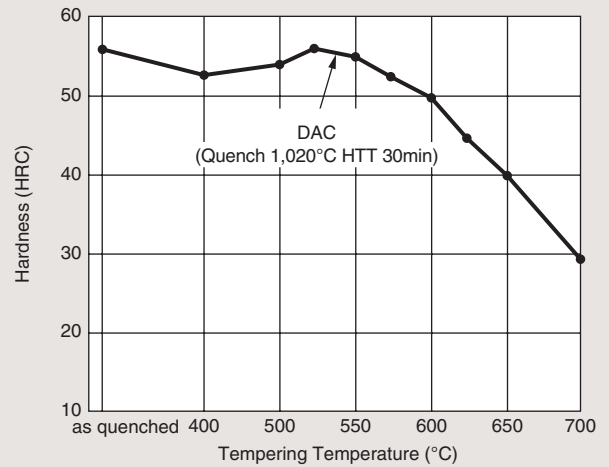
### Hardend hardness

45~48HRC general size dies.  
43~46HRC big size dies.

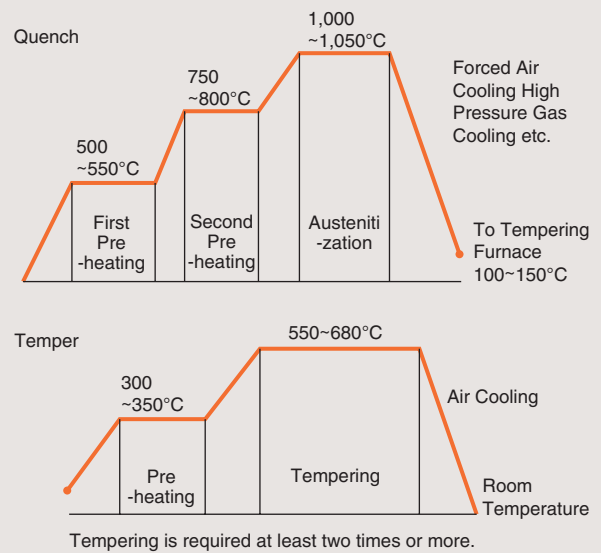
### Quench cooling speed and Microstructure (X400)

Oil cool	Half Temperature Time (30min.)
Half Temperature Time (60min.)	Quench Temperature 1020°C Hardness 44HRC
	
	
	

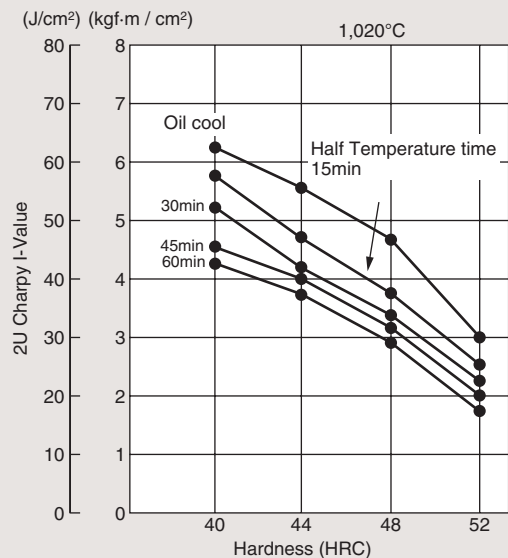
### Quenched & tempered hardness



### Standard Heat Treatment Process



### Tempered hardness vs Charpy I-Value



# DAC55

## DAC55 For High Performance Diecasting

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 development.
- \*Higher strength at elevated temperature.
- \*Good hardenability.




### Applications

- \*Precision diecasting die.
- \*Big and medium dies for diecasting.
- \*Squeeze diecasting die.

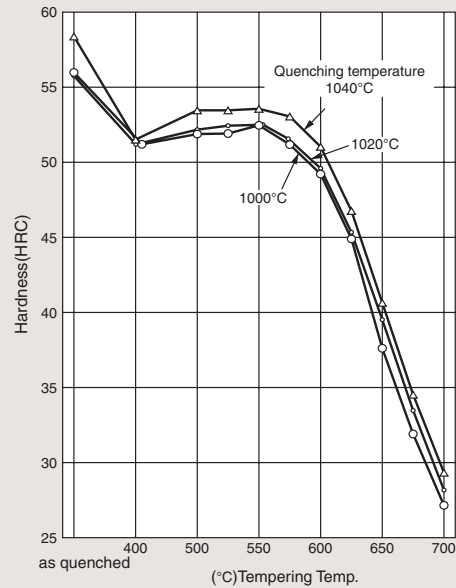
### Standard Heat Treatment

Quench 1010-1030°C quick cool  
 Temper 550°C-640°C  
 Hardness 43-53 HRC

### Quench cooling speed and Microstructure (X 400)

Oil cool	Half Temperature Time (15min.)
	
	<p style="margin: 0;">Half Temperature Time (30min.)</p> <p style="margin: 0;">Quench Temperature 1020°C Hardness 44HRC</p>

### Quenched & tempered hardness

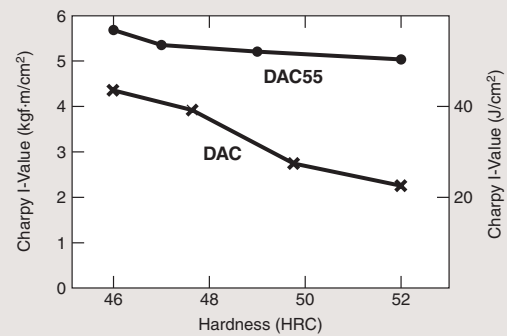


### Recommended hardness

Hardness (HRC)	Application
50-53	Small / Squeeze Die ( Anti-Heat Crack )
46-50	General Use Die
43-46	Large Die (Priority: Toughness)

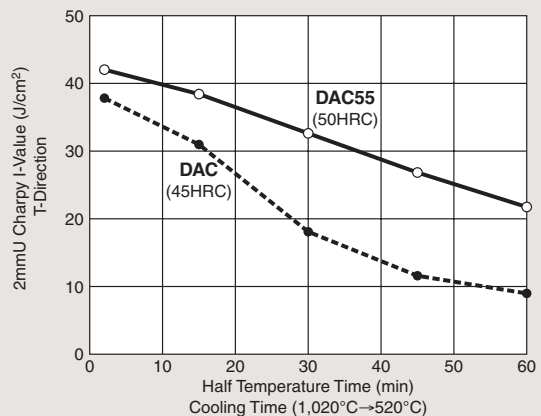
(Remarks) Recommended hardness may not apply depending on projection or casting conditions

### Tempered hardness vs Charpy I-Value



### Quench Cool Speed vs Charpy I-Value

(Test Result of 250mm Qubic Block)



# DAC10

## DAC10 For Precision Diecasting

As material of die for diecast products required higher level of surface, and 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 good 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 VTR parts or OA components which require erosion resistance.

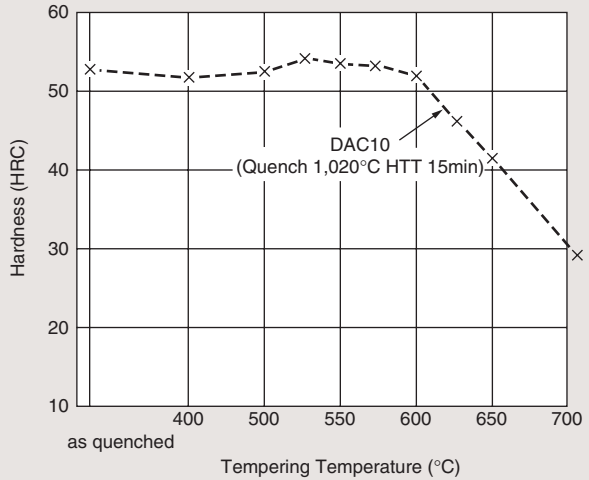
### Standard Heat Treatment

Quench 1010-1030°C quick cool  
 Temper 570°C-610°C  
 Hardness 44-51 HRC

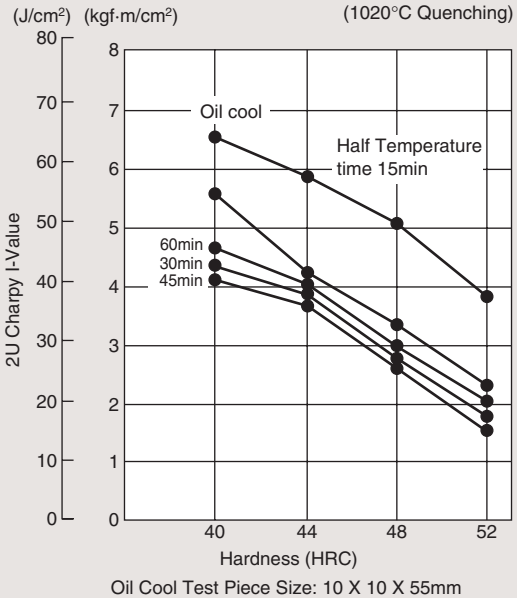
### Quench cooling speed and Microstructure (X 400)

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

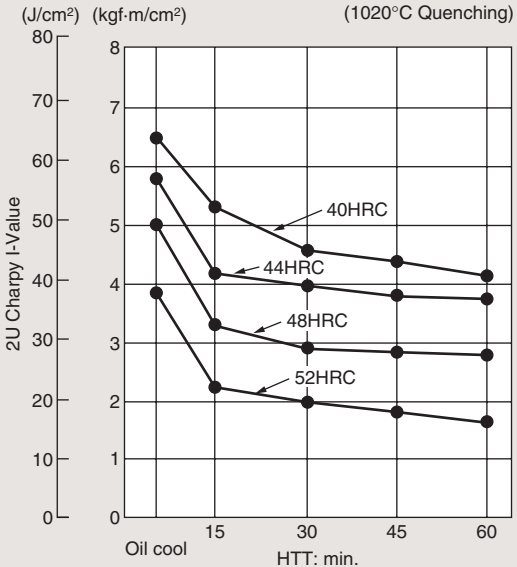
### Quenched & tempered hardness



### Tempered hardness vs Charpy I-Value



### Quench Cool Speed vs Charpy I-Value



# DAC45

## DAC45 For Diecasting Al-Alloy containing high Silicon

Exclusively developed for dies used in elevated temperature casting of 750°C molten steel. Superb erosion resistance.

### Features

- \*Exceptional high strength at elevated temperature.
- \*Higher resistant to crack development.

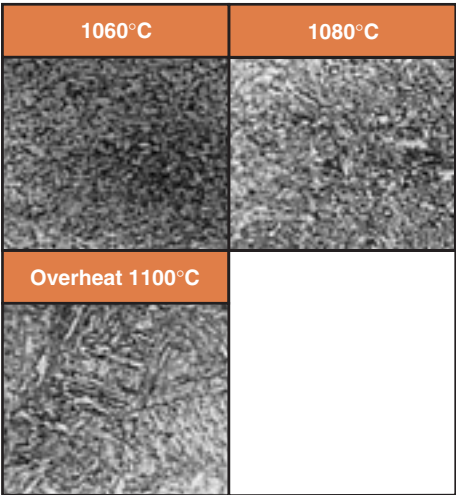
### Applications

- \*Die for High Silicon Aluminium Diecasting like ADC14.
- \*Die for Copper Alloy Diecasting.
- \*Erosion resistant pin, insert die parts.

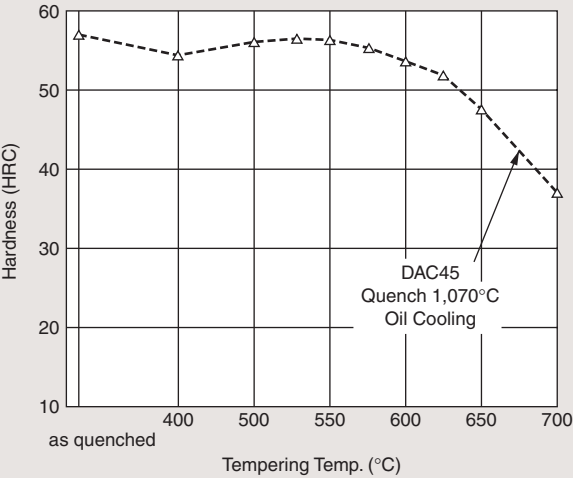
### Standard Heat Treatment

Quench 1060-1070°C oil cool  
 Temper 570°C-610°C  
 Hardness 47-51 HRC

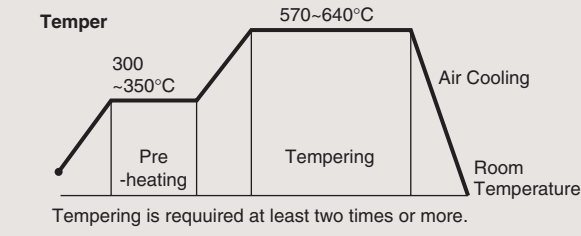
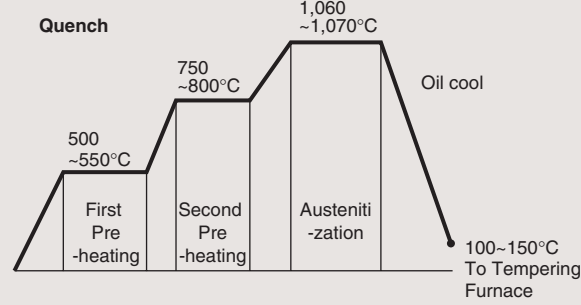
### Quench temperature and Microstructure (X 400)



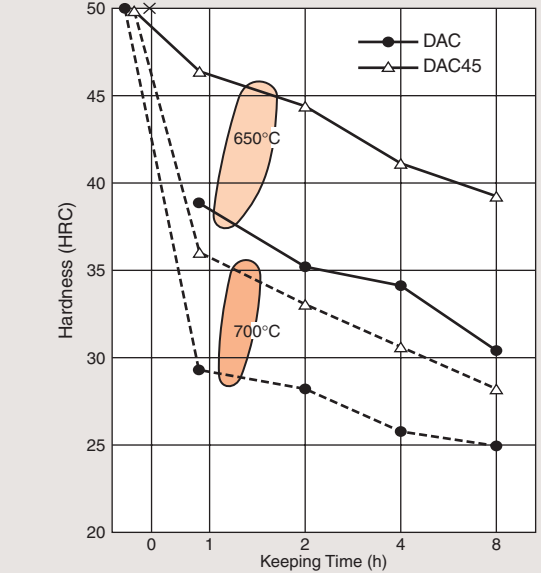
### Quenched & tempered hardness



### Standard Heat Treatment Process



### Softening Resistance





# YXR33

## YXR33 For High quality Insert Pin

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.

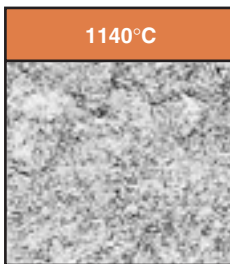
### Applications

- \*Erosion resistant insert pin.
- \*Insert die parts.

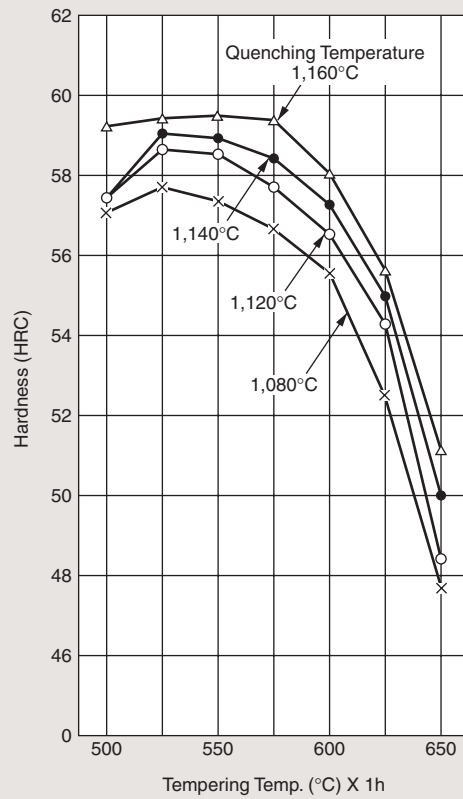
### Standard Heat Treatment

Quench 1080-1140°C oil cool  
 Temper 550°C-600°C  
 Hardness 52-58 HRC

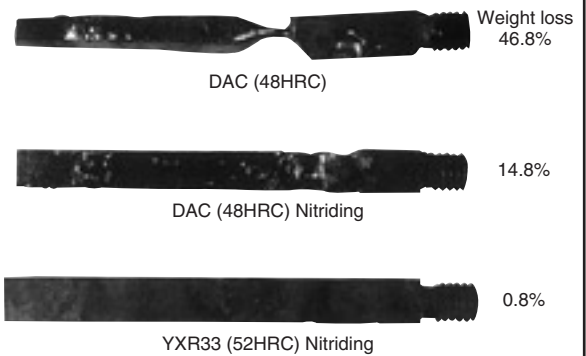
### Microstructure as quenched & tempered (X 400)



### Quenched & tempered hardness

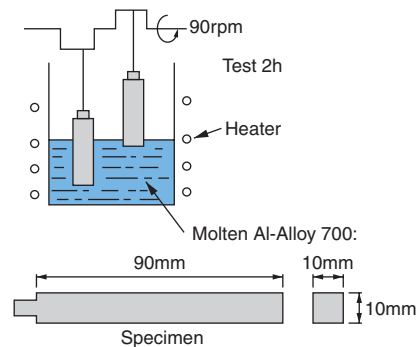


### Specimen after Meltdown Damage Test



### Meltdown Damage Test

(Specimen and Testing Condition)



# FDAC/HPM7

## Prehardened free machining die steel

### FDAC

FDAC is based on DAC for main components with addition of Sulphur for machinability. As delivered pre-hardened to 38-42HRC, direct cavity making is possible.

### HPM7

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

### Features

- \*Good machinability.
- \*As delivered prehardened, no further heat treatment is necessary.
- Possible to reduce manufacturing time and total cost.

### Applications

- Die for small lot , simple die, plain die, holding lock.
- FDAC...priority strength.
- HPM7...priority & toughness machinability.

### Mechanical Properties (Reference)

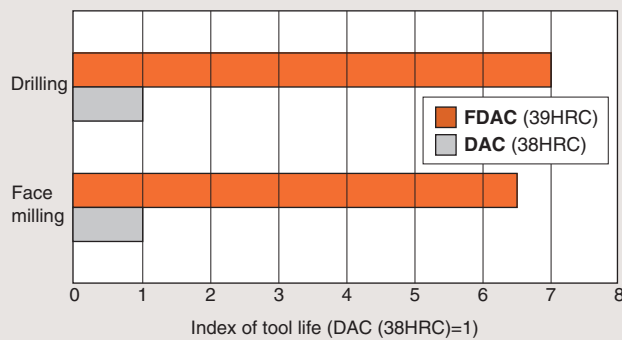
	Hardness (HRC)	0.2% Yielding Strength (MPa)	Tensile Strength (MPa)	Elongation (%)	Reduction of Area (%)
<b>DAC</b>	40	1070	1250	12	58
<b>FDAC</b>	40	1060	1240	11	20
<b>HPM7</b>	32	860	980	20	55

### Charpy I - Value (Reference)

	Hardness (HRC)	Longitudinal direction (J/cm <sup>2</sup> )	Transverse direction (J/cm <sup>2</sup> )
<b>DAC</b>	40	58	39
<b>FDAC</b>	40	19	10
<b>HPM7</b>	32	67	61

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

### Machinability



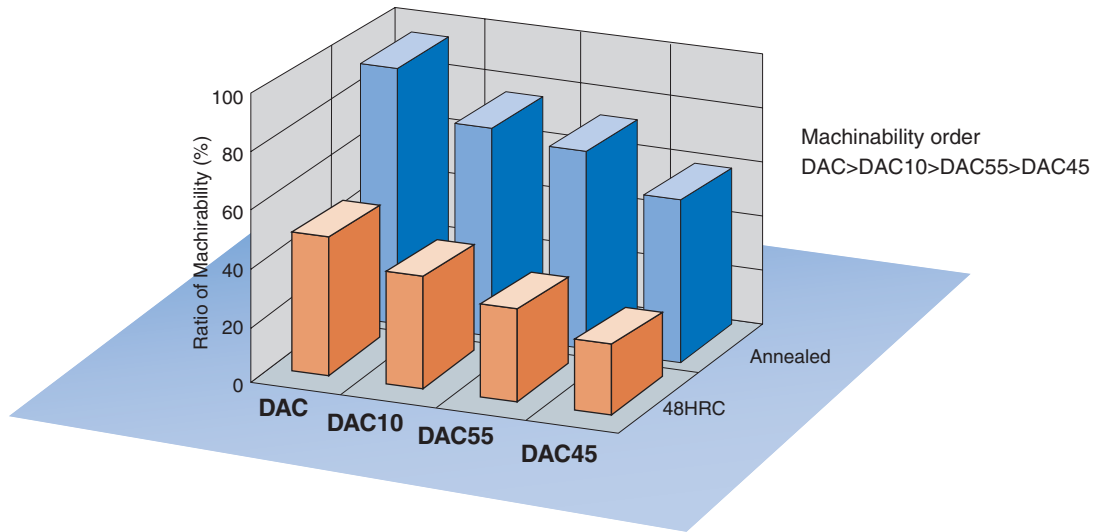
### Cutting condition

Face milling	
Cutter	f63
Insert	Coated cemented carbide
Number of inserts	1
Cutting speed	130m/min
Feed	0.15mm/Tooth
Depth	0.5mm
Coolant	dry
Life	VB=0.3mm

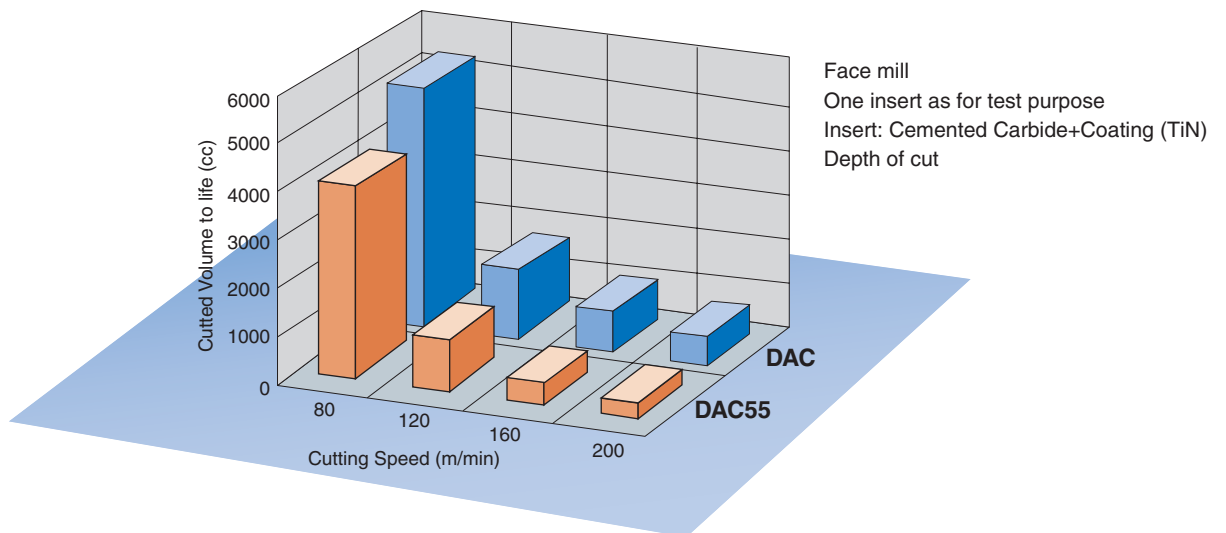
Drilling	
Tool	HSS Co φ4
Cutting speed	20m/min
Feed	0.1mm/rev
Depth	40mm (Blind)
Coolant	Water-Soluble
Life	Number of cutting hole

# Machinability

Comparison of machinability by Endmill machining



Comparison of machinability by Facemill machining



Cutting condition by Endmill (Reference)

Tool Material	DAC			DAC10		DAC55		
	Annealed condition	43HRC	48HRC	Annealed condition	48HRC	Annealed condition	48HRC	51HRC
Powder HSS	V=25 f=0.07	V=20 f=0.05	n. a.	V=15 f=0.07	n. a.	V=15 f=0.07	n. a.	n. a.
Powder HSS+Coating	V=30 f=0.07	V=25 f=0.05	n. a.	V=20 f=0.07	n. a.	V=20 f=0.07	n. a.	n. a.
Cemented Carbide+Coating Standard edge	V=45 f=0.05	V=35 f=0.03	V=25 f=0.03	V=35 f=0.05	V=15 f=0.03	V=35 f=0.05	V=17 f=0.03	V=15 f=0.03
Cemented Carbide+Coating Hi-speed edge	V=50 f=0.08	V=40 f=0.05	V=30 f=0.05	V=50 f=0.08	V=25 f=0.05	V=50 f=0.08	V=30 f=0.05	V=25 f=0.05

# 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, DAC55, DAC10, DAC45, FDAC, E-DAC.

State of Die	Welding Rod	Welding Method	Welding Condition	Welding Process Chart	Temp. between weldlayers
Annealed State	DAC or same steel	TIG	Welding bar 1.6~4.0φ		250: Above
Hardened State	YAG		Flux of Ar gas 8-15R/min		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.

## Actual Performance by Customers

Diecast Products Brand	Machine Capa (die size mm)	Comparision of Actural Performance by Customers		Effect
		Current	Application	
Autoparts surface priority	800ton 120X210X300	DAC (44HRC) 37K shot 1st heat crack	DAC (48HRC) 50K shot 1st heat crack	1.35 times
OA Components (precision die)	250 ton 80X200X300	DAC15K shot 1st heat crack 30K shot repair. 80K shot scrap	DAC10 24K shot 1st heat crack. No grinding repair. 120K shot scrap	1.6 times min.
OA Components (precision die)	650 ton 90X215X380	DAC 1K shot 1st bite 30K shot scrap	DAC10 10K shot no bite	3 times min
Autoparts surface priority	2000 ton	DAC (47HRC) 60K shot heat crack	100K shot still on service	1.6times min.
Autoparts	2500 ton	DAC (43HRC) heat crack	DAC55 (48HRC) later heat crack	4 times
Autoparts (thin insert)	n.a.	DAC 20K shot breakage	DAC55 40K shot and more	2 times
Wheel	1800 ton	DAC/DAC4 heat crack	2 times shot of DAC/DAC4 before crack	2 times
P/Computer Case (Mg)	n.a.	DAC 5K shot heat crack	DAC55 25K shot no repair	5 times min
High melting point Al-alloy autoparts	320 ton 90X200X300	DAC 5K shot 1st heat crack	DAC45 10K shot 1st heat crack but still in service	2 times
High melting point Al-alloy autoparts	Insert	DAC (52HRC) 3.5K shot meltdown	DAC45 (52HRC) 13K shot meltdown	4 times
Autoparts	Insert Pin	DAC 3K shot meltdown & galling	YXR33 10K shot still on service	3 times
High melting point Al-alloy autoparts	Insert Pin	SKH51 (60HRC) 2K shot breakage	YXR33 (54HRC)+TiN 20K shot meltdown	10 times


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