

Advanced Technology, Best Quality

SPECIAL STEEL & MOLD BASE



www.wonilsteel.co.kr



Wonil Special Steel. We expand a new horizon to the Special Steel industry.

Special steels are fundamental materials of the modern industries.

Wonil Special Steel is one of major distribution company of the Korean special steel industry, also ensures you that it has high level of expertise in our product.

Wonil can provide the materials you need within a day at a reasonable price, and has the largest stock of special steel in Korea, ready to provide the best services to our customers.

The Korean Specialist of Special Steel – Wonil is continuously growing to be the leader of the Korean special steel manufacturing industry.



Message from CEO




WONIL
SPECIAL STEEL

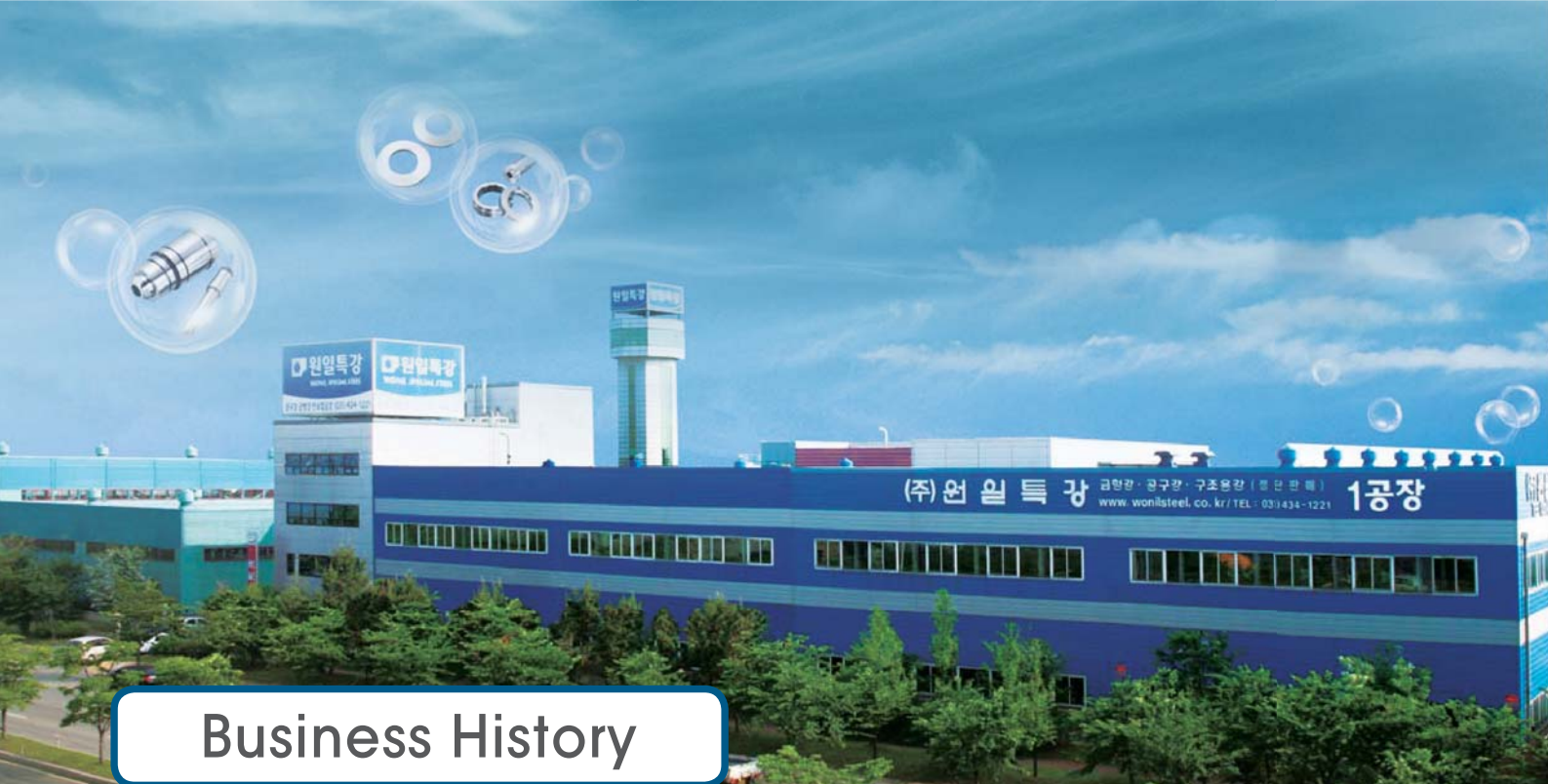
As the C.E.O of Wonil Special Steel, I and my fellow employees at Wonil appreciate to the customers devoted to the development of each fields. With trust and excellent service as our corporate philosophy, We devote ourselves to efficient supplying of special steel, a fundamental material in the vehicle, industrial machinery, vessel, electronics, aircraft, and heavy industry.

Acknowledging the rapid development of the overall industry, in particular, the vehicle, electronics, machinery, and mould industry, and also the need for rapid delivery of diverse and high quality products, Wonil pledge to secure diverse stock of high quality special steel, structural materials, and mould and toolmaking steel, and promise fast delivery in adequate price range through our one-day supplying system. I wish your company all the best.

CEO of Wonil Special Steel Co. Ltd.

YONG-MUN SHIN





Business History

- | | | | |
|-----------|---|-----------|---|
| Oct. 1977 | Establishment of Wonil Special Steel Co. Ltd. | Nov. 2002 | Completion of Sihwa Plant |
| Sep. 1984 | Acquired dealership of Doosan Heavy Industries & Construction(formerly Korea Heavy Industries & Construction) | Jul. 2003 | Commences steel manufacturing business |
| Mar. 1988 | Acquired Exclusive dealership of Daido Steel, Japan, in Korea | Sep. 2005 | Expansion and relocation of Busan Division |
| May. 1988 | Completion of Busan Plant | Sep. 2007 | Relocation of headquarters and expansion of Sihwa Plant |
| Jul. 1990 | Acquired dealership of SeAH Changwon Specialty Steel Corporation(formerly POSCO Special Steel Co. Ltd.) | Apr. 2008 | Awarded as exemplary taxpayer |
| Mar. 1992 | Acquired dealership of SeAH Besteel Corporation (formerly KIA Special Steel Co. Ltd.) | Mar. 2009 | Awarded the Day of Commerce Presidential Unit of Citation |
| Jun. 1994 | Listed on KOSDAQ | Nov. 2010 | Establishment of Sihwa-II Plant |
| | | Mar. 2011 | Awarded the Best taxpayer |
| | | Nov. 2012 | Awarded the 49th Day of Trade Million-dollar Export Tower Award |
| | | Mar. 2014 | Work/based Learning system Company |
| | | Aug. 2016 | Completion of Jincheon Plant |



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Main Equipments

We're equipped with various cutting equipments, including H2001, the largest sawing machine in Korea, to precisely meet the needs and deadline for high volume of small orders.

Equipment Status

Equipments	HQ·Sihwa Factory	Busan Factory	Total
Sawing Machine	36, including H-2001	20, including H-1080	56
Hoist	21, including 30T	10, including 30T	31

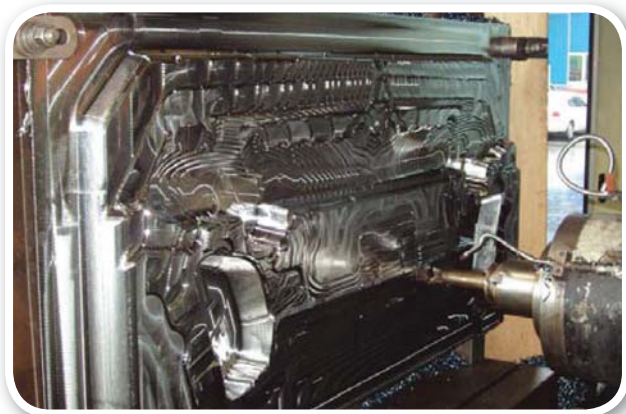
- Maximum Capacity : 2,000T x 2,000W x 6,000L
- Manufacturing Equipments : CNC Boring, PRANO Milling, Radial, etc.



H-2001 Sawing Machine



H-1700 Sawing Machine



Manufacturing Facility



Vehicle Fender Mould



Products

We stock our company up with the product of major domestic and international brands, also we can immediately provide the material best fit for use in best sizes, thanks to our diverse selection of manufacturing equipments.

Major Suppliers

Domestic	International
<p>SeAH Changwon Specialty Steel corporation Doosan Heavy Industrles & Construction Co.,Ltd. SeAH Besteel corporation Korea Iron & Steel Co., Ltd. SeAH Special Steel Co.,Ltd. Hyundai Steel Co, Ltd</p>	<p>(JAPAN) Daido Steel Co.,Ltd. Hitachi Metals,Ltd. NGK INSULATORS,Ltd. Sanyo Special Steel Co.,Ltd. Nippon Koshuha Steel Co.,Ltd. Kobe Steel,Ltd. JCFC (AUSTRIA) Bohler Bleche GMBH (TAIWAN) Gloria Material Technology Corp.</p>



HP 1A, 4A, 4MA

High Quality Plastic Mould Steel, Manufactured by Doosan Heavy Industries & Construction

Characteristics

- **HP1A**
 - Excellent machinability
- **HP4A(D1)**
 - Excellent machinability
 - Less residual stress and less deformation
 - Extreme hardness and superior wear resistance
- **HP4MA(D2)**
 - Excellent machinability
 - Less residual stress and less deformation
 - Uniform hardness throughout the cross section
 - Extreme hardness and superior wear resistance



Quality Properties

● Vacuum-Degassing Process

Our plastic mould steel, forged with ingots processed through vacuum-degassing, 1) are very clean, 2) has no pores, and 3) are not segregated and has no flaws.

● Chemical Composition

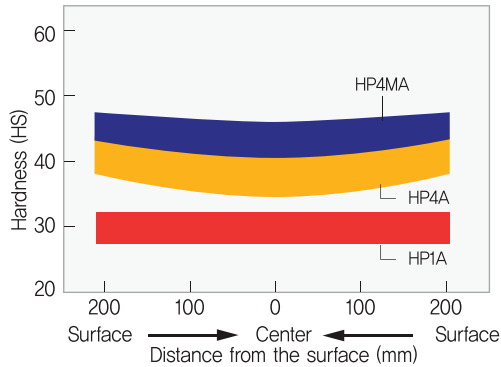
Material	Chemical Composition (wt%)				
	C	Ni	Cr	Mo	Special Alloys
HP1A	> 0.50	< 0.50	-	-	Added
HP4A(D1)	0.25 ~ 0.35	0.20 ~ 0.50	1.00 ~ 1.50	0.20 ~ 0.40	Added
HP4MA(D2)	0.25 ~ 0.35	0.20 ~ 0.50	1.50 ~ 2.00	0.30 ~ 0.60	Added

● Mechanical Properties

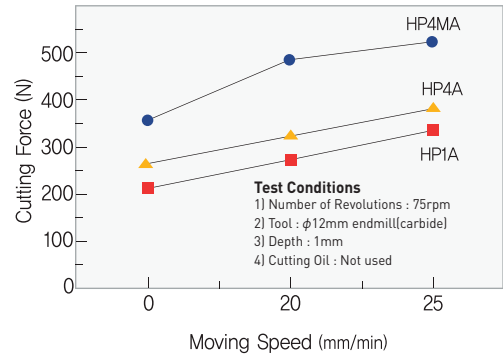
Material	Yield Point (N/mm ²)	Tensile Strength (N/mm ²)	Elongation (%)	Reduction of Area (%)	Impact Abso. Energy (Joule)	Surface Hardness
HP1A	350~450	700 ~ 800	> 15	> 35	> 15	HS 28 ~ 33
HP4A(D1)	650~800	800 ~ 900	> 15	> 40	> 60	HRC 28 ~ 32
HP4MA(D2)	750~900	900 ~ 1,100	> 15	> 40	> 90	HRC 31 ~ 34

Sectional Hardness Distribution

Small difference in the hardness of the surface and the center

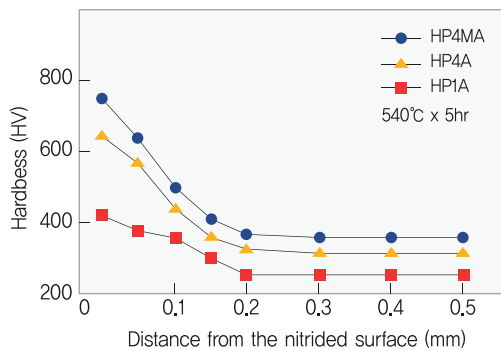


Machinability

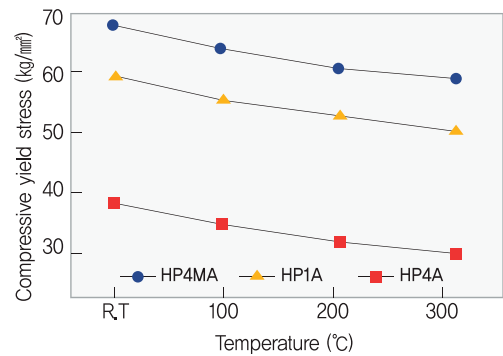


Nitriding Characteristics

The figure shows the nitriding curve by gas nitriding



High Temperature Compressive Properties



The defects caused during design change or using mold are dealt through welding. Welding strong steel requires caution and care, as they generally have low weldability. The table below shows the standard conditions for welding.

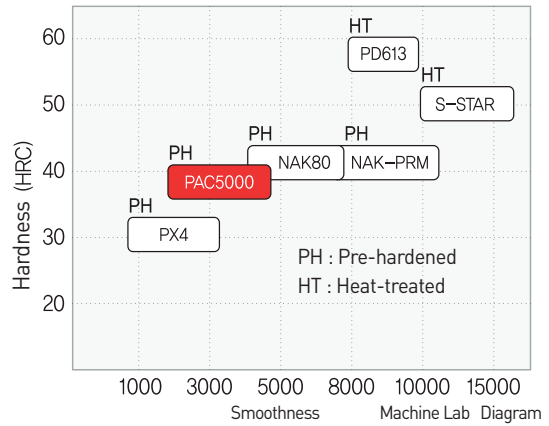
Category	Repair Welding			Note
	HP1A	HP4A(D1)	HP4MA(D2)	
Filler Metal	AWS ER70S-4 ER70S-6	AWS ER80S-B2 ER80S-G	AWS ER80S-B2 ER80S-G ER90S-B3	Diameter of the welding rod : 1.6φ, 2.4φ
Preheat Temperature	250±50°C (200-300)	300±50°C (200-350)	250±50°C (200-300)	Fuel Gas : LNG Fuel Pressure : 0.5kg/cm ²
Post Heat				TP HP1A : 270±20°C HP4A : 350±20°C HP4MA : 320±20°C
Post Weld Heat Treatment, PWHT				Conducted when good performance, such as Mirror Surface Finishing or Corrosion Protection Finishing is needed.

PAC5000

High Hardness, Pre-hardened General Use Plastic Mould Steel, Manufactured by DAIDO STEEL

Characteristics

- Smoothness**
 Smoothed to correspond to over #5,000
- Corrosion Prevention Process**
 Less corrosion stain after repair welding, and excellent surface finish
- Thermal Conductivity**
 High thermal conductivity enables the material to endure high cycle
- #5,000 Manual Grinding**



• PAC5000



• P20 40HRC Steel

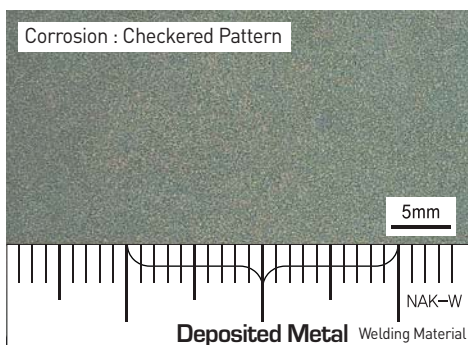


[General Grinding Process]

Turning and fraise → Grinding Wheel (#220-#320-#400) → Sandpaper (#320-#400-#600-#800-#1000-#1200-#1500) → Diamond Paste Polish (#1200-#1800-#3000-#5000)

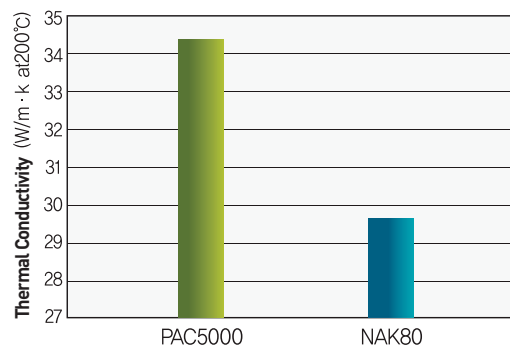
Smoother than other materials

Corrosion Prevention Process



Less corrosion stain after repair welding, and excellent surface finish

Thermal Conductivity



High thermal conductivity enables the material to endure high cycle

NAK80, 55

High Smoothness Plastic Mould Steel, Manufactured by DAIDO STEEL

Age hardenable, specially melted HRC40 pre-hardened highly functional precise plastic mould steel

Attributes and Main Applications

Category	NAK55	NAK80
Attributes	<ul style="list-style-type: none"> Heat-treated with HRC37-43 and ready to use Excellent machinability and surface Easy to grind after cutting and electrospark machining Great overlay weldability Lesser strain, fit for detailed moulding 	<ul style="list-style-type: none"> In addition to the attributes of NAK55 Excellent grindability Smooth and elaborate electrospark prevention surface
Main Applications	<ul style="list-style-type: none"> High-performance/detailed moulding Rubber moulding Press moulding Components of industrial machinery 	<ul style="list-style-type: none"> For products focused on Products focused on smoothness, including transparent products Products prioritizing electrospark prevention surface

Chemical Composition

DAIDO Code	JIS Code	Chemical Composition (wt%)							
		C	Si	Mn	Ni	Cu	Mo	Al	Additive
NAK55	-	0.15	0.3	1.5	3.0	1.0	0.3	1.0	Additive S
NAK80	-	Grindability enhancing additive "S" not added							

Physical Attributes

• Coefficient of Expansion ($\times 10^{-6}/^{\circ}\text{C}$)

DAIDO Code	20~100°C	20~200°C	20~300°C
NAK55 NAK80	11.3	12.5	13.4

• Thermal Conductivity (W/m·k)

DAIDO Code	20°C	100°C	200°C	300°C
NAK55 NAK80	38.9 (0.093)	39.3 (0.094)	41.9 (0.100)	32.7 (0.102)

() cal/cm·sec·°C

Magnetic Attributes

DAIDO Code (JIS)	Max. Magnetic Permeability	Magnetic Saturation (G)	Residual Magnetism (G)	Coercivity (Oe)
NAK55 NAK80	380	16,350	8,500	14.0
(S55C)			13,800	15.0

() G=10⁻⁴ T



NAK-PRM

40HRC High Hardness Smooth Steel for Plastic Mould, Manufactured by DAIDO STEEL

Characteristics

Smoothness

Excellent smoothness, minimal irregularities on the surface (orange peel effect), fit for applications in over #8,000

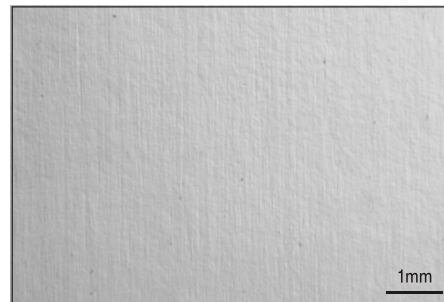
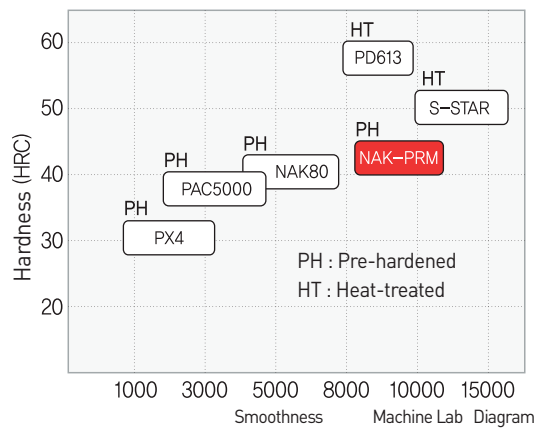
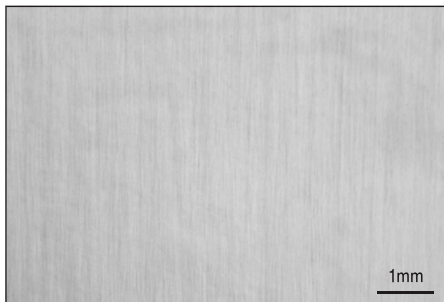
Corrosion Prevention

Less corrosive compared to NAK80

Durability

Shorter distance between the surface and heating and cooling hole, Applicable in moulds which need durability including Heat&Cool technique

Smoothness



[General Grinding Process]

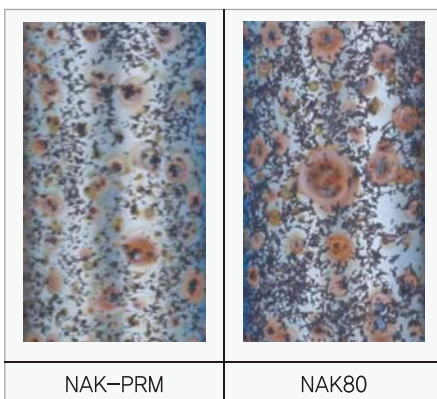
Turning and fraise → Grinding Wheel (#220-#320-#400) → Sandpaper (#320-#400-#600-#800-#1000-#1200-#1500) → Diamond Paste Polish (#1200-#1800-#3000-#5000-#8000)

Lesser Pin-hole, less irregularities, excellent quality

Corrosion Prevention

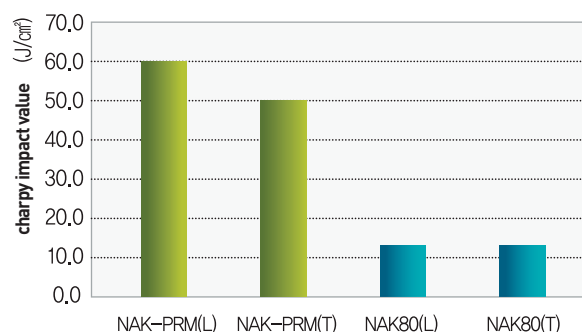
Test Conditions

Temp.: 50 °C
Humid: 98%
Time: 24 H



Less Corrosive compared to NAK80

Durability



Higher toughness compared to NAK80

Overview

This porous plastic mould steel was developed to reflect the complication and the thinness of molded plastics due to the needs of high-function and detailed plastic parts, and also to correspond with the recent decrease in the number of parts.

Characteristics

● **Excellent breathability**

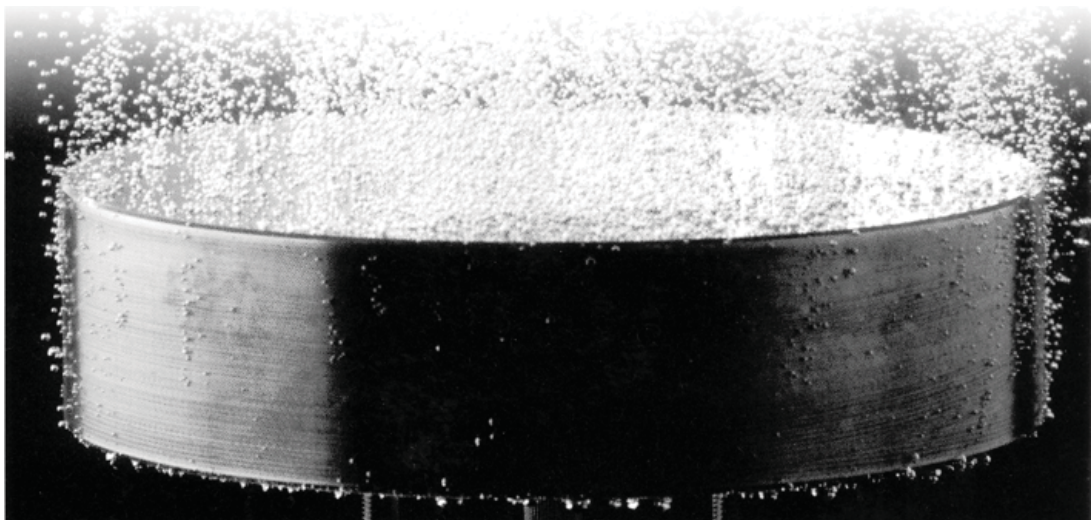
Using the "Powder HIP technique" which sinters the metal powders in high temperature and pressure through HIP(Hot Isostatic Pressing), the steel exhibits excellent air permeability due to its porous state.

● **Excellent corrosion resistance and abrasion resistance**

As a powder metallurgy stainless tool steel, the material is also applicable on industrial resin moulds.

Physical Attributes

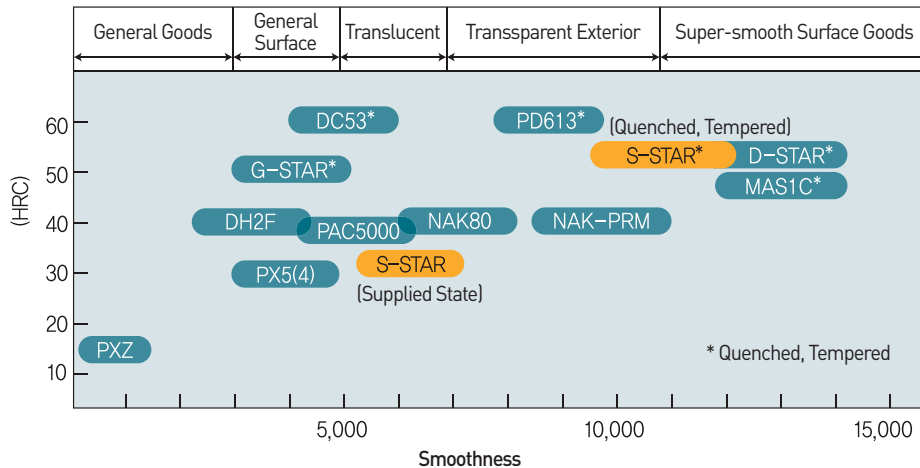
Items	Measures	Unit
Specific Gravity	6.2 - 6.6	
Coefficient of Expansion	12-13X10 ⁻⁶ (293-423K)	1K
Thermal Conductivity	16 - 18(Room Temperature)	W/m · K
Flexural Strength	343(Pre-heat treatment) - 686(Post-heat treatment)	MPa
Matrix Hardness	25(Pre-heat treatment) - 50(Post-heat treatment)	HRC
Avg. size of pores	7μ-10μ	
Porosity	15±3%	



S-STAR

Super-smooth Surface Plastic Mould Steel, Manufactured by DAIDO STEEL

Supplied in 32HRC Rre-hardened, ready to use, and 53HRC after Q/T heat treatment.
Excellent corrosion resistance and smoothness in both states.



Supplied State

DAIDO Code (JIS)	Supplied State (Hardness)	Chemical Composition (%)				
		C	Si	Cr	Mo	V
S-STAR (SUS420J2 Enhanced)	Pre-hardened (31~34HRC)	0.38	0.9	13.5	0.1	0.3

S-Star Attributes

Alloy Design
ESR(Electro-slag Remelting)
Manufacturing(Homogenization Processing)

1. Excellent Corrosion Resistance (Martensite Stainless Steel)
2. Heat-processed strength : max. 53HRC (Quenched at 1030°C)
3. Super-smoothness
4. Minute post-heat treatment strain(smaller than 0.03%)
5. Homogeneous internal structure
6. Decent corrosion prevention and electrospark machining
7. Pre-hardened 32HRC usable

Mechanical properties

	(HRC)	
	32	53
Tensile Strength (N/mm ²)	1100	1940
0.2% Proof Stress (N/mm ²)	890	1540
Elongation(%)	15	9
Bending (%)	55	28
Impact Value 2uE20°C (J/cm ²)	60	25

Heat Conductivity

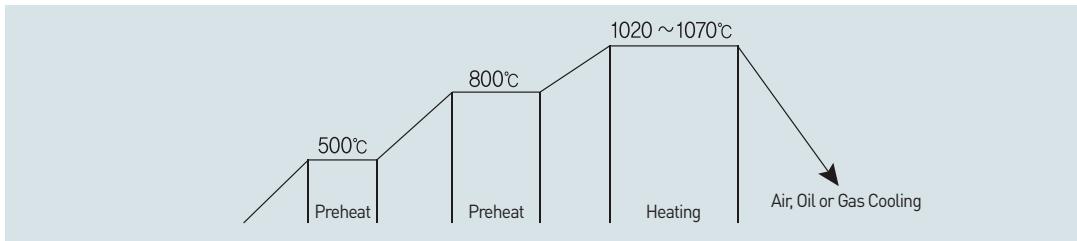
Heat Conductivity (W/m·K)				
20°C	100°C	200°C	300°C	400°C
23	23.4	23.9	24.7	25.1

Coefficient of Expansion

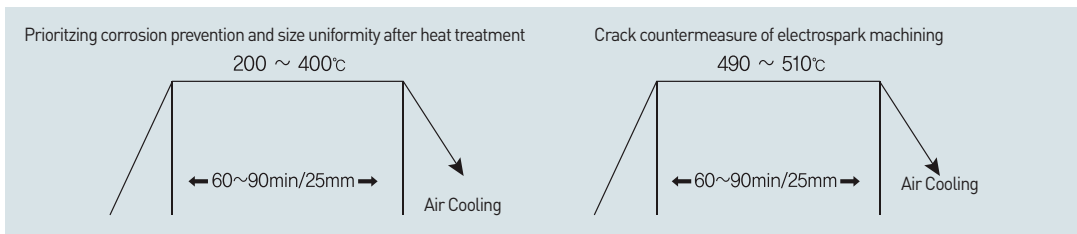
Coefficient of Expansion(x10 ⁻⁶ /°C)			
20~100°C	20~200°C	20~300°C	20~400°C
10.8	11.1	11.3	11.5

Heat Treatment Conditions and Hardness

Quenching

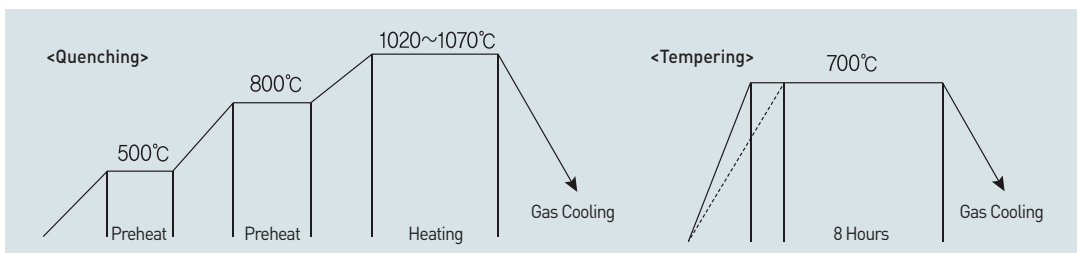


Tempering (Two tempering is preferred at both low and high temperatures)



- (Note)
- Temper at below 400°C for best corrosive prevention
 - Temper at 490~510°C to prevent cracks from electrospark machining
 - Temper at low degrees(200~400°C), or undergo stabilizing for best age hardness
 - Undergo preliminary heat treatment, and perform main treatment after surface finishing for best finishing touches

Pre-heat Treatment



- (Note)
- Does not assure lower than $\pm 0.01\%$ strain rate, as the strain rate may vary according to the mould size and heat treatment attributes

Welding Method

Heat Treatment	Welding Rod (For TIG)	Heat Treatment	
		Pre-heat	Post-heat
Pre-hardened (32HRC)	AWS : ER420 (JIS SUS420J2)	200~250°C	650°C
Quenched and Tempered (52HRC)	AWS : ER420 (JIS SUS420J2)	200~250°C	510°C X 2 (Prevention of cracks from electrospark machining) 250°C X 2 (For best corrosive prevention and strain rate)

ULTRA, SUPRA, PLUS

Super-hard Beryllium Copper Alloy for Plastic Mould, Manufactured by NGK

Characteristics

- Excellent Thermal Conductivity
- Excellent corrosion and wear resistance
- Decent smoothness
- Decent gas soot resistance
- Decent machinability and weldability
- Comparably excellent high-temperature hardness for mass-produced steel
- Significant shortening of molding cycle time
- Elimination and minimization of cooling circuit
- Minimization of strain and bend of molding
- Elimination of the Hot Spot



Chemical Composition

Type	UNS No	Chemical Compositions (wt%)	
NGK PLUS	C17510	Be Ni Cu	0.20 ~ 0.60 1.40 ~ 2.20 Bal
NGK SUPRA and NGK ULTRA	C17200	Be Ni + Co Ni + Co + Fe Cu	1.80 ~ 2.00 More than 0.20 Below 0.60 Bal

Major Application

PLUS	SUPRA/ULTRA
<ul style="list-style-type: none"> • Low Pressure Blow Molding • Low Pressure Injection Molding • Special Steel or Aluminum Molding Core • Injection Nozzle • Hot Runner Manifold • Aluminum Die Cast Plunger 	<ul style="list-style-type: none"> • High Pressure Blow Molding • High Pressure Injection Molding • Special Steel or Aluminum Molding Core • Injection Nozzle • Hot Runner Manifold

Physical Attributes

Type	Thermal Conductivity (W/m°C)	Coefficient of Expansion (1/°C)	Modules of Elasticity (KN/°C)	Hardness (HRC)	Tensile Strength (N/°C)	Elongation (%)
PLUS	245	17.6 X 10 ⁻⁶	132	HB100	800	3%
SUPRA	131	17.8 X 10 ⁻⁶	127	HRC30	1100	15%
ULTRA	105	17.8 X 10 ⁻⁶	127	HRC40	1200	7%

High Performance Precipitation Hardening Copper Alloy Metal, Manufactured by NGK

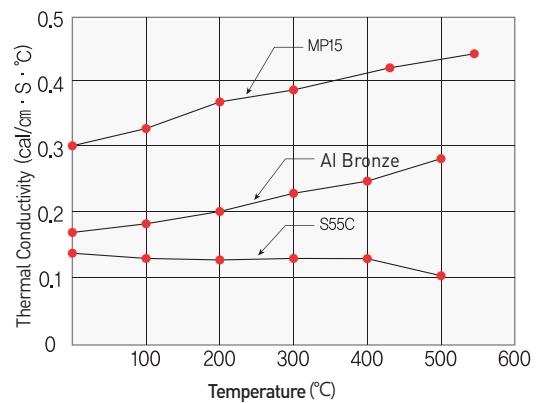
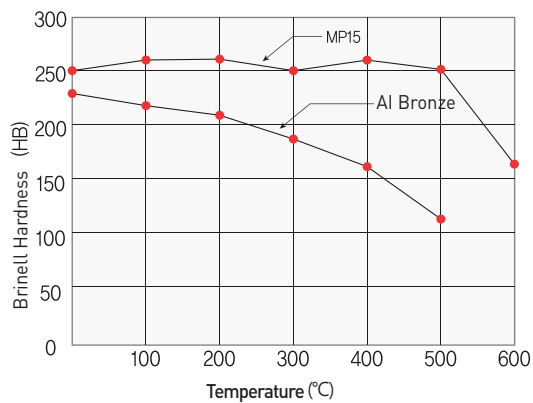
Characteristics

- Plastic Ejection Mould Steel, equipped with excellent thermal conductivity and balanced high temperature hardness
- Enhances the efficiency of heating and cooling of moulds, and reduces the time needed for casting and molding
- Enhances the efficiency of heat strain prevention and maintenance
- Thins casted and molded goods, and improves the goods' quality
- Excellent machinability, electrospark machining, and weldability

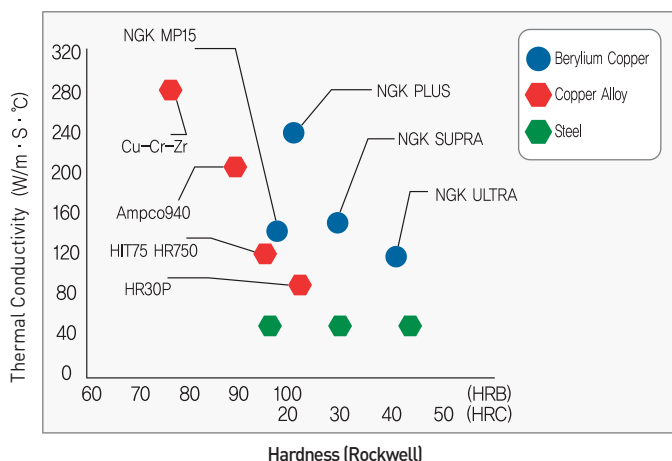
Physical Attributes

MP15	Specific Gravity	Specific Heat (cal/g·°C)	Thermal Conductivity(W/m·K)	Coefficient of Expansion(20-500°C)	Melting Temperature(°C)
	8.6	0.1	120	17.6×10^{-6}	1010 ~ 1070
MP15	Hardness (HRC)	Tensile Strength(N/°C)	0.2% Proof Strength(N/°C)	Total Module of Elasticity(N/°C)	Elongation(%)
	20	650 ~ 750	530 ~ 630	11.8×10^4	5 ~ 15

High Temperature Attributes



Welding Material Chart



Cold Work Tool Steel

STD11

Representative High Alloy Tool Steel

General Properties

- High cleanliness and quality
- Homogeneous structure
- Uniform Hardness
- Excellent wear resistance
- High strength

Chemical Compositions

Grade	Chemical Compositions (wt%)								
	C	Si	Mn	P	S	Ni	Cr	Mo	V
STD11	1.40	/0.40	/0.60	/0.030	/0.030	-	11.00	0.80	0.20
	1.60						13.00	1.20	0.50
D2	1.40	0.10	0.10	/0.030	/0.030	-	11.00	0.70	0.50
	1.60	0.60	0.60				13.00	1.20	1.10

Coefficient of Thermal Expansion

Average Expansion Coefficient ($\times 10^{-6}/^{\circ}\text{C}$)			
100°C	200°C	300°C	400°C
12.0	12.5	12.8	12.9

Heat Treatment Conditions and Hardness

Heat Treatment			Hardness	
Annealing	Quenching	Tempering	Annealing (HB)	Q/T (HRC)
800 - 870°C Slow Cooling	1000 - 1050°C Air, Gas, Oil Cooling	550 - 680°C Air Cooling	≤255	≥58

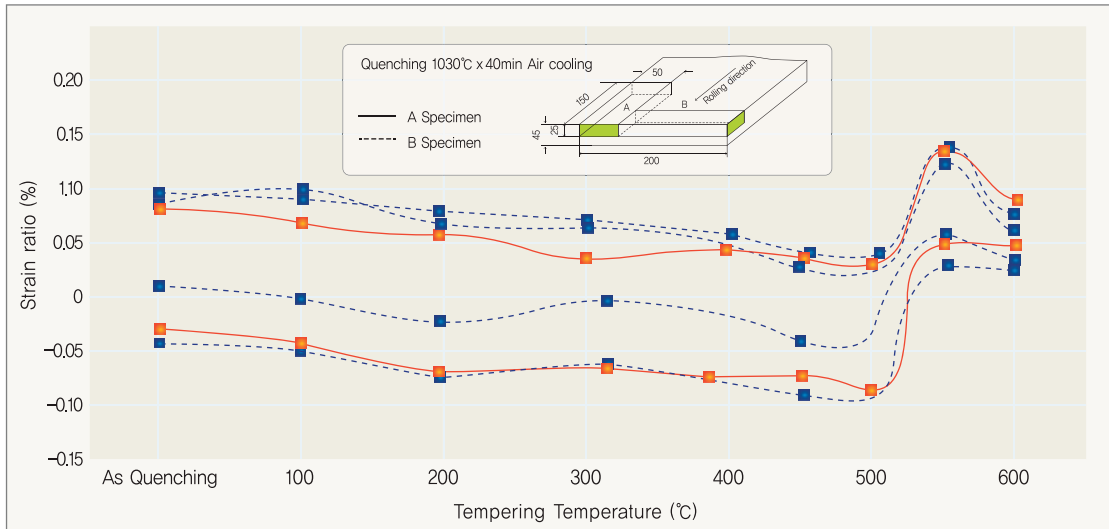


PUNCH

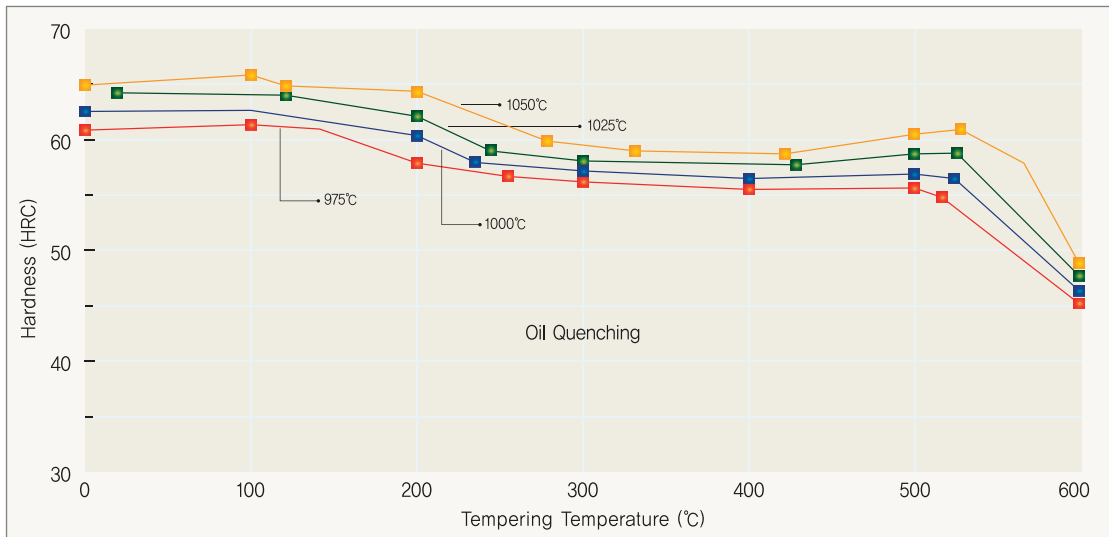
CUTTER

SHEAR BLADE

The Strain Ratio of Heat Treatment



Heat Treatment Hardness Curve



ROLL

BLANKING DIE

Cold Work Tool Steel

DC53

High Hardness/High Toughness New Cold Work Die Steel, Manufactured by DAIDO STEEL

Overview

A new material perfectly supplementing the lack of hardness in high temperature tempering and lack of toughness, the weaknesses of the existing cold work tool die steel SKD11. Developed with a superior material, enabling overall substitution of SKD11 in the General and Detailed Mold Steel Industry.

Basic Properties

- Higher Hardness
- Twice the toughness of SKD11
- Improving giant carbide of SKD11
- Other Properties
 - Superior machinability and grindability
 - Superior heat treatment
 - Superior wire electrospark machinability
 - Superior surface smoothing process
 - Superior weld repair

Major Applications

Shearing, hole punch, dies, detailed mold, gauge, etc.

Heat Treatment Conditions and Hardness

Usual quenching

Quenching

*Heating (Refer to the right table)

Standard heating time (salt bath)

Dia.thickness(mm)	Immersing time(min)
5	5 - 8
10	8 - 10
20	10 - 15
30	15 - 20
50	20 - 25
100	30 - 40

Tempering

Repeated twice

Vacuum quenching

Quenching

Heating (Refer to the right table)

Standard heating time

Thickness(mm)	Heating time
100mm and under	20 - 30min/25mm
Over 100mm	10 - 20min/25mm

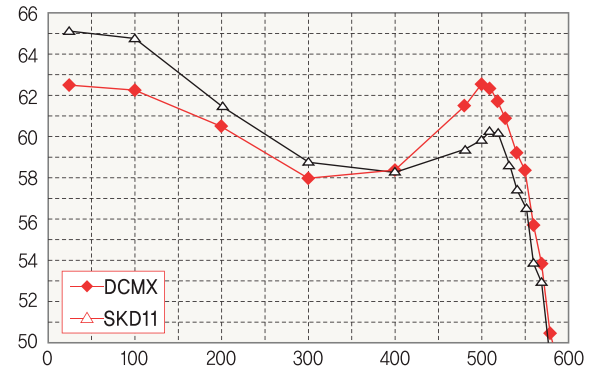
Tempering

Repeated twice

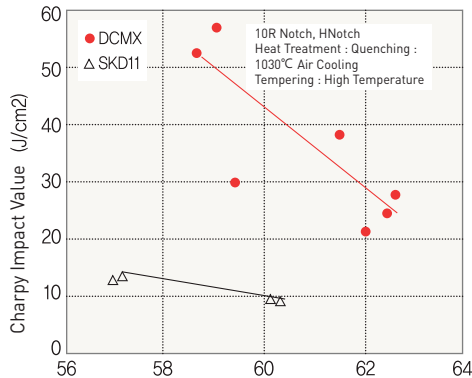
Characteristics

- 1. High Hardness**
62 HRC Hardness Acquirable, high wear resistance
- 2. High Toughness**
High toughness, strong to breaks or cracks
- 3. Low Anisotropy**
Extremely low anisotropy enables easier size modification after heat treatment
- 4. Machinability**
Added free-machining element and coarsened char enhances machinability

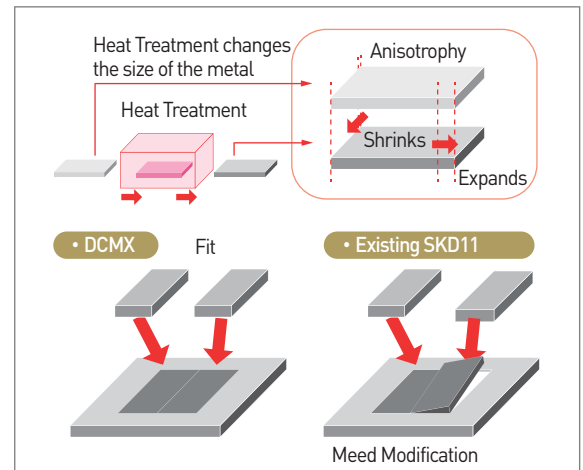
62HRC Hardness Acquirable



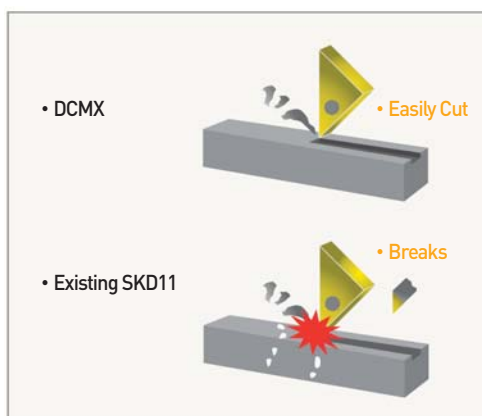
Higher toughness compared to SKD11



Low anisotropy enables easier size modification after heat treatment



Contributes to the reduction of mold lead time



Heat Treatment Conditions and Hardness

Re-forging Temperature(°C)	Heat Treatment		
	Annealing	Quenching	Tempering
900 ~ 1160	920 ~ 980 Slow Cooling	1000 ~ 1050 Air Cooling Recommend 1030	Low : 50 ~ 200 High : 480 ~ 560 Air Cooling more than 2 times
Stabilization Process (°C)	Hardness		
	Annealing	Quenching, Tempering	
400X >1H	≤235HB	56-61HRC	

Cold Work Tool Steel

SKS3/SK3-4

Low Alloy Tool Steel / Carbon Tool Steel

Characteristics

Type	Characteristics	Applications
SKS3	Used where alloy tool steel is needed for decent hardness.	Cold Work Mold Dies, Blanking Dies, Bending Dies, Master Tool, Forming Roll, Broach
SK3	Easiest to process among all tool steel when annealed, and has high impact resistance.	Chisel, Drill, Hammer, Hole Punch, Blanking dies, Tab

Chemical Composition

Type	C	Si	Mn	P	S	Cr	W	Ni	Mo	V
SKS3	0.90~1.00	≤0.35	0.90~1.20	≤0.030	≤0.030	0.50~1.00	0.50~1.00	-	-	-
SK3	1.00~1.10	≤0.35	≤0.50	≤0.030	≤0.030	-	-	-	-	-
SK4	0.90~1.00	≤0.35	≤0.50	≤0.030	≤0.030	-	-	-	-	-

Heat Treatment Conditions and Hardness

Type	Temperature of Treatment (°C)			Hardness		Applicability
	Annealing	Quenching	Tempering	Annealing (HB)	Tempering (HRC)	
SKS3	750~800 Slow Cooling	800~850 Oil Cooling	150~200 Air Cooling	≤ 217	≥ 60	TAP, DIES, GAUGE
SK3	750~800 Slow Cooling	760~820 Water Cooling	150~200 Air Cooling	≤ 212	≥ 63	TAP, GAUGE
SK4	740~760 Slow Cooling	760~820 Water Cooling	150~200 Air Cooling	≤ 207	≥ 61	Woodcraft Drill, Pen-tip

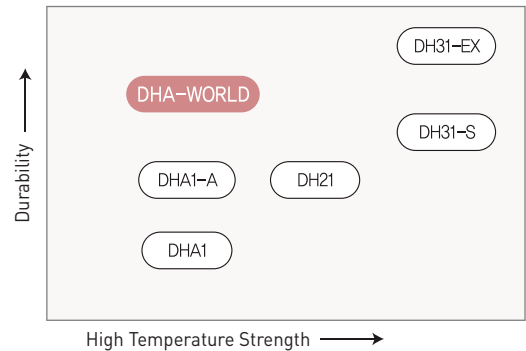
Characteristics

1. Excellent quenching property

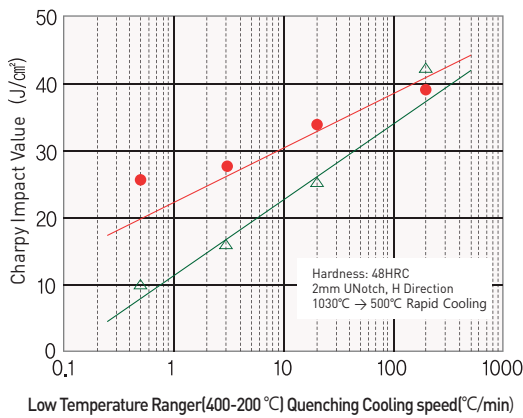
Optimization of chemical compound and new manufacturing technology significantly enhanced quenching property, allowing easier heat treatment and high toughness on the center of large-scale moulds

2. Heat Checking Resistance

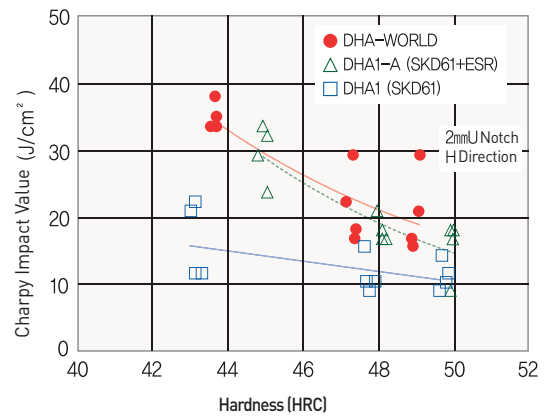
As the material has high toughness, with the durability equal of or over DHA1-A(SKD61 ESR), the steel can enhance heat checking resistance.



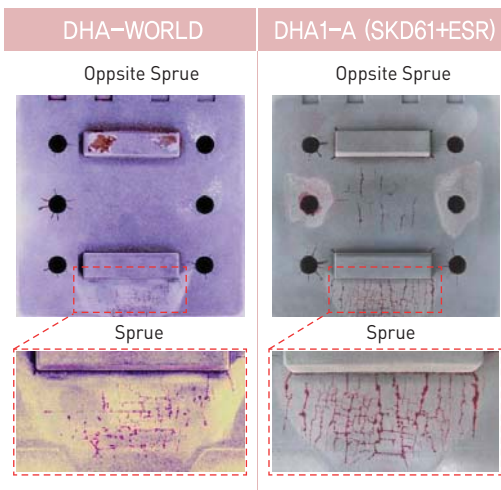
High toughness, even when slowly cooled due to excellent quenching property



Excellent toughness, even in the center of large molds(200x600x300mm)



Good Heat Checking Resistance (10000 Times : 42HRC)



Heat Treatment Conditions and Hardness

Forging Temperature (°C)	Conditions of Heat Treatment		
	Annealing	Quenching	Tempering
900~1200	820~870 Slow Cooling	1000~1050 Air Cooling	550~650 Air Cooling
Hardness		Transformation Point(°C)	
Annealing	Quenching and Tempering	Ac	Ms
<229HB	35~53 HRC	815~875	300 Austenizing 1030°C

Hot Work Tool Steel

STD61

Representative High Reliability General Use Hot Work Tool Die Steel

General Properties

- Excellent toughness and red hardness
- Excellent wear resistance
- Minimal heat treatment transformation
- Contains abundant Vanadium, fit for hot work die steel
- Fit for aluminum and magnesium extrusion dies

Chemical Compositions

Grade	Chemical Compositions (wt%)								
	C	Si	Mn	P	S	Ni	Cr	Mo	V
STD61	0.32	0.80	/0.50	/0.030	/0.030	-	4.50	1.00	0.80
	0.42	1.20					5.50	1.50	1.20
H13	0.32	0.80	0.20	/0.030	/0.030	/0,75	4.75	1.10	0.80
	0.45	1.25	0.60				5.50	1.75	1.20

Coefficient of Thermal Expansion

Average Expansion Coefficient ($\times 10^{-6}/^{\circ}\text{C}$)						
~100°C	~200°C	~300°C	~400°C	~500°C	~600°C	~700°C
9.53	10.5	11.6	12.3	12.9	13.2	13.6

Heat Treatment Conditions and Hardness

Heat Treatment			Hardness	
Annealing	Quenching	Tempering	Annealing (HB)	Q/T (HRC)
800 - 870°C Slow Cooling	1000 - 1050°C Air, Gas, Oil Cooling	550 - 680°C Air Cooling	≤229	≤53

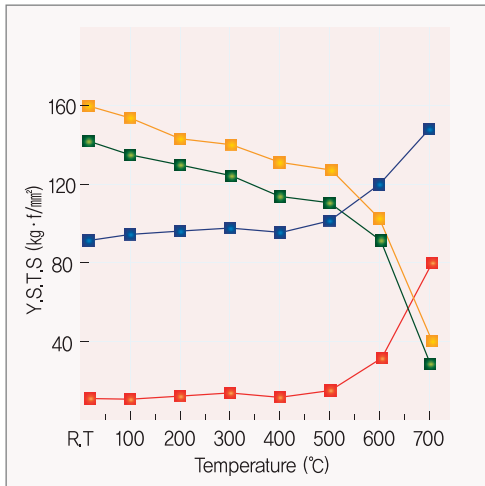


EXTRUSION DIE

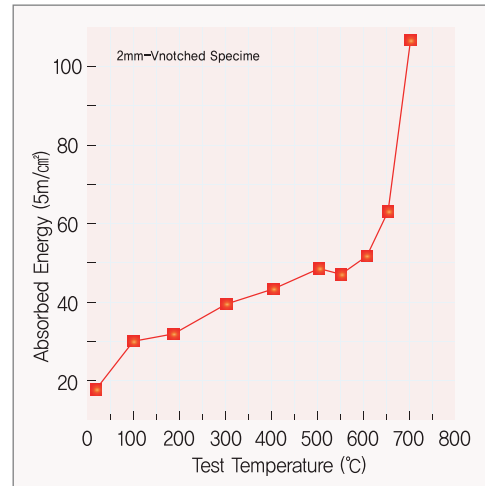


DIE CASTING DIE

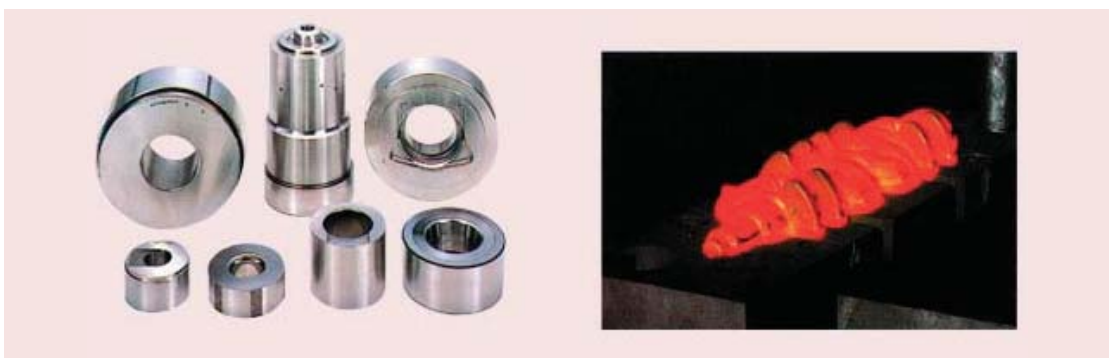
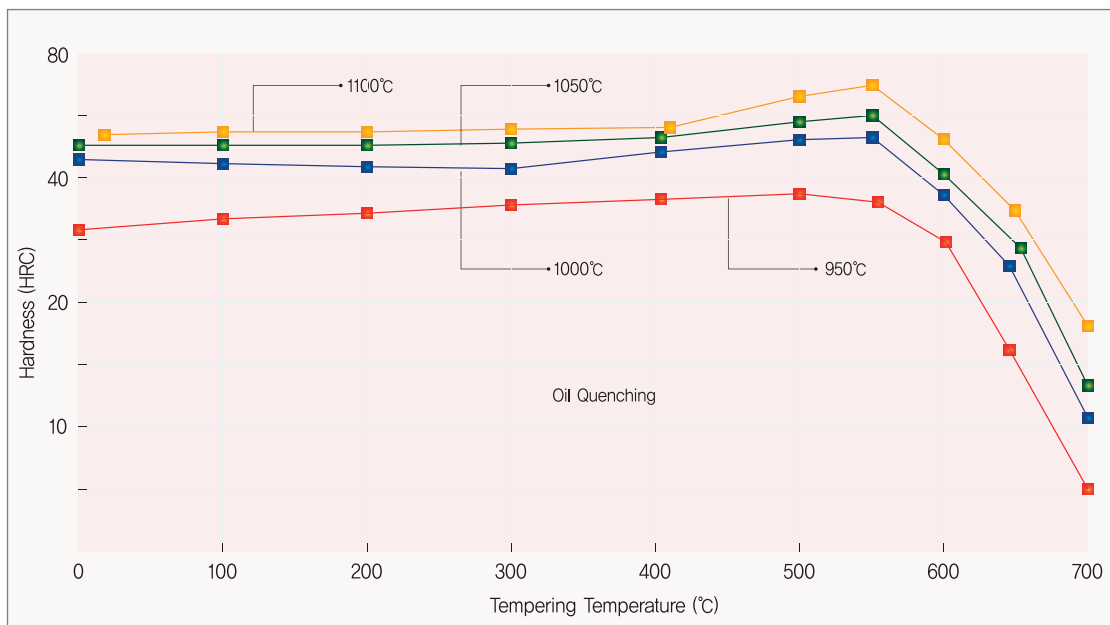
Physical properties in high temperatures



Impact value in high temperatures



Heat Treatment Hardness Curve



DIE CASTING DIE

HOT FORGING DIE

DH SERIES

High Quality Hot Work Tool Steel, Manufactured by DAIDO STEEL

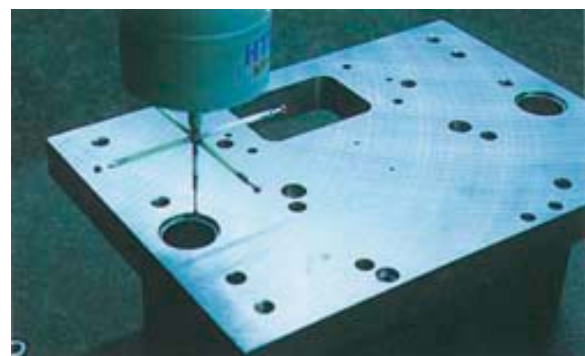
DH2F Free-cutting Hot Work Die Steel

Attributes

- Skin-passed to HRC37~41(Surface hardness), does not need heat treatment. Fit for production of complex and detailed mold or components which
- Excellent cuttability, easy to cut and shape
- Reduction of mold production days and cost reduction
- Excellent thermal shock and corrosion resistance
- Surface processing significantly enhances wear and corrosion resistance

Major Applications

- Aluminum/zinc die casting mold, die casting mold component, aluminum extrusion mold, plastic/press mold, die plate/stripper mold, etc.



DH31-S High Performance Heat Work Mold Steel

Attributes

- High softening resistance and excellent thermal shock resistance.
- Excellent quenching property leads to high toughness of large-scale molds
- Better cuttability compared to existing materials

Major Applications

- Long life-precise-large scale aluminum die casting mold, hot forge mold, aluminum expulsion mold, aluminum die casting pin, plunger sleeve, etc.

Heat Treatment Conditions and Hardness

- Heat treatment conditions identical to Hot Work Tool Steel SKD61

Heat Treatment Conditions(°C)			Transformation Point (°C)		Hardness (°C)	
Annealing	Quenching	Tempering	Ac	Ms	Annealing (HB)	Quenching and Tempering (HRC)
820 - 870°C Slow Cooling	1000 - 1050°C Air, Gas, Oil Cooling	550 - 880°C Air Cooling	805 ~885	315	≤ 235	≤ 53

* Faster cooling speed results in higher toughness

DH32 High Performance Heat Work Mold Steel

DH32 is a new hot work die steel which improved the hardness in the high temperature, the weakness of hot work die steel SKD61, and enhanced the toughness compared to matrix series steels, to be applied from general use to high performance use.

Attributes

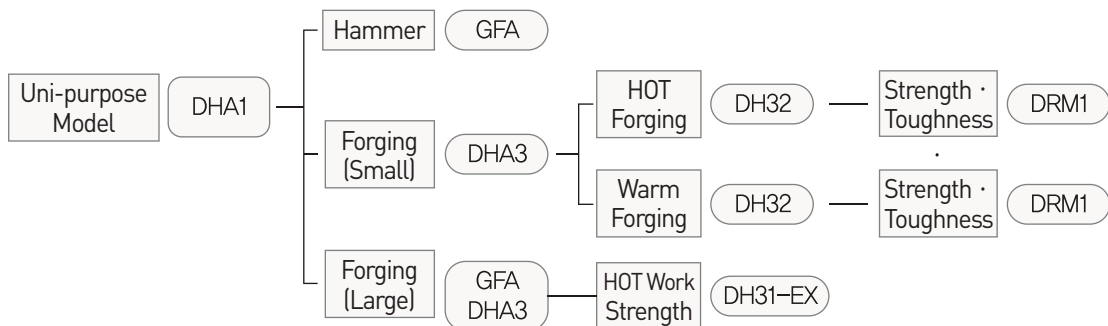
- Enables usual hardness of between HRC50~54, and high-hardness design, 3~5 points higher than SKD61
- 1.5 time higher toughness compared to matrix high speed series
- Heat treatment condition same to the heat treatment conditions of SKD61

Forging Temperature (°C)	Heat Treatment Condition			Hardness	
	Annealing	Quenching	Tempering	Annealing (HB)	Quenching and Tempering (HRC)
1100~900	820 - 870°C Furnace Cooling	1000~1050 Oil cooling (Forced Air cooling)	550~650 (Air cooling)	≤ 229	≤ 54

Major Applications

- Upsetting die for bearing race, punch die for final gear, die mold for gear molding
- Die for gas cylinder valve, sliding punch die for gear molding, punch and die for wheel hub
- Die for bearing insert pin, punch die for bearing race

Selection Standards



PUNCH

DIE

HMD1

Low Alloy Cold Work Mold Steel

Characteristics

- Surface hardening by flame treatment
- No pretreatment such as normalizing
- High fracture toughness and wear resistance from flame hardening treatment
- Excellent machinability with formation of fine carbides

Quality Properties

Chemical Composition

Chemical Compositions (wt%)								
C	Si	Mn	P	S	Ni	Cr	Mo	Special Alloys
0.70 ~ 0.80	0.90 ~ 1.05	0.70 ~ 0.80	≤0.020	≤0.020	≤0.15	1.00 ~ 1.10	0.20 ~ 0.25	Added

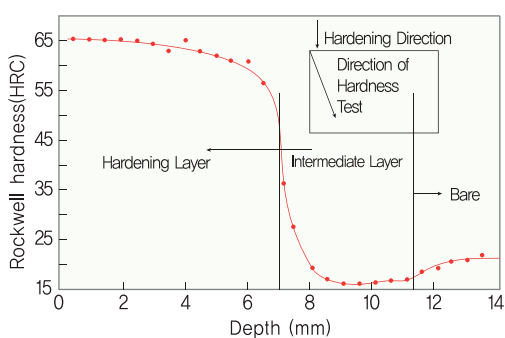
Heat Treatment Conditions and Hardness

Heat Treatment			Hardness	
Annealing	Hardening	Tempering	Annealing (HB)	Tempering (HRC)
825~875 Slow cooling	875~950 Air cooling	150~200 Air cooling	≤235	≥61

Mechanical Properties

Yield point (kg f/mm ²)	Tensile Strength (kg f/mm ²)	Elongation (%)	Reduction of Area (%)	Impact value (kg f-m/cm ²)	Hardness (HB)
≥35	≥70	≥25	≥45	≥1.70	≥200

Hardenability



※ Hardness variation on depth after surface hardening treatment.



General Properties

- High cleanliness and quality
- High thermal shock resistance
- Excellent wear resistance
- Uniform hardness



Quality Properties

Chemical Compositions

(Unit : Wt%)

C	Si	Mn	Cr	Ni	Mo
0.45 ~ 0.60	<0.40	0.60 ~ 1.10	0.70 ~ 1.70	1.30 ~ 2.50	0.40 ~ 1.00

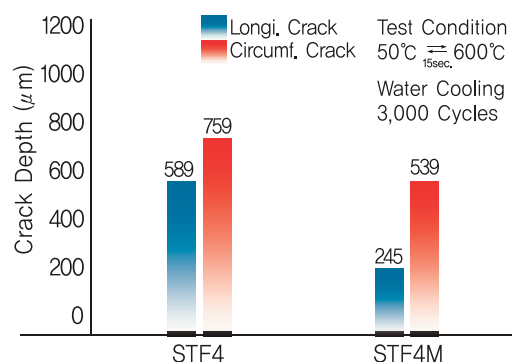
Heat Treatment Conditions and Hardness

Heat Treatments			Hardness
Annealing	Quenching	Tempering	Quenching + Tempering HRC
750~850°C	840~880°C	500~650°C X 2times	38.0 ~ 43.0

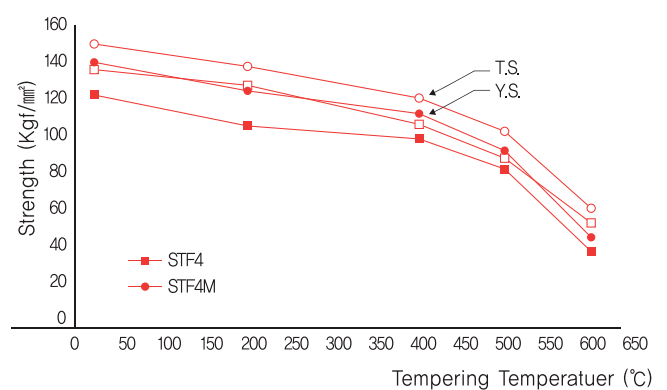
Physical Properties

Temperature (°C)	Room Temperature	~ 200	~ 400	~ 600	~ 700
Coefficient of Thermal Expansion (10 ⁻⁶ /°C)	-	12.1	13.1	13.5	13.8
Thermal Conductivity (W/m · K)	35.8	38.3	37.5	35.8	35.0

Thermal Shock Properties



Mechanical Properties



Bearing Steel

SUJ2

High Carbon Chromium Bearing Steel

Products and Characteristics

Type	Characteristics	Applications
SUJ2	High carbon chromium steel with high wear and impact resistance, used for ball bearing and roll bearing manufacturing. Has very small carbide granules, as the spheroidization of carbides result in significant impacts on the performance.	BALL BEARING, ROLLER BEARING, DRAWING DIE, GUIDE PIN for DIE

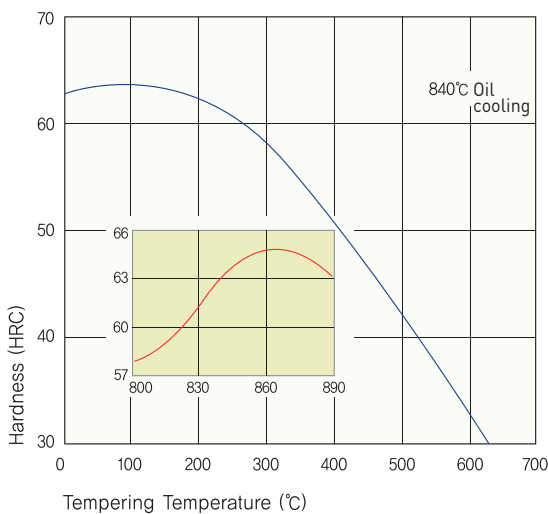
Chemical Compositions

Grades	C	Si	Mn	P	S	Cr	Mo
SUJ2	0.95~1.10	0.15~0.35	0.20~0.50	below 0.025	below 0.020	1.30~1.60	-

Heat Treatment Conditions and Hardness

Grades	Forging Temperature	Annealing	Quenching	Tempering	Annealing (HB)	Annealing (HRB)	Quenching (HRC)	Tempering (HRC)
SUJ2	850~1,100 (Slow Cooling)	780~810	800~840	140~180	≤201	≤94	63~65(Roll)	≥60

Heat Treatment Curve



- SUJ2 is used on rolls for rolling works or cold work molds due to its high wear resistance. Other products include SUJ3, 4, 5. SUJ3 contains more manganese, has higher quenching property, and therefore is fit for large-scale machinery. SUJ4, 5 are Mo-series metal, and has excellent tensile strength, excellent elasticity, and excellent wear resistance.

SM20C · 45C, SCM4 · 21, SNCM8 · 21 etc.

Structural Steel for various machine components, gears, and shafts

Properties of Structural Carbon Steel

Structural Carbon Steel has excellent physical attributes. Enhanced by heat treatment (generally through the process of annealing, quenching, and tempering), structural carbon steel contains improvement additive alloy elements. Usually used on components with good toughness, including shafts, gears, and nuts.

Chemical Compositions

Grades	C	Si	Mn	P	S	Cr	Mo	Ni	W	V
SM20C	0.18~0.23	0.15~0.35	0.30~0.60	≤0.030	≤0.035	-	-	-	-	-
SM45C	0.42~0.48	0.15~0.35	0.60~0.90	≤0.030	≤0.035	-	-	-	-	-
SCM440(4)	0.38~0.43	0.15~0.35	0.60~0.85	≤0.030	≤0.030	0.90~1.20	0.15~0.30	-	-	-
SCM415(21)	0.13~0.18	0.15~0.35	0.60~0.85	≤0.030	≤0.030	0.90~1.20	0.15~0.30	-	-	-
SNCM439(8)	0.36~0.43	0.15~0.35	0.60~0.90	≤0.030	≤0.030	0.60~1.00	0.15~0.30	1.60~2.00	-	-
SNCM220(21)	0.17~0.23	0.15~0.35	0.60~0.90	≤0.030	≤0.030	0.40~0.65	0.15~0.30	0.40~0.70	-	-

Heat Treatment Conditions and Hardness

Type	Heat Treatment Temperature (°C)		Tensile Test (No.4 tensile test piece)				Impact test (No.3)	Hardness Test
	Quenching	Annealing	Yield Point kgf/mm ² (N/mm ²)	Tensile Test kgf/mm ² (N/mm ²)	Elongation %	Torsion %	Impact test kgfm/mm ² (J/cm ²)	Hardness HB
SM20C	-	-	≥25	≥41	≥28	-	-	116~174
SM45C	820~870°C water cooling	550~650°C Rapid cooling	≥35	≥48	≥20	-	-	167~229
SCM440(4)	830~880 Oil Cooling	530~630	≥85 (≥834)	≥48 (≥980.7)	≥12	≥45	≥6 (≥59)	285~352
SCM415(21)	1 st 850~900 Oil 2 nd 800~850 Oil Or maintain 925 then 850~900 Oil Cooling	150~200 Air Cooling	-	≥85 (≥834)	≥16	≥40	≥7 (≥69)	235~321
SNCM439(8)	820~870 Oil cooling	580~680	≥90 (≥883)	≥100 (≥980.7)	≥16	≥45	≥7 (≥69)	293~352
SNCM220(21)	1 st 850~900 Oil 2 nd 800~850 Oil	150~200 Air Cooling	-	≥85 (≥834)	≥17	≥40	≥6 (≥59)	248~341

High Speed Tool Steel

SKH51, SKH55, SKH59

Representative high strength, high toughness, high wear resistance tool steel

Products and Characteristics

Type	Characteristics	Applications
SKH51	SKH51 is used on cutting machines, and other uses which require wear resistance. Is abundant in elements which can withstand high and mid-speed cutting.	CUTTING MACHINE DRILL, REAMER, ENDMILL, HOB, CUTTER, BITE, PUNCH, TAP, BROACH, etc.
SKH55	SKH55 is abundant in elements such as W, Mo, Cr, Co, and V, which can withstand high and mid-speed cutting. Used in difficult-to-cut material manufacturing tool.	
SKH59	Mo-Co series high speed tool steel equipped with excellent tensile strength, toughness, high hardness, and high cutting resistance. Used in various shredding and cutting tools.	

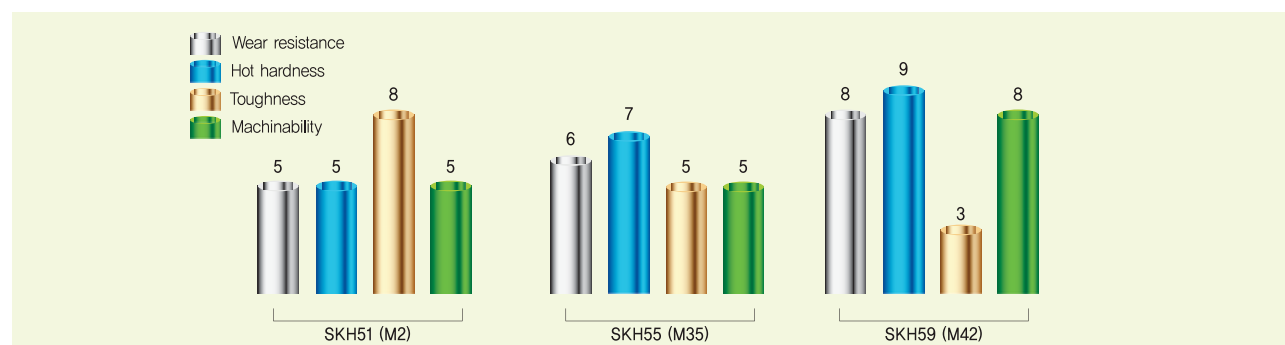
Chemical Compositions

Grades	C	Si	Mn	P	S	Cr	Mo	W	V	Co
SKH51	0.80 ~0.90	≤0.40	≤0.40	≤0.030	≤0.030	3.80 ~4.50	4.50 ~5.50	5.50 ~6.70	1.60 ~2.20	-
SKH55	0.80 ~0.90	≤0.40	≤0.40	≤0.030	≤0.030	3.80 ~4.50	4.80 ~6.20	5.50 ~6.70	1.70 ~2.30	4.50 ~5.50
SKH59	1.00 ~1.10	0.15 ~0.35	0.25 ~0.45	≤0.025	≤0.010	3.50 ~4.25	1.25 ~2.00	9.00 ~10.00	1.00 ~1.50	7.75 ~8.75

Heat Treatment Conditions and Hardness

Type	Temperature of Treatment (°C)			Hardness	
	Annealing	Quenching	Tempering	Annealing (HB)	Tempering (HRC)
SKH51	800~850 Slow Cooling	(1)1,220~1,250 Oil (2)1,200~1,230 Oil	550~570 Air Cooling	≤ 255	≥ 63
SKH55	800~850 Slow Cooling	(1)1,230~1,260 Oil (2)1,200~1,240 Oil	560~580 Air Cooling	≤ 277	≥ 64
SKH59	830~870 Slow Cooling	1,180~1,210 Oil	540~580 Air Cooling	≤ 277	≥ 65

(1) Simple shaped tool (2) Complex-shaped tool (needing high toughness)



Products and Characteristics

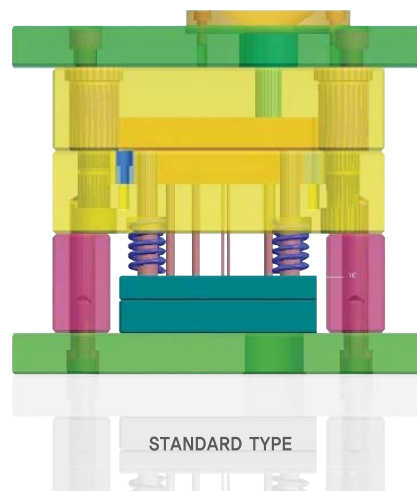
Type	REFERENCE SPEC.				Applications
	KS	JIS	AISI/ASTM	OTHERS	
General Structural Use Hot Rolled Steel Plate	SS400 (PLATE)	SS400	A36	-	<p>General use structural steel plate used for construction, bridge, vessel, vehicle, and other structures</p> <p>Among the series of SS330, SS400, SS490, and SS540, SS400 is the most frequently used product</p>
Intermediate Carbon Plate	SM35C (SLAB)	S35C	AISI 1035	-	<p>Slab refers to an intermediate product for manufacture of final hot rolled steel plate product, and is used to fulfill the need for extremely thick plates above 130T, which is the limit of steel plates made in general steel mills.</p>
Machine Structural Use Carbon Steel Plate	SM45C (PLATE)	S45C	A193 Gr.2H	-	<p>Alloy steel plate used for machinery, vehicle, and other machine components. Usually used on molds, such as SM10C, S-45, and S-55</p>



Major Products

WONIL SPECIAL STEEL USER produces various kinds of products to order.

- STANDARD TYPE MOLD BASE
- SPECIAL TYPE MOLD BASE
- DIE CASTING MOLD BASE(DIE CASTING TYPE)
- CAVITY RETAINER SETS
- Rough and Finish Turning Operations
- 3D Modeling Operations
- PLATE & Multi PIN BUSH



STANDARD MOLD BASE



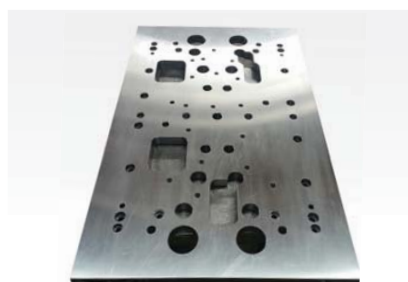
DIE CASTING



Pocket finish turning



3D Modeling



PLATE



Multi PIN BUSH

① DOOSAN ② DAIDO ③ HITACHI ④ KOBE ⑤ ASSAB ⑥ SeAH ⑦ NGK

CLASSIFICATION		REFERENCE SPEC.				APPLICATIONS	
		KS	JIS	AISI	Others		
Structural Steel	Carbon Steel	SMxxC	SxxC	10xx	-	shafts, gears, chains, bolts etc.	
	Alloy Steel	SCM440(4) SCM415(21) SNCM8 SNCM21 SACM645	SCM440 SCM415 SNCM439 SNCM220 SACM645	4140 - 4340 8620 -	-	shafts, gears, bolts, nuts, pins, studs, keys, bites, cranks, transmissions, couplings, cams etc.	
Bearing steel		STB2	SUJ2	52100	-	bearings, shafts etc.	
Plastic Mould Steel		HP1A ^①	S55C mod.	1050 mod.	KTSM21 ^④	mould base core & cavity bumper mould etc.	
		HP4A ^①	SCM440 mod.	4140 mod.	KTSM31 ^④		
		HP4MA ^①	SNCM mod.	P20 mod.	KTSM3M ^④		
		HP4MA(HH) ^①	PAC5000 ^②				high grade mould
		HP70 ^①	NAK-PRM ^② NAK80 ^②	-	CENA1 ^③		
		-	NAK55 ^②	-	-		
		HEMS1A ^①	SUS420J2 mod.	420 mod.	S-STAR ^② STAVAX ^⑤	corrosion resistant precision mould	
		-	MP15 ^⑦ HR750 ^④	-	HIT75 ^③	CD case, VTR sash etc.	
		-	HIPORAS ^④	-	PORCERAX II ^③	steel that allows air to go through	
-	ULTRA HH(LH) ^⑦	-	MOLDMAX ^⑤	plastic cosmetic vessel, nozzle, etc			
High Carbon Tool Steel		STC3	SK3	W1	-	tab gauges, tab dies etc.	
		STC4	SK4	W1	-		
Hot Work Tool Steel		-	SKD61 mod.	-	DHA1-A ^② DH31-EX ^② DHA-WORLD ^② DH2F ^② DH32 ^②	Extrusion dies, die-casting dies, hammer dies, ram dies etc.	
		-	SKD61	H13	DHA1 ^② DAC ^③		
		STF4M ^①	SKT4	L6	-		
Cold Work Tool Steel		STD11	SKD11	D2	DCMX ^② DC53 ^②	press dies, rolls, drawing dies, gauge etc.	
		STS3	SKS3	O1	GOA ^②		
Flame Hardening Steel		HFH1 ^① KFHS1 ^⑥	HMD1 ^③	-	-	blanking & trimming dies	
High Speed Tool Steel		SKH51	SKH51	M2	YXM1 ^③	reamer, end mill, hob, cutter, bite, drill, punch, tab, broach etc.	
		SKH55	SKH55	M35	YXM4 ^③		
		SKH59	SKH59	M42	YXM42 ^③		
		KCW1 ^⑥	DRM1, 2, 3 ^② YXR3 ^③	-	-		

Steel hardness conversion table

ROCKWELL		Vickers	Brinell	Shore	Rough tensile strength x 1000psi
C	B				
150kg	100kg				
68	-	940	-	97	-
67	-	900	-	95	-
66	-	865	-	92	-
65	-	832	-	91	-
64	-	800	-	88	-
63	-	772	-	87	-
62	-	746	-	85	-
61	-	720	-	83	-
60	-	697	-	81	-
59	-	674	-	80	326
58	-	653	-	78	315
57	-	633	-	76	305
56	-	613	-	75	295
55	-	595	-	74	287
54	-	577	-	72	278
53	-	560	-	71	269
52	-	544	500	69	262
51	-	528	487	68	253
50	-	513	475	67	245
49	-	498	464	66	239
48	-	484	451	64	232
47	-	471	442	63	225
46	-	458	432	62	219
45	-	446	421	60	212
44	-	434	409	58	206
43	-	423	400	57	201
42	-	412	390	56	196
41	-	402	381	55	191
40	-	392	371	54	186
39	-	382	362	52	181
38	-	372	353	51	176
37	-	363	344	50	172
36	(109)	354	336	49	168
35	(108.5)	345	327	48	163
34	(108.0)	336	319	47	159
33	(107.5)	327	311	46	154
32	(107.0)	318	301	44	150
31	(106.0)	310	294	43	146
30	(105.5)	302	286	42	142
29	(104.5)	294	279	41	138
28	(104.0)	286	271	41	134
27	(103.0)	279	264	40	131
26	(102.5)	272	258	38	127
25	(101.5)	266	253	38	124
24	(101.0)	260	247	37	121
23	100.0	254	243	36	118
22	99.0	248	237	35	115
21	98.5	243	231	35	113
20	97.8	238	226	34	110
(18)	96.7	230	219	33	106
(16)	95.5	222	212	32	102
(14)	93.9	213	203	31	98
(12)	92.3	204	194	29	94
(10)	90.7	196	187	28	90
(8)	89.5	188	179	27	87
(6)	87.1	180	171	26	84
(4)	85.5	173	165	25	80
(2)	83.5	166	158	24	77
(0)	81.7	160	152	24	75
-	78.7	150	143	22	71
-	75.0	140	133	21	66
-	71.2	130	124	20	62
-	66.7	120	114	-	57
-	62.3	110	105	-	-
-	56.2	100	95	-	-
-	52.0	95	90	-	-
-	48.0	90	86	-	-
-	41.0	85	81	-	-



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