TGK
SPECIAL STEEL PVT. LTD.

The name you can trust...

Manual of Tool Steel and Die Steel Products

CONTENTS

I. Company Overview 1
II. Process flow 3
III. Steel grade check list 7
IV. Introduction to types of steel 9
(a) **High Speed Steel**
M2 9
M2A 11
M2B 13
M35 15
M35A 17
M42 19
4241/4341 21
M3 23
M4 25
M7 27
M18 29
M52S 31
(b) **Powder Metallurgy**
TPM 330 35
TPM 558 37
TPM 638 39
TPM 6711 41
Many more grades of HSS & DIE STEEL
(c) **Cold Work Steel**
D2 43
D3 45
O1 47
O2 49
A2 51
TGX-6 (DC53 Equivalent) 53
A8M 55
S7 57
1.2767 59
TSFD2 61
TSFDC53 63
(d) **Hot Work Steel**
H-13 & H13M 65
TGE13 67
TGGP13 71
TGE-23 75
H-11 & H-11M 79
TGP11 81
1.2367 Supra 85
H-10 89
H-21 93
1.2714 95
(e) **Plastic Moulds**
TGS 136 97
TGP 50 99
TGP80 101
TGP40 103
1.2311 104
V. TITANIUM 105
VI. HSS CUTTING TOOLS 107
VII. CARBIDE CUTTING TOOLS 112

I. TGK Company Overview

M/S. TGK SPECIAL STEEL PVT. LTD. is a new Joint venture company which have been established & co-operated with KUSHAL METAL & STEEL INDUSTRIES, Mumbai, recently for cutting tools raw material like High Speed Steel & Die Steel business in the Indian market. We would like to introduce few history about our mother company as follows.

Our mother company M/s. Tiangong International Company Limited, from August 1981, the day of its establishment, started its pursuit of a splendid dream. Thirty one years as one day, Tiangong made its way one of the world's large scaled and powerful enterprises in the field of a special steel and metal cutting tools. From the manufacturing of metal cutting tools, to the smelting and processing of High Speed Steel (HSS) and Die Steel Tiangong experienced great changes and developments time and time again.

Tiangong mainly produces High Speed Steel (HSS), HSS cutting tools and Steel. From 2001, every year, it was evaluated as China's largest HSS production manufacturer of the year. From 2005, Tiangong was evaluated as China's largest HSS exporter of the year. The company has set up and a complete set of production lines of HSS, die steel & cutting tools. For thirty one years, in line with the business concept as "everything starts from integrity" relying on experience managerial team, in the light of precise market orientation and strict quality control system, Tiangong wins the confidence of domestic buyer as well as Foreign one and scales the heights of scale volume.

The company produces fifty thousand tons of High speed steel yearly, staying the head of the world. With the annual output of 500 million twist drills and the export business volume of 100 million dollars, Tiangong's products are exporting in the market of over 50 countries in Europe. The company is also exporting to America, South Korea, Hongkong, Taiwan & India since 1968, started in the name of M/s. Dinesh Hardware Mart & then gradually in 1987 M/s. Kushal Metal & Steel Industries was created, Kushal Metal & Steel Industries has served Indian Tool room Industry for more than 40 years.

Tiangong means (TG) and Kushal Metal means (K) as a new joint venture company M/s. TGK Special Steel Pvt. Ltd., is running from the beginning of January 2012.

TGK Special Steel Pvt. Ltd. is one of the Top Company to Sell

High Speed Steel	(TG M-2, TG M-35, TG 4241, TG M-42)
Hot Die Steel	(TG-H13, TG-H11, TGE-13, TGGP-13, TGE23, TG 1.2367SUP, TG H-10)
Cold Work Steel	(D2,D3,O1,A2,DC-53)
Plastic Mould Steel	(TGS 136, TGP 50, TGP 80, PHX SUPRA)
HSS Cutting Tools	
Titanium Alloys	
Carbide Cutting Tools	

To Service better & to respond faster to our domestic customers requirements we are expanding our network of Representative, Branches / Offices & Warehouses across India.

With our Hitech Warehouses in Mumbai, Bhiwandi & Ahmedabad; We can reach every part of India on time every time.

An overview of our ware houses we have the following infrastructure:

- Cranes 25 ton's - 1 No, 15 Ton's - 3 Nos., 10 Ton's - 5 Nos. , 5 Tons's - 5 Nos.
- Vertical BandSaw Machine - 6 Nos. (Max 2500 x 1500, 2500 x 700)
- Horizontal bandsaw Machine -16 Nos. (Max 2200 x 1000, 800 x 800, 550 x 300, 650 x 500, 360 x 360, 350 x 300, 260 x 260)
- Circular Saw (4000 mm x 100 mm)
- Magnet Lifter - 3 Ton's, 2 Ton's, 1 Ton, 500 Kg.

Machine Shop:

• Surface Grinder (Max 1300x2100) • Rotary Grinder (32" Across Corners) • Plano Miller (1400x2300 max)

I. Principal Company Overview

Tiangong International Company Limited, established in 1981, with 3,300 employees, is a Chinese manufacturer in special tool steel, die steel, titanium materials and cutting tools, a national key high-tech enterprise, one Top 500 Chinese private enterprise and one Top 500 Chinese private enterprise with respect to manufacturing, ranking the first among private enterprises of special steel production in China, as well as top 3 die steel production enterprise in the world and the number one in China for five years consecutively. After 36 years of development, Tiangong has established an integral scientific research, production and sales system ranging from mining, special material production and tool fabrication. Now, it has world advanced production equipment and process technology, featuring with quite obvious industrial advantages.

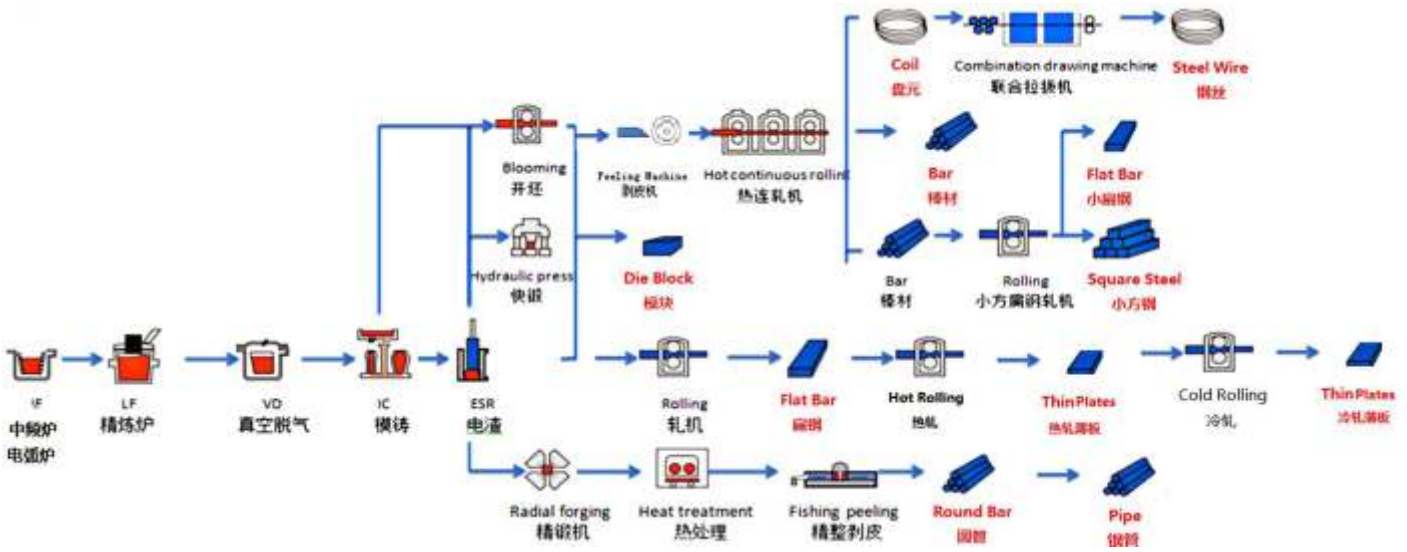
Currently, high-speed steel, die steel, cutting tools and titanium alloy products of Tiangong are widely used in aviation, automobile, high-speed train, petrochemical engineering, machining and other different fields, widely sold in almost one hundred countries and regions including western countries, Hong Kong, and Taiwan. The Company has set up international sales branches in the USA, India, South Korea, Czech, Italy, Russia, Turkey, Canada and other countries and regions.

Tiangong International was listed in the main board of Hong Kong Exchanges and Clearing Limited on Jul. 26, 2007 [Hong Kong Stock No.: 00826]. The subsidiary Tiangong Limited was listed on New OTC on Dec. 3, 2015 [Code: 834549].

Tiangong International insists on implementing the path of combined production, study and scientific research, establishing favorable production, study and scientific research cooperation relationship with Central Iron & Steel Research Institute, Southeast University, Nanjing Tech University, etc. Tiangong International has established high-speed steel research center with Central Iron & Steel Research Institute, high-speed steel and tool engineering research center with Southeast University, Jiangsu Ocean Engineering New Material Laboratory with Nanjing Tech University, as well as Jiangsu post-doctoral Scientific Research Workstation, making Tiangong International the most leading-edge and most authoritative test base and scientific research center in terms of high-speed steel, tool steel and die steel. With the help of production, study and scientific research, Tiangong International has fostered a great batch of skilled practical talents with strong innovation, applied over one hundred national patents successfully and improved research capability and production technology significantly.

Tiangong International is the only enterprise realizing whole industrial chain and all variety special new material production, establishing a complete production chain ranging from mining, smelting, secondary melting, forging, cold rolling and hot rolling, pulling and rolling, as well as further processing. Tiangong International can produce 50,000t high-speed steel per year, covering all types of products ranging from round bar, flat bar, square bar, steel wire, vertical bar, and sheet metal. Besides, Tiangong International can produce 200,000t die steel per year, with products covering from round bar, flat bar, modules, etc. Tiangong International can produce almost 10,00t titanium alloy products per year, with products covering rods, pipes, medium thick boards, thin boards, rod stocks and wires.

In Oct. 2016, Tiangong International won the lawsuit against anti-dumping and anti-subsidy of European Union, becoming the first enterprise winning such case in Chinese special steel industry. On Jul. 26, 2017, China high-quality tool and die material industrial technology innovation strategic alliance initiated by Central Iron & Steel Research Institute, China Die & Mould Industry Association, China Special Steel Enterprise Association, Jiangsu Tiangong Tool Co., Ltd., China Metallurgical Information and Standardization Institute was set up in Beijing, symbolizing that Tiangong International will provide strategic support for "Made in China 2025".




Ladle Finery


Electric Arc Furnace


VOD


Electric Annealing Furnace


Electroslag Remelting


HSS Ingot Casting

RADIAL FORGING

FLAT BAR ROLLING


NEW CONTINUOUS ROLLING MACHINE

ULTRASONIC INSPECTING

LAB

Digital Rockwell Hardness

Electronic Brinell Hardness

Type 2206 Surface Roughness measuring apparatus

American and Swiss spectrometers content of W, Mo, Cr, V, Co, S, P, N, Nb and so on.

III. Steel grade check list

Types of steel	Tiangong Steel Grade	AISI	DIN	JISS	UDDEHOLM	BOHLER	DAIDO
Hot forging die steel	TGE13	H13	1.2344	SKD61	ORVAR 2M	W302 ISOBLOC	
	TGGP13	H13	1.2344	SKD61	ORVAR SUP		
	TGE23				DIEVAR	W403VMR	DH31-S
	1.2367 SUP		1.2367				
	H10		1.2365				
	TGGP11	H11	1.2343		VIDAR SUPEIOP	W400VMR	
Cold forging die steel	O1	O1	1.2510	SKS3	ARNE		
	O2	O2	1.2842				
	A2	A2	1.2363		RIGOR		
	1.2080	D3	1.2080	SKD1			
	TSFD2	D2	1.2379	SKD10		K110	DC11
	SKD11			SKD11			
	TSFDC53						DC53
Powder Metallurgy		CRUCIBLE		ERASTEEL		BOHLER	
	TPMM4	cpmRexM4		ASP2004		S690	
	TPM330			ASP2023		S790	
	TPM558			ASP2030		S390	
	TPM9638	cpmRex45		ASP2052		S590	
	TPM6711			ASP2060		S290	

Types of steel	Tiangong Steel Grade	ASTM	DIN	JISS	UDDEHOLM	BOHLER	DAIDO
Plastic die steel	TGS136	420		SUS420J2			
	TGP50		1.2083		STARVAX		
	TGP80						NAK80
High-speed tool steel	M3	M3-1	1.3344	SKH52			
	TGM42	M42	1.3247	SKH59		S500	
	TGM2B	M2	1.3343	SKH51		S600	
	TGM35A	M35	1.3243	SKH55		S705	
	M4	M4		SKH54			
	M7	M7	1.3348	SKH58		S400	
	W18	T1	1.3355	SKH2		S200	
	M52S						

Tiangong	Similar to Grade	C	Cr	W	Mo	V	Co
TPM330	ASP2023	1.28	4.2	6.4	5	3.1	--
TPM558	ASP2052	1.6	4.8	10.5	2	5	8
TPM638	ASP2030	1.28	4.2	6.2	5	3.1	8.5
TPM380	ASP2053	2.48	4.2	4.2	3.1	8	
TPMB31	CPM 3V	0.8	7.5	--	1.3	2.75	

Tiangong	Similar to Grade	C	Cr	W	Mo	V	Co
TPMD91	CPM S90V	2.3	14		1	9	
TPMB42	K490(Microclean)	1.4	6.4	3.5	1.5	3.7	
TPMB44	CPM 4V	1.35	5	--	2.95	3.85	
TPM6711	ASP2060	2.3	6.5	6.5	7	6.5	10.5
TPM555	ASP2015	1.55	4	12		5	5

IV. INTRODUCTION TO TYPES OF STEEL

Steel Grade (TG M-2 (DIN-1.3343)

Steel properties : For all metal-cutting tools for roughing or finishing, such as twist drills, all kinds of milling cutters, screw taps, screw dies, broaches, reamers, countersinks, thread chasers, segments for circular saws, shaping tools and woodworking tools. Also highly suitable for cold-forming tools, such as cold extrusion rams and dies, as well as cutting and precision cutting tools, plastic moulds with elevated wear resistance and screws.

Applications : Standard high-speed steel grade. High toughness and good cutting power owing to its well-balanced alloy composition; thus suitable for a wide variety to applications.

It is typical steel grade of W-Mo current hss, with high toughness, good thermal plasticity, high hardness, as well as red gardness and hot hardness.

TGM2 is suitable for produce in high quality cutting tools, such as hob, knife, and milling cutter. TGM2A is suitable for produce in common cutting tools with high toughness, also suitable for cold-forming tools. M2 is suitable for produce common tools.

Similar Steel Grade :

CHINA	BRAZIL	AUSTRIA	GERMANY	SLOVANIA	JAPAN			CHEZ. REP
TG	VILLARES	BOHLER	DEW	RAVNE	HITACHI	NIPPON	SANYO	POLDI
TGM2	VW/M2	S600	1.3343	BRM2	YXM1	H51	QH51	MAX SP. MO5S

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
M2	0.86-0.94	<0.03	<0.03	0.20-0.45	0.20-0.40	***	3.80-4.50	4.70-5.20	1.70-2.10	5.90-6.70	***	Annealed	<255

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Drawn / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Drawn / Centreless Ground : Φ 2.0-14.4mm

UNDER ANNEALED CONDITION :
Hardness : HB205-255

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
As Cold drawn / Hot rolled / forged, in annealed condition.

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Bar	Forged bar	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ 81.0-205.0mm	Φ 2.0 - 16.0mm

SIZE : Flats

Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Square

4mm to 100mm

SIZE : Sheets

Thickness	Width	Length
0.5mm to 20mm	810mm	2500mm

Steel Grade (TG M-2 (DIN-1.3343)

HEAT TREATMENT :

Annealing:

Annealing temperature: 860-880°C, keep this temperature by 2-4 hours, then cooling to 600°C in the speed of less than 30°C/h. If after cold drawn process, suggest add stress relieving annealing process Under the temperature of 600-700°C, keep this temperature by 2 hours.

Quenching & Tempering (salt bath)

Quenching :

Pre-heating in two steps :

Heating temperature under : 400-500°C and 850-900°C

Austenitizing temperature : 1185-1225°C

Heating coefficient 10-15 sec/mm, quenching under 580-620°C, then cooling to room temperature.

Tempering:

Tempering temperature under : 540-560°C, tempering 3 times, each time 1 hour, then cooling to room temperature.

Steel Grade (TG M-2A (Special Grade for Taps)

Steel properties: Comparing to M2, Grade TGM2A has low percentage of carbon, added Niobium. With low percentage of carbon to increase toughness, and Niobium added to fined crystal grains of steel to obtain high strength and toughness. This grade is specially suitable for tabs of thread tools.

Material: Forged/Hot Rolled round bars - Spherodized annealed - Grinding/turned/peeled.

Chemical Composition: (%)

TG	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
	C	S	P	Si	Mn	Nb	Cr	Mo	V	W	other	Heat Treatment	Hardness
TGM-2A	0.83-0.85	Max 0.010	Max 0.030	0.30-0.40	0.20-0.40	0.10-0.12	3.90-4.20	4.80-4.85	1.80-1.90	6.00-6.20	***	Annealed	<255

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Draw / Sand Blasted : Φ 2.0-13.5mm
- Cold Drawn Centerless Ground : Φ 2.0-14.4mm

SIZE : Rounds

Cold Drawn/Ground Bar	Hot Rolled Annealed & Peeled	Forged+Annealed+Turned Bar	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ81.0-255.0mm	Φ 2.0-13.5mm

UNDER ANNEALED CONDITION:
Hardness : Max. 255HB

STRAIGHTNESS:
Max. 2.0 mm/m

OVALITY :
1/2 *TOLERANCE

NON-METALIC INCLUSIONS :
Acc. to ASTM E 45 method
A th. 1,0 / heavy 0.5 - B th. 1.0 / heavy 0,5 - C th. 1,0 / heavy 0,5 - D th. 1.5 / heavy 0.5.

MICROSTRUCTURE: Acc. to SEP 1615

	≤16mm	≤ 16-25mm	≤ 25-40mm	≤ 40-63mm	≤ 63-100mm	≤ 100-160mm	≤ 160-200mm
	A	A	A	A	A	A	A
	B	B	B	B	B	B	B
	C	C	C	C	C	C	C
TG Stage	1B	2B	3B	4B	5B	6A, 5B	7A, 6B

GRAIN SIZE:
The grain size (ASTM) should be 10~11.5#

ULTRASONIC TEST:
According to SEP 1921 class E/e/3, 100% scanning.

Steel Grade (TG M-2A (Special Grade for Taps)

HEAR TREATMENT :		
Soft annealing 780-860°C	*Cooling* 10-20°C/h furnace	*Hardness* max.280HB
Stress relief annealing 600-650°C	*Cooling* furnace	
1st pre heating up to approx.450°C	*2nd and 3rd pre heating* a) 850°C b) 850-1050°C	*Hardening* 1200-1220°C
Quenching saltbath 550°C oil, air, vacuous		
Tempering : Thrice 550-560°C Hardness after tempering 63-66HRC.		

Steel grade (TGM2B)

Smelting method: 15T intermediate frequency furnace +LF+VD+ ESR

Main characteristics: Favorable tenacity, high red hardness and excellent abrasion resistance

Major applications:

✧ Due to favorable hardness and abrasion resistance, it's mainly used to fabricate tools to cut materials which are difficult to be cut. It's mainly used as various cutting tools, for example, drilling bits, screw taps, milling cutters, drawing tools, roller cutters, etc.

Chemical constituent %:

C	W	Mo	Cr	V	Co	P	S
0.89	6.2	4.8	4.15	1.9	--	≤0.026	≤0.003

O (ppm)	N (ppm)	H (ppm)
≤20	≤100	≤2.5

Physical property:

Room temperature density (g/cm^3)	Specific heat of room temperature (J/g.K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Resistivity (Ohm mm^2/m)
8.12	0.46	19.0	217,000	0.54

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

(1) Delivery under balling annealing state, delivery hardness ≤269HB.

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

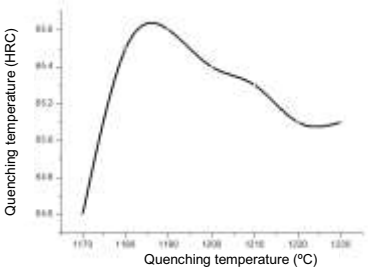
- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Draw / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Drawn Centerless Ground : Φ 2.0-14.4mm

SIZE : Rounds

Cold Drawn/Ground Bar	Hot Rolled Annealed & Peeled	Forged+Annealed+Turned Bar	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ 81.0-255.0mm	Φ 2.0-13.5mm

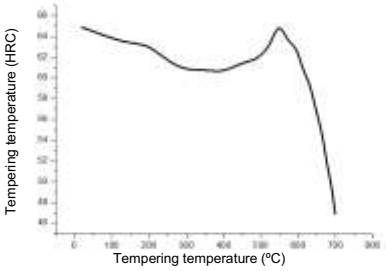
Steel grade (TGM2B)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 860-880ºC for heat insulation; cooling to 550ºC slowly and then removing from the furnace	1,210~1,220ºC quenching, salt bath; Air cooling to room temperature after 500~600ºC level by level quenching	Tempering temperature 540~560ºC; tempering for 3 times; material temperature shall reach the temperature interval; each time of heat insulation shall be not less than 1h; air cooling to room temperature

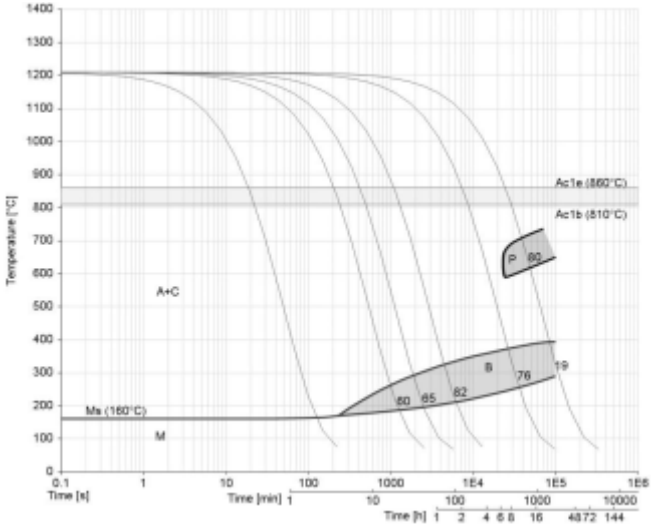


Quenching temperature and hardness relation curve

1,210ºC quenching



Tempering temperature and hardness relation curve



CCT curve

Steel Grade (TG M-35 (DIN-1.3243)

Steel Properties: This kind steel is suitable for conditions involving thermal stresses and discontinuous cutting. Heavy-duty miling cutters of all kinds, gear cutter, highly stressed twist drills and taps, profile knives, machining of high-strength material, broaches.

Applications: It is one of the W-Mo Co hss grade with good cutting character. The res hardness, hot hardness and wearing resistance are all better than W6M05Cr4V2.

Similar Steel Grade :

CHINA	BRAZIL	AUSTRIA	GERMANY	SLOVANIA	JAPAN		CHEZ. REP
TG	VILLARES	BOHLER	DEW	RAVNE	HITACHI	NIPPON	RAVNE
TGM35	VK5E	S700	1.3245	BRCMO	YXM4	HM35	MAXSP 75D

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)										Delivery Condition	
IS	C	S	P	Si	Mn	Cr	Mo	V	W	Co	Heat Treatment	Hardness
M35	0.88-0.96	<0.03	<0.03	0.20-0.45	0.20-0.40	3.80-4.50	4.70-0.52	1.70-2.00	6.00-6.70	4.55-5.50	Annealed	<255
M35A	0.91-6.0	<0.003	<0.022	***	***	4.0	4.8	1.92	***	4.85		

New Development M35A Chemical & Application: • Suitable for fabricating various abrasion-resistant and impact-resistant tools for powerful cutting, high-level trimming dies, screw dies, tools of complicated shapes requiring tenacity, reamers, milling cutters, punches, etc. • Mainly used as roller cutters, drawing tools, end mills, etc.

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE :
QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Drawn / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Draw / Centreless Ground : Φ 2.0 -14.4mm

UNDER ANNEALED CONDITION :
Hardness : HB205-255

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
As Cold drawn / Hot rolled / forged, in annealed condition.

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed Peeled	Forged Bar & Turned	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ 81.0-255.0mm	Φ 2.0 - 13.5mm

SIZE : Flats

Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Square

4mm to 100mm

SIZE : Sheets

Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

Steel Grade (TG M-35 (DIN-1.3243)

HEAT TREATMENT :

Annealing:
Annealing temperature: 860-880°C, keep this temperature by 2-4 hours, then cooling to 600°C in the speed of less than 30°C/h if after cold drawn precess, suggest and stress relieving annealing process. Under the temperature of 600-700°C, keep this temperature by 2 houres. Quenching & Tempering (salt bath).

QUENCHING :
Pre-heating in two steps :
Heating temperature under : 400-500°C and 850-900°C
Austenitizing temperature : 1180-1220°C
Heating coefficient 10-15sec/mm, quenching under 580-620°C, then cooling to room temperature

Tempering :
Tempering temperature under : 540-560°C, tempering 3 times, each time 1 hour, then cooling to room temperature.

Steel grade (TGM35A)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics: Favorable tenacity, high red hardness and excellent abrasion resistance.

Major applications:

- ✧ Suitable for fabricating various abrasion-resistant and impact-resistant tools for powerful cutting, high-level trimming dies, screw dies, tools of complicated shapes requiring tenacity, reamers, milling cutters, punches, etc.
- ✧ Mainly used as roller cutters, drawing tools, end mills, etc.

Chemical constituent %:

C		Mo	Cr	V	Co	P	S
0.91	6.0	4.8	4.0	1.92	4.85	＜0.022	＜0.003

O (ppm)	N (ppm)	H (ppm)
≤20	≤100	≤2

Physical property:

Room temperature density (g/cm^3)	Specific heat of room temperature (J/g.K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Resistivity [Ohm mm^2/m]
8.1	0.46	19.0	217,000	0.60

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

(1) Delivery under balling annealing state, delivery hardness ≤269HB.

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Drawn / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Draw / Centreless Ground : Φ 2.0 -14.4mm

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed Peeled	Forged Bar & Turned	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ 81.0-255.0mm	Φ 2.0 - 13.5mm

SIZE : Flats

Thickness	Width
5mm-150mm	5mm-810mm

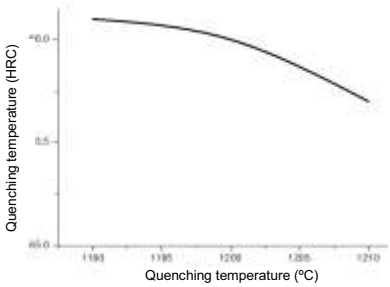
SIZE : Square

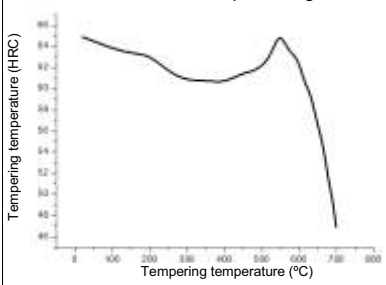
4mm to 100mm

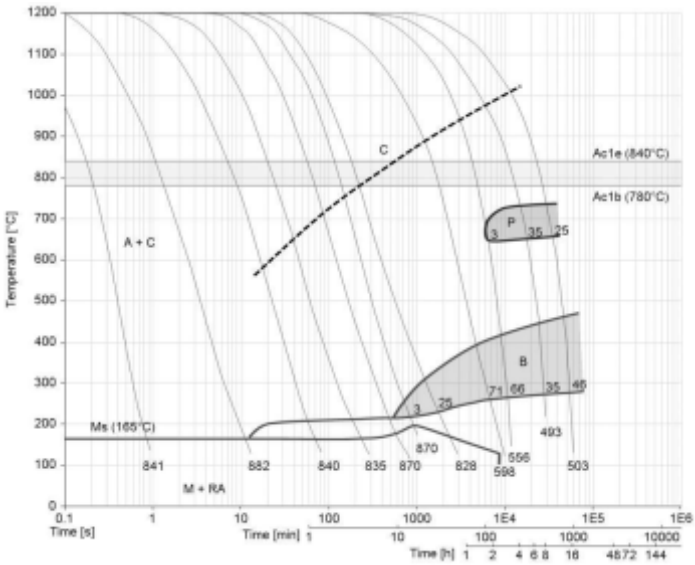
SIZE : Sheets

Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

Steel grade (TGM35A)

<table>
<tr><td colspan="3">Thermal treatment</td></tr>
<tr><td>Softening annealing</td><td>Quenching</td><td>Tempering</td></tr>
<tr><td>Heating to 880-900ºC for heat insulation; cooling to 550ºC slowly and then removing from the furnace</td><td>1,210~1,220ºC quenching, salt bath;
Air cooling to room temperature after 500~600ºC level by level quenching</td><td>Tempering temperature 540~560ºC; tempering for 3 times; material temperature shall reach the temperature interval; each time of heat insulation shall be not less than 1h; air cooling to room temperature</td></tr>
<tr><td colspan="2"> 

Quenching temperature and hardness relation curve</td><td colspan="1">1,210ºC quenching
 

Tempering temperature and hardness relation curve</td></tr>
<tr><td colspan="3"> 

CCT curve</td></tr>
</table>

Steel grade (TGM42)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

High steel hardness, reaching 68HRC after quenching and tempering, favorable hot hardening, capable of manufacturing various complicated tools with high precision.

Major applications:

- ✧ Capable of manufacturing abrasion resistant and impact resistant tools for various types of powerful cutting.
- ✧ High-level trimming dies, screw dies, formed punches of complicated shapes requiring tenacity, etc.;
- ✧ Scrapers, hobs, drilling bits, etc.
- ✧ Cold forging molds.

Chemical constituent %:

C	Si	Mn	W	Cr	Mo	V	Co	P	S
1.08	0.3	0.3	1.45	3.95	9.40	1.15	7.85	≤0.020	≤0.001

O (ppm)	N (ppm)	H (ppm)
≦15	≦100	≦2.5

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
8.01	460	19.00	220,000	10.8	11.6

Ultrasonic flaw detection: As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state: (1) Delivery under balling annealing state, delivery hardness ≤269HB

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Drawn / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Draw / Centreless Ground : Φ 2.0 -14.4mm

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed Peeled	Forged Bar & Turned	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ81.0-255.0mm	Φ 2.0 - 13.5mm

SIZE : Flats

Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Square

4mm to 100mm

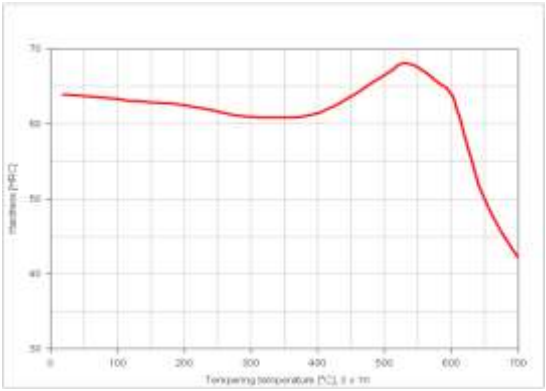
SIZE : Sheets

Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

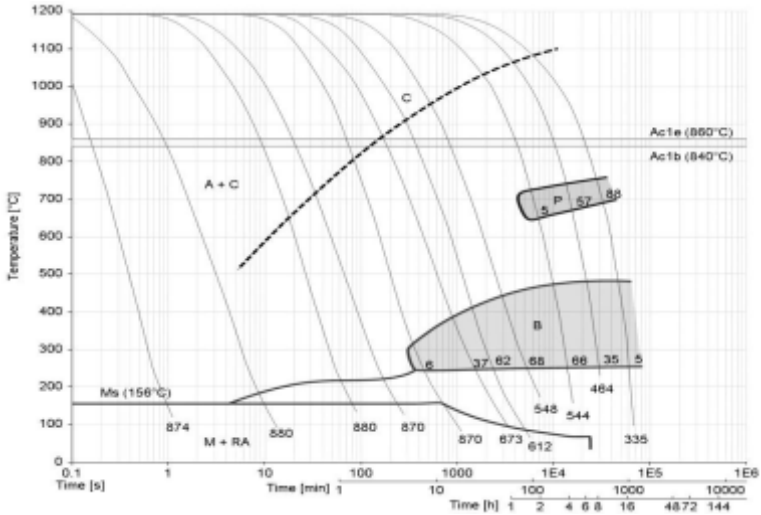
Steel grade (TGM42)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 850ºC for heat insulation; cooling to 550ºC slowly and then removing from the furnace	1,175-1,180ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 540-570ºC, at least three times of tempering

1,180ºC quenching



Tempering temperature and hardness relation curve



CCT curve

Steel Grade (TG 4241 / TG 4341)

Steel Properties: It is mainly used to produce drill, tap, saw bit and high efficiency wood tool.

Applications : It is an economical low alloy high-speed steel with good red hardness, good toughness and thermal plasticity. It is generally used soft and moderate intensity metal.

Chemical Composition: (%)

Special grade	C	S	P	Si	Mn	Cr	Mo	V	W
TG4241	0.90-0.95	≤0.020	≤0.030	0.80-1.20	0.25-0.40	4.00-4.50	1.00-1.20	0.80-1.00	1.80-2.50
TG4341	0.83-0.93	≤0.020	≤0.030	0.70-1.00	0.20-0.40	3.80-4.40	2.50-3.50	1.20-1.80	3.50-4.50

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80mm
- Hot Rolled & Sand Blasted (Coil) : Φ 2.0 -13.5mm
- Cold Drawn Centreless Ground : Φ 2.2-14.4mm

UNDER ANNEALED CONDITION :
Hardness : HB205-255

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
As Cold drawn / Hot rolled / forged, in annealed condition.

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Bar	Forged bar	Coil
Φ 2.0 - 14.4mm	Φ 14.5 - 80.0mm	Φ 81.0 - 255.0mm	Φ 2.0 - 13.5mm

SIZE : Flats

Thickness	Width
5mm - 150mm	5mm - 810mm

SIZE : Squares

4mm to 100mm

SIZE : Sheets

Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

Steel Grade (TG 4241 / TG 4341)

HEAT TREATMENT :

Annealing:

Annealing temperature: 860-880°C, keep this temperature by 2-4 hours, then cooling to 600°C in the speed of less than 30°C/h. If after cold drawn precess, suggest add stress relieving annealing process Under the temperature of 600-700°C, keep this temperature by 2 houres.

Quenching & Tempering (salt bath)

Quenching:

Pre-heating in two steps:

Heating temperature under : 400-500°C and 850-900°C

TG4241 austenitizing temperature : 1150-1180°C

TG4241 austenitizing temperature : 1160°C-1190°C

Heating coefficient 10-15 sec/mm, quenching under 580-620°C, then cooling to room temperature.

Quenching temperature difference in 5-10°C between TGM2, TGM2A;

TGM2A's quenching temperature is higher than TGM2

Tempering:

Tempering temperature under: 540-560°C, tempering 3 times,
each time 1 hour, then cooling to room temperature.

Steel grade (M3)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

M3 is high-speed tool steel of tungsten and molybdenum system with high vanadium, for tools used for cutting requiring favorable abrasion resistance.

Major applications:

- ✧ Screw taps, turning tools, milling cutters, drilling bits, etc.
- ✧ Cold forging molds.

Chemical constituent %:

C	Si	Mn	W	Cr	Mo	V	Co	P	S
1.07	0.35	0.3	6.3	3.95	6.20	2.40		≤0.025	≤0.005

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (/Kg·K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
8.07	460	19	217,000	11.3	11.7

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

(1) Delivery under balling annealing state, delivery hardness ≤269HB.

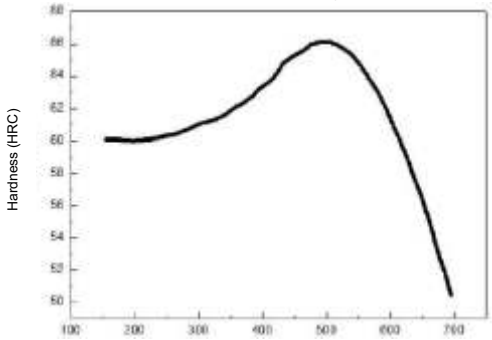
Supply specification:

Product name	Specification
Round bar	Ø2.5-257.125mm

Steel grade (M3)

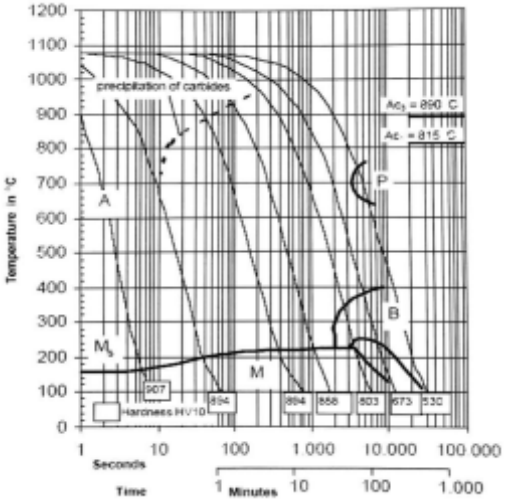
Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 860ºC and cooling slowly to room temperature in the furnace	1,190-1,230ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 540-570ºC, at least three times of tempering

1,220ºC quenching



Quenching temperature (ºC)

Tempering temperature and hardness relation curve



CCT curve

Steel grade (M4)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

M4 is high-speed tool steel of tungsten and molybdenum system with high vanadium. It has high hardness and excellent abrasion performance.

Major applications:

✧ Turning, chipping and slotting tools, spiral drills, thread drilling, contour cutting tools, broaching tools, reamers.

Chemical constituent %:

C	Mn	W	Cr	Mo	V	Co	P	S
1.33	0.40	5.60	4.15	4.60	3.95	-	≤0.028	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
7.97	440	20	226,000	10.4	11.3

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

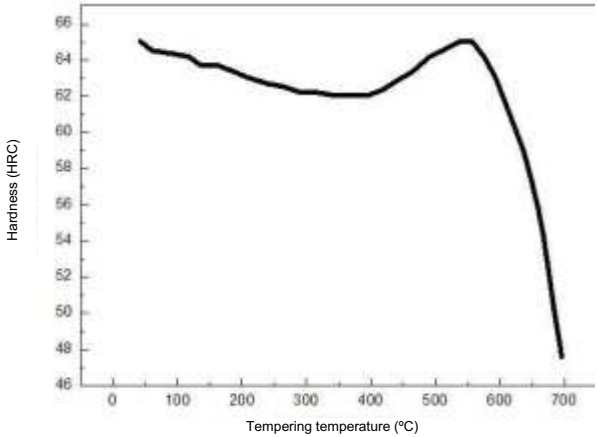
(1) Delivery under balling annealing state, delivery hardness ≤269HB.

Supply specification:

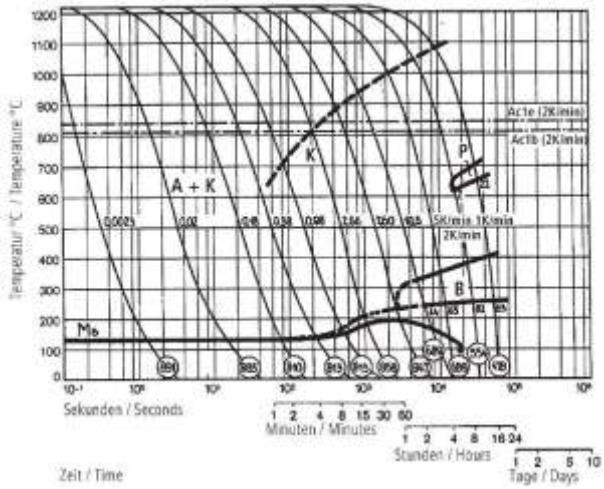
Product name	Specification
Round bar	Ø15~160mm

Steel grade (M4)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 840ºC for heat insulation and cooling to room temperature in the furnace	1,190-1,230ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 540-560ºC, at least three times of tempering



Tempering temperature and hardness relation curve



CCT curve

Descriptions and data in the file are typical cases. We will not make guarantee for them. Besides, we reserve the final right to interpret improvement in materials, quality and/or performance.

Steel grade (M7)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

M4 is high-speed tool steel of tungsten and molybdenum system. It's featuring with favorable hardness, abrasion resistance, favorable softening resistance under high temperature and tenacity.

Major applications:

✧ Turning, chipping and slotting tools, spiral drills, thread drilling, contour cutting tools, broaching tools, reamers.

Chemical constituent %:

C	Si	Mn	W	Cr	Mo	V	Co	P	S
0.98	0.35	0.3	1.80	4.00	8.50	1.90	-	≤0.028	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
8.30	0.46	19.0	217,000	12.5	13.2

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

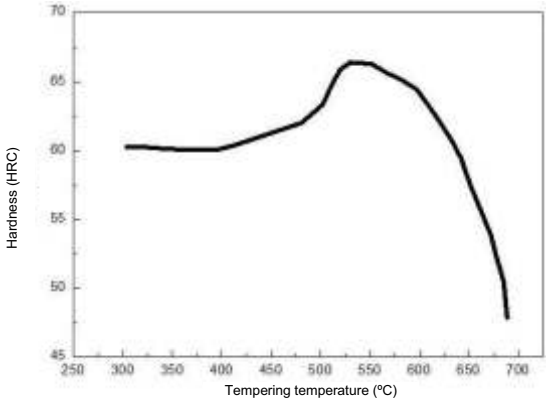
(1) Delivery under balling annealing state, delivery hardness ≤269HB.

Supply specification:

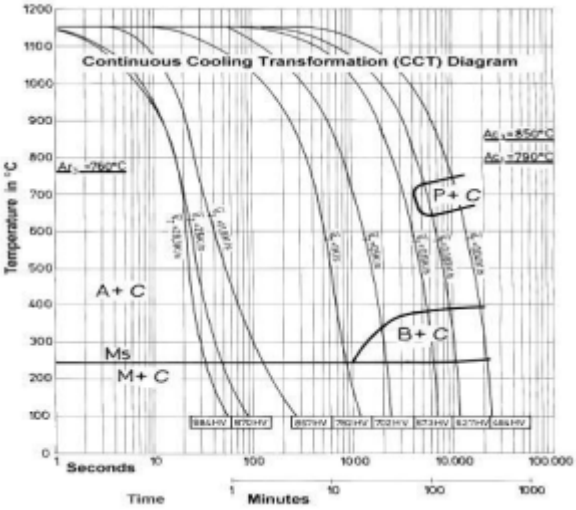
Product name	Specification
Round bar	Ø15~80mm

Steel grade (M7)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 860ºC for heat insulation and cooling to room temperature in the furnace	1,180-1,220ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 540-560ºC, at least three times of tempering



Tempering temperature and hardness relation curve



CCT curve

Steel grade (W18)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

W18 is high-speed tool steel of tungsten system. It's featuring with extremely high abrasion resistance, softening performance, favorable tenacity and cutting performance, as well as competency.

Major applications:

✧ Turning, chipping and slotting tools, spiral drills, thread drilling, contour cutting tools, broaching tools, reamers.

Chemical constituent %:

C	Si	Mn	W	Cr	Mo	V	Co	P	S
0.78	0.35	0.30	17.95	4.15	≤0.30	1.10	-	≤0.028	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
8.70	0.46	19.0	217,000	11.1	11.7

Ultrasonic flaw detection:

As per SEP1921 D/d or customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

(1) Delivery under balling annealing state, delivery hardness ≤269HB.

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FOLLOWING MACHINE : QUICK FORGING (12.5MN), HAMMER, PRECISION FORGING →

- Precision Forging : Φ 81-255mm
- Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm
- Cold Drawn / Sand Blasted (Coil) : Φ 2.0-13.5mm
- Cold Draw / Centreless Ground : Φ 2.0 -14.4mm

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed Peeled	Forged Bar & Turned	Coil
Φ 2.0 - 14.4mm	Φ14.5-80.0mm	Φ81.0-255.0mm	Φ2.0 - 13.5mm

SIZE : Flats

Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Square

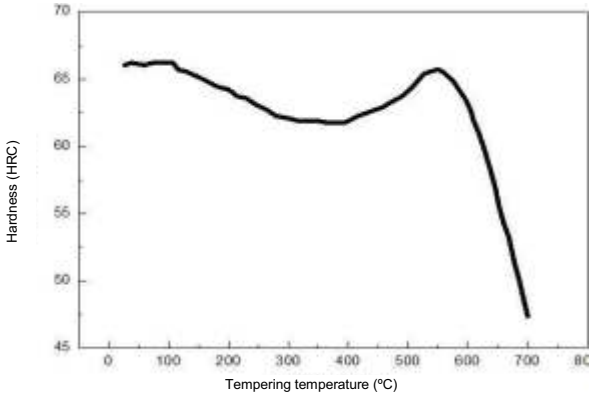
4mm to 100mm

SIZE : Sheets

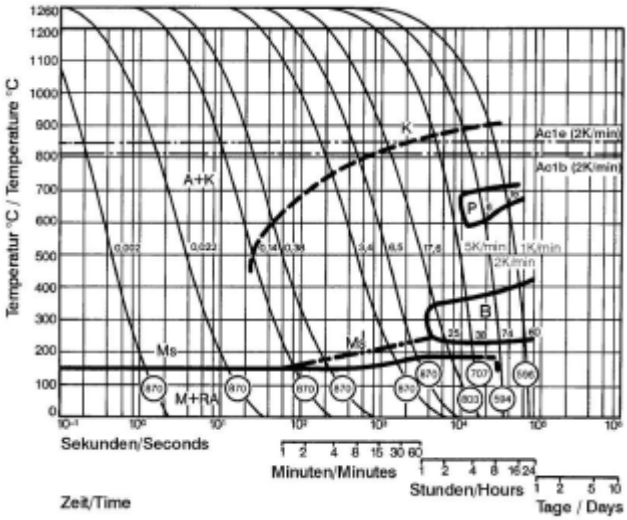
Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

Steel grade (W18)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 860ºC for heat insulation and cooling to room temperature in the furnace	1,250-1,290ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 550-570ºC, at least three times of tempering



Tempering temperature and hardness relation curve



CCT curve

Steel grade (M52S)

Smelting method: 15T intermediate frequency furnace +LF+VD+ESR

Main characteristics:

High-sulfur high-speed steel, extremely high material surface fineness, convenient for cutting and high machinable property.

Major applications:

✧ Applicable to pagoda drills (stepped drills) and other drilling bit products.

Chemical constituent %:

C	Si	Mn	W	Cr	Mo	V	Co	P	S
0.90	0.29	0.30	1.12	3.97	4.27	1.83	0.027	≤0.028	0.10

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	20ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
8.01	460	19.00	217,000	10.8	11.6

Ultrasonic flaw detection:

As per SEP1921 E/e or customer requirements.

Purity:

A (Sulfide)		B (Oxide)		C (Silicate)		D (Cyclic oxide)	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
----	---	0.5	0.5	0.5	0.5	1.0	0.5

Delivery state:

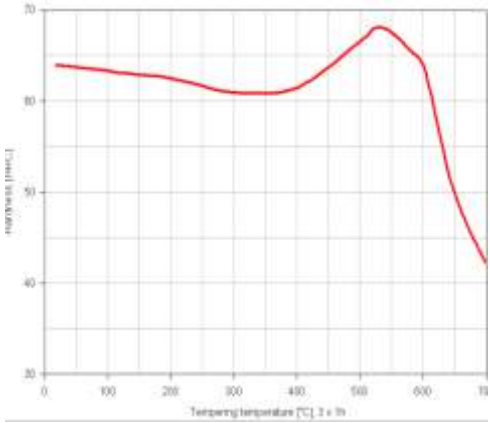
(1) Delivery under balling annealing state, delivery hardness ≤269HB.

Supply specification:

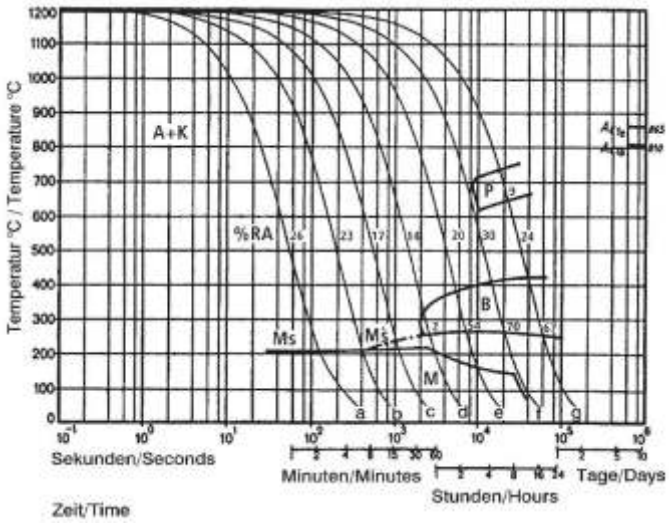
Product name	Specification
Round bar	Ø13~120mm

Steel grade (M52S)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 770ºC-840ºC for heat insulation and slow cooling	1,140-1,180ºC quenching; high-speed gas quenching or hot oil cooling	Tempering temperature 540-570ºC, at least three times of tempering



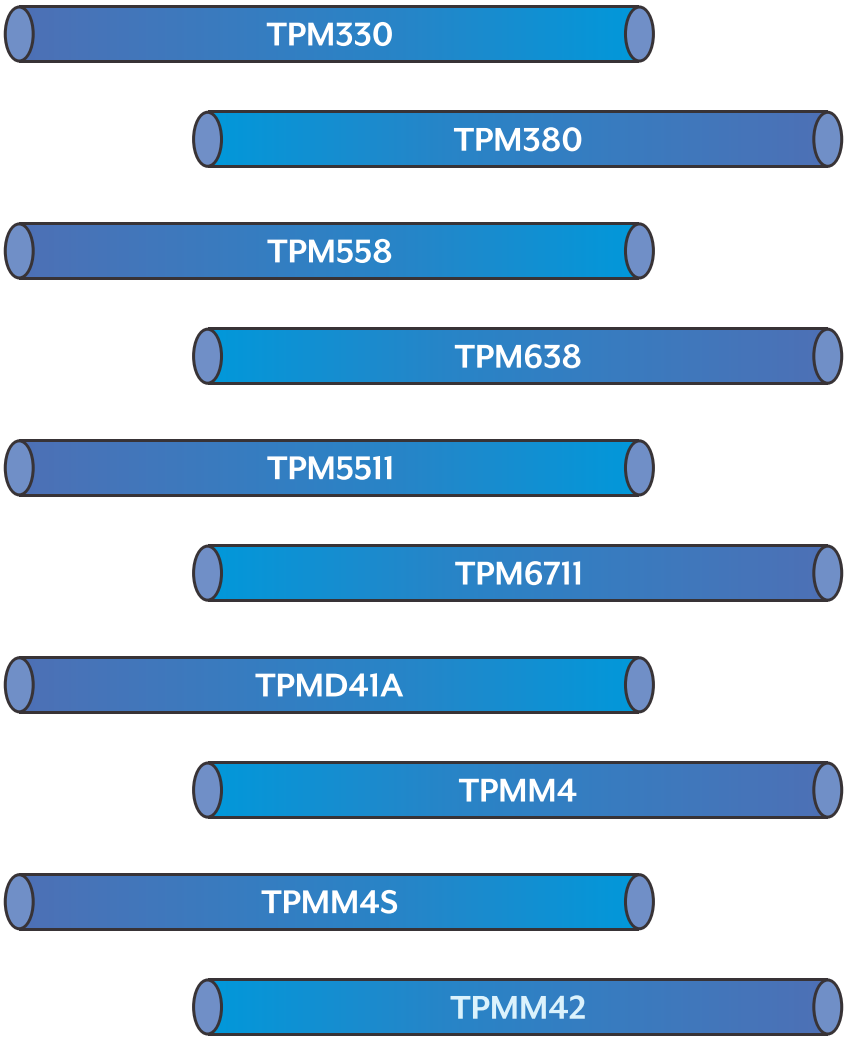
Tempering temperature and hardness relation curve



CCT curve

POWDER STEEL **SERIES**

PRODUCT CATALOGUE



POWDER STEEL SERIES

COMPARISON TABLE

No.	TG Grade												
		Bohler	Erasteel	Crucible	ASSAB	Carpenter	AISI/DIN /JAP	C	W	Mo	Cr	V	Co
1	TPMM35						M35	0.92	6	4.9	4.2	1.9	4.8
2	TPMM2						M2	0.9	6.1	4.9	4	1.83	-
3	TPMM3						M3	1.06	6.1	6	4	2.5	-
4	TPM330	S790	ASP2023				M3-2	1.3	6.4	5	4.1	3	-
5	TPMM4	S690	ASP2004					1.45	5.5	4.9	4.1	3.9	-
6	TPMM4S	S690	ASP2004					1.4	5.5	4.85	4.1	3.9	+S
7	TPMM42			CPM Rex M42				1.1	1.35	9.4	3.85	1.1	7.95
8	TPM638	S590	ASP2030	CPM Rex 45				1.3	6.4	5	4.2	3.1	8.5
9	TPM555		ASP2015	CPM Rex T15				1.63	12	0.25	4.25	4.75	5
10	TPM539						M48	1.54	9.6	5.1	3.8	3	9.2
11	TPM558	S390	ASP2052					1.6	10.4	2	4.8	5	8
12	TPM5511	S290						2	14.3	2.5	3.8	5.1	11
13	TPM5610					Maxamet		2.15	13	0.45	4.75	6	10
14	TPM692	K340						2.47	0.9	3.9	4.25	8.85	1.9
15	TPM380		ASP2053					2.48	4.2	3.1	4.2	8	-
16	TPM6711		ASP2060					2.3	6.5	7	4.2	6.5	10.5
17	TPMB43		ASP2005					1.5	2.5	2.5	4.2	4	-
18	TPMB13							0.55	-	3	4.15	1	-
19	TPMB31			CPM 3V				0.81	-	1.35	7.75	2.8	-
20	TPMB32						SB-WEAR	1.16	1.25	1.6	7.8	2.45	-
21	TPMB44			CPM 4V				1.4	-	3.5	4.7	3.7	-
22	TPMB91			CPM 9V				1.83	-	1.35	5.25	8.7	-
23	TPMB101S			CPM 10V				2.5	-	1.3	5.25	9.35	-
24	TPMD21							2.78	-	1.1	25	2.5	-
25	TPMD31				ELMAX			1.7	-	1	18	3	-
26	TPMD41A	M390						1.9	0.6	1	20	4	-
27	TPMD91			CMP S90V				2.36	-	1.06	14.23	8.62	-

Steel Grade (TPM330)

CHEMICAL COMPOSITION

C	Cr	W	Mo	V
1.3	4.10	6.40	5.00	3.00

PRODUCTION DESCRIPTION

TPM330 has fine carbide particles, even distribution and good toughness.

Applications: cold-worked parts, rollers, extrusion dies and high performance cutting tools.

SIZE SUPPLIED

Product	Round (mm)	Plate (mm)
Wire Rolled Forged	Φ 3.2-320	200 x 503

DELIVERY CONDITION

Typical soft annealed hardness is under 260HB.

MICROSTRUCTURE

1. The carbides are fine and even distribution; the carbide size is 5um (The average size of 3 grain large carbides under 10 fields of view under 1000X, the maximum value is not greater than 5um).
2. The inhomogeneity of eutectic carbide is not more than grade 1.

ULTRASONIC INSPECTION

According to SEP1921- E/e standard
According to GB/T6402-2008 standard grade 4
According to customer requirements

PURITY

Type A		Type B		Type C		Type D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
0	0	1.0	0.5	1.0	0.5	1.0	0.5

PHYSICAL PROPERTIES

1. Density (p) : 8.1g/cm^3
2. Modulus of Electricity (E)KN/mm^2

Temperature/°C	25	400	600
E	230	205	184

3. Thermal Conductivity (λ)W/(m·K)

Temperature/°C	25	400	600
λ	24	28	27

4. Thermal Expansions (α_m) × (10^{-6}/°C)

Temperature/°C	25	400	600
λ	24	28	27

5. Specific Heat (c) J/KG.°C)

Temperature/°C	25	400	600
C	420	510	600

SOFT ANNEALING

Soft annealing in a protective atmosphere at 860 °C~900 °C for 3~5h, followed by slow cooling at 10°C/h down to 500°C, then air cooling.

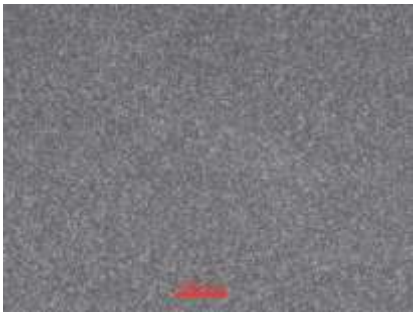
STRESS RELIEF ANNEALING

Stress-relieving at 750°C ~ 800°C for approximately 2h, then air cooling.

Steel Grade (TPM330)

MICROSTRUCTURE

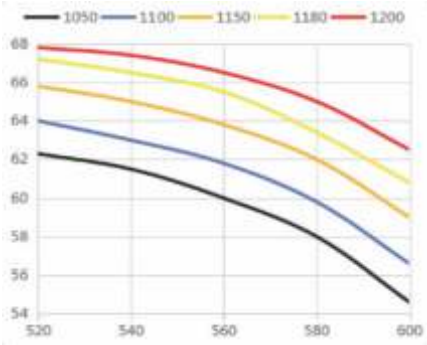
TPM330 is the 3rd - generation gas - atomized powder, which is completed by HIP, then formed by forging.



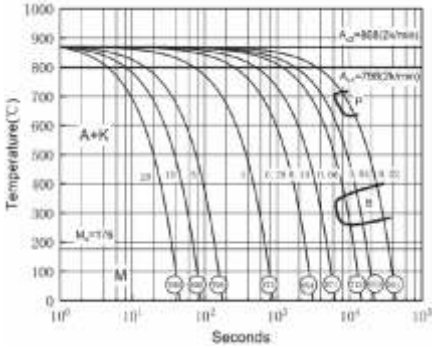
Inhomogeneity of Eutectic Carbide: Level 0

Large Grain Carbide Size : 3.5um

GUIDELINES FOR HARDENING



CCT CURVE



COMPARATIVE PROPERTIES

Steel Grade (TPM558)

CHEMICAL COMPOSITION

C	Cr	W	Mo	V	Co
1.6	4.8	10.4	2.0	5.0	8.0

PRODUCTION DESCRIPTION

TPM558 is high alloy steel, high wear resistance, high, red hardness.

Applications: Heavy machining tools (not only for the processing of steel, but also for the processing of non-ferrous metal such as nickel base and titanium); hobs, slotting cutter, milling knives, complicated cutter, threaded cutter, etc.

SIZE SUPPLIED

Product	Round (mm)	Plate (mm)
Rolled Forged	Φ 22.320	200 x 503

DELIVERY CONDITION

Typical soft annealed hardness is under 300HB.

MICROSTRUCTURE

1. The carbides are fine and distribution; the carbide size is 5um (The average of size of 3 grain large carbides under 1000X, the maximum value is not greater than 5um).
2. The inhomogeneity of eutectic carbide is not more than grade 1.

ULTRASONIC INSPECTION

According to SEP1921- E/e standard
According to GB/T6402-2008 standard grade 4
According to customer requirements

PURITY

Type A		Type B		Type C		Type D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
0	0	1.0	0.5	1.0	0.5	1.0	0.5

PHYSICAL PROPERTIES

1. Density (p) : 8.1g/cm^3
2. Modulus of Electricity (E)KN/mm^2

Temperature/°C	25	400	600
E	254	218	196

3. Thermal Conductivity (λ)W/(m·K)

Temperature/°C	25	400	600
λ	20.96	23.80	23.01

4. Thermal Expansions (α_m) × (10^{-6}/°C)

Temperature/°C	25	400	600
(α_m)	10.32	10.99	11.49

5. Specific Heat (c) J/KG.°C)

Temperature/°C	25	400	600
C	420	510	600

SOFT ANNEALING

Soft annealing in a protective atmosphere at 860 °C~900 °C for 3~5h, followed by slow cooling at 10°C/h down to 500°C, then air cooling.

STRESS RELIEF ANNEALING

Stress-relieving at 750°C ~ 800°C for approximately 2h, then air cooling.

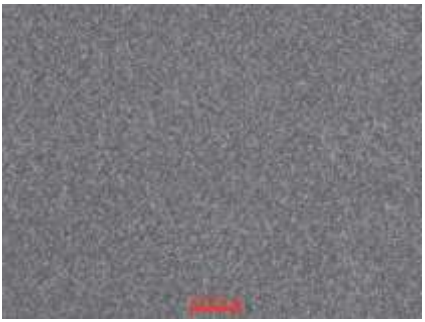
Steel Grade (TPM558)

STRESS RELIEF ANNEALING

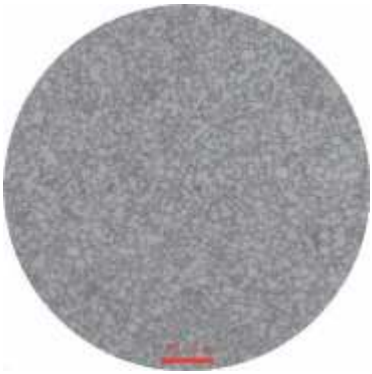
Stress-relieving at 750°C~800°C for approximately 2h, then air cooling.

MICROSTRUCTURE

TPM558 is the 3rd - generation gas - atomized powder, which is completed by HIP, then formed by forging.

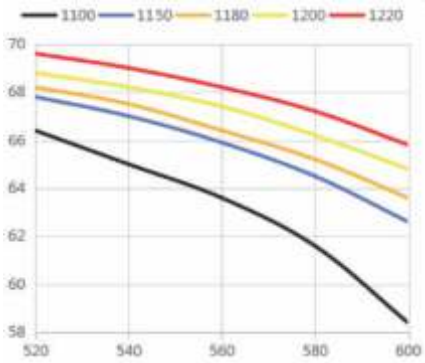


Inhomogeneity of Eutectic Carbide: Level 0

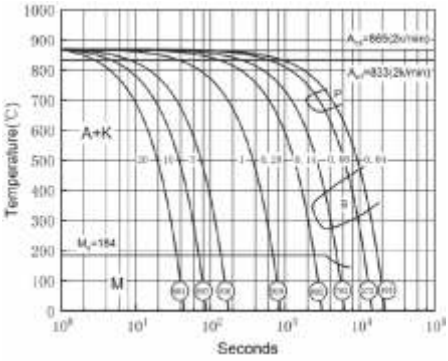


Large Grain Carbide Size : 3.5um

GUIDELINES FOR HARDENING



CCT CURVE



COMPARATIVE PROPERTIES

Steel Grade (TPM638)

CHEMICAL COMPOSITION

C	Cr	W	Mo	V	Co
1.3	4.2	6.4	5.0	3.1	8.5

PRODUCTION DESCRIPTION

TPM638 is high wear resistance, high compressive strength under high hardness, and good hardenability.

Applications: high performance cutting tools, such as end mills, hobs, planers, etc.

SIZE SUPPLIED

Product	Round (mm)	Plate (mm)
Wire Rolled Forged	Φ 3.2-320	200 x 503

Product	Round (mm)	Plate (mm)
TPM638	Φ 1.2-2.4	0.94 x 1.4 -1.68 x 2.0

DELIVERY CONDITION

Typical soft annealed hardness is under 300HB.

MICROSTRUCTURE

1. The carbides are fine and distribution; the carbide size is 5um (The average of size of 3 grain large carbides under 10 fields of view under 1000X, the maximum value is not greater than 5um).
2. The inhomogeneity of eutectic carbide is not more than grade 1.

ULTRASONIC INSPECTION

According to SEP1921- E/e standard
According to GB/T6402-2008 standard grade 4
According to customer requirements

PURITY

Type A		Type B		Type C		Type D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
0	0	1.0	0.5	1.0	0.5	1.0	0.5

PHYSICAL PROPERTIES

1. Density (p) : 8.1g/cm^3
2. Modulus of Electricity (E)KN/mm^2

Temperature/°C	25	400	600
E	240	214	192

3. Thermal Conductivity (λ)W/(m·K)

Temperature/°C	25	400	600
λ	30.97	33.10	31.64

4. Thermal Expansions (α_m) × (10^{-6}/°C)

Temperature/°C	25	400	600
(α_m)	10.42	11.06	11.36

5. Specific Heat (c) J/KG.°C)

Temperature/°C	25	400	600
C	420	510	600

SOFT ANNEALING

Soft annealing in a protective atmosphere at 860 °C~900 °C for 3~5h, followed by slow cooling at 10°C/h down to 500°C, then air cooling.

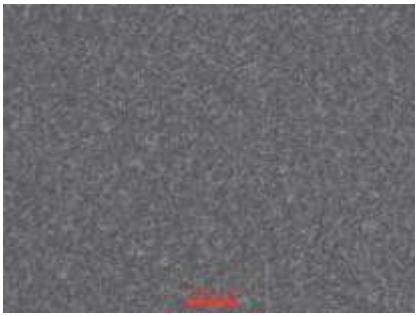
STRESS RELIEF ANNEALING

Stress-relieving at 750°C ~ 800°C for approximately 2h, then air cooling.

Steel Grade (TPM638)

MICROSTRUCTURE

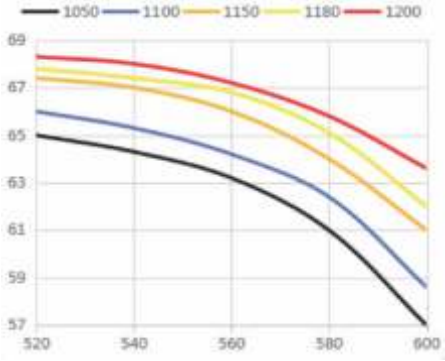
TPM638 is the 3rd - generation gas - atomized powder, which is completed by HIP, then formed by forging.



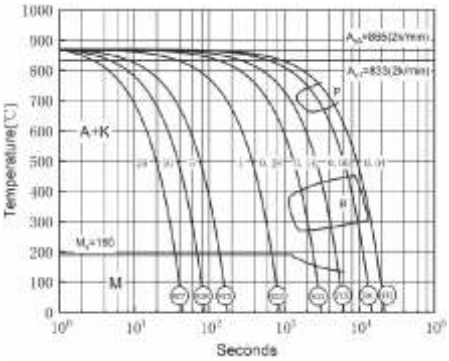
Inhomogeneity of Eutectic Carbide: Level 0

Large Grain Carbide Size : 3.5um

GUIDELINES FOR HARDENING



CCT CURVE



COMPARATIVE PROPERTIES

Steel Grade (TPM6711)

CHEMICAL COMPOSITION

C	Cr	W	Mo	V	Co
2.30	4.2	7.0	6.5	6.5	10.5

PRODUCTION DESCRIPTION

TPM6711 has small carbide particles and uniform distribution, which is a good substrate for PVD and CVD.

Applications: end milling, bearing and other parts, broach, tap, cold working tools, drill, etc.

SIZE SUPPLIED

Product	Round (mm)	Plate (mm)
Wire Rolled Forged	Φ 3.2~300	255 x 510

DELIVERY CONDITION

Typical soft annealed hardness is under 340HB.

MICROSTRUCTURE

1. The carbides are fine and distribution; the carbide size is 5um (The average of size of 3 grain large carbides under 10 fields of view under 1000X, the maximum value is not greater than 5um).
2. The inhomogeneity of eutectic carbide is not more than grade 1.

ULTRASONIC INSPECTION

According to SEP1921- E/e standard
According to GB/T6402-2008 standard grade 4
According to customer requirements

PURITY

Type A		Type B		Type C		Type D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
0	0	1.0	0.5	1.0	0.5	1.0	0.5

PHYSICAL PROPERTIES

1. Density (p) : 8.1g/cm^3
2. Modulus of Electricity (E)KN/mm^2

Temperature/°C	25	400	600
E	250	222	200

3. Thermal Conductivity $(\lambda)W/(m \cdot K)$

Temperature/°C	25	400	600
λ	24	28	27

4. Thermal Expansions $(\alpha_m) \times (10^{-6}/°C)$

Temperature/°C	25	400	600
(α_m)	10	10.6	11.1

5. Specific Heat (c) J/KG.°C)

Temperature/°C	25	400	600
C	420	510	600

SOFT ANNEALING

Soft annealing in a protective atmosphere at 860 °C~900 °C for 3~5h, followed by slow cooling at 10°C/h down to 500°C, then air cooling.

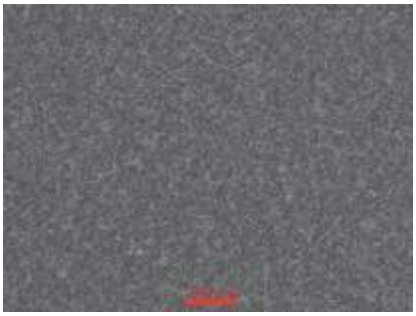
Steel Grade (TPM6711)

STRESS RELIEF ANNEALING

Stress-relieving at 750°C~800°C for approximately 2h, then air cooling.

MICROSTRUCTURE

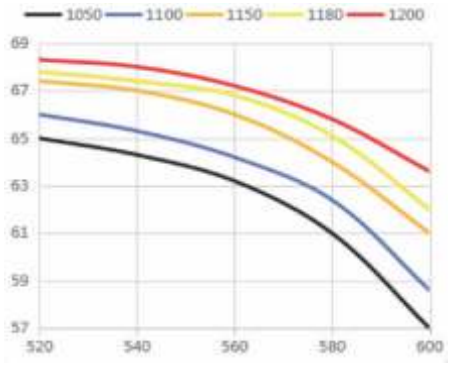
TPM6711 is the 3rd - generation gas - atomized powder, which is completed by HIP, then formed by forging.



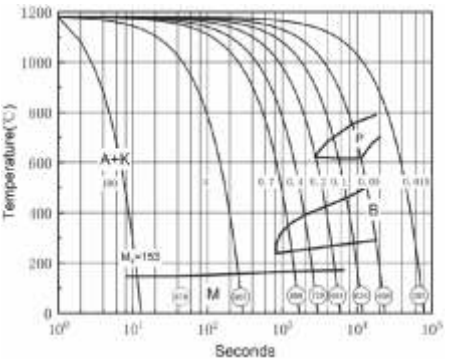
Inhomogeneity of Eutectic Carbide: Level 0

Large Grain Carbide Size : 3.5um

GUIDELINES FOR HARDENING



CCT CURVE



COMPARATIVE PROPERTIES

Steel grade (TG D-2 (DIN-1.2379)

Steel Properties : 12% ledeburitic chromium steel. Maximum wear resistance, good toughness. Best cutting-edge endurance and resistance to tempering, can be nitrided after special heat treatment

Applications: Thread rolling rolls and thread rolling dies, cold extrusion tools, cutting and stamping tools for sheet thicknesses up to 6mm, precision cutting tools up to 12 mm. Cold pilger mandrels, circular-shear blades, deep-drawing tools. pressure pads and highly resistant plastic moulds. E.S.R. materials, high compression strength and fine robustness. The spheroical annealed make it easily processed by shearing and cutting with no crake while processing. Applied in thickness no less than 2mm punch mould, all kind of small mould for shearing and cutter together with screw rolled or slappered mould as well as some other forming mould like rulers.

Similar Steel Grade :

BRAZIL	AUSTRIA	GERMANY		SLOVANIA	ITALY	JAPAN			S.KORIA	CHEZ.REP
VILLARES	BOHLER	DEW	GRODITZ	RAVNE	LUCCHINI	HITACHI	NIPPON	SANYO	DOOSAN	POLDI
VD2	K110	1.2379	1.2379	OCR12VM	DUYOS2379	SLD	KD11V	QC11	STD 11	2002K

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
XT8W6M05Cr4V2	1.45-1.60	≤0.03	≤0.03	0.10-0.60	0.20-0.60	***	11.0-13.0	0.70-1.00	0.70-1.00	***	***	Annealed	≤Hb255

PRODUCTION PROCESS:

EAF→LF→VD→ESR→BLOOM IN FORGED (5TONS HAMMER) → Forged Annealed Turned : Φ 81-1000mm; Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm; Cold Drawn/Centreless Ground : Φ 2.0 -14.4mm → ANNEALED CONDITION

Flat Bar:

EAF → LF → VD → FORGED (5TONS HAMMER) / HOT ROLLED (910) → HOT ROLLED (850) → ANNEALED CONDITION

UT STANDARD:
SEP 1921, (DEC.84)E/e

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
As Hot rolled & forged, delivery condition : Annealed

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed & Peeled	Forged Annealed Turned
Φ 2.0-14.4mm	Φ14.5-80.0mm	Φ81.0-1000mm

SIZE : Flats

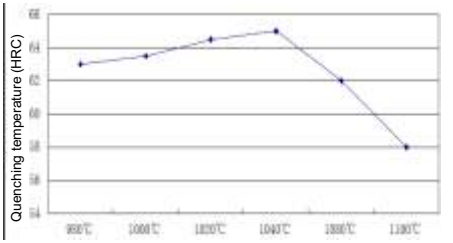
Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Sheets

Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

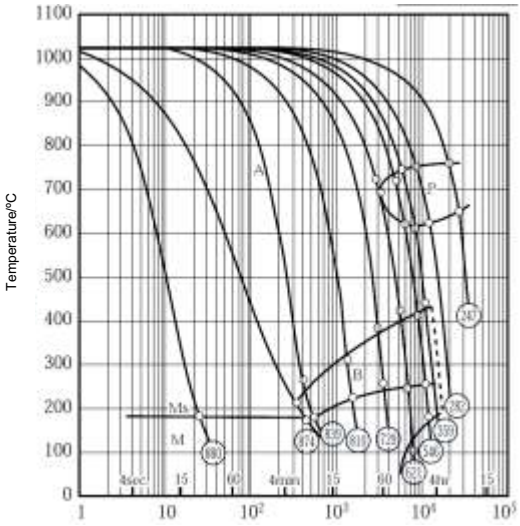
Steel grade (TG D-2 (DIN-1.2379)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 830~860ºC for heat insulation and cooling slowly	1,020~1,040ºC quenching, oil cooling or air cooling	150~250ºC, twice tempering (Underlining tenacity) 500~530ºC, twice tempering (Underlining hardness)



Quenching temperature and hardness relation curve

Tempering temperature and hardness relation curve



CCT curve

Steel grade (TG D-3 (DIN-1.2080)

Steel Properties: Ledeburitic - high - carbon high - chromium tool steel, very high wear-resistance.

Applications : Tools for cutting sheets up to 4mm thickness, trimming dies, blanking dies for paper and plastics, long- and round-section shear blades for sheet thicknesses up to 2 mm, drawing and deep drawing tools. Woodworking tools, stone pressing tools, pressure pads and highly wear-resistant plastic moulds, profile rolls.

Similar Steel Grade :

CHINA	AUSTRIA	GERMANY	SLOVANIA	JAPAN	CHEZ REP
TG	BOHLER	DEW	RAVNE	SANYO	POLDI
D3	K100	1.2080	OCR12	QC1	2002

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
XT8W6M05Cr4V2	1.90-2.20	≤0.02	≤0.03	0.10-0.40	0.15-0.45	***	11.0-12.0	***	****	***	***	Annealed	≤Hb250

PRODUCTION PROCESS:

Round Bar:

EAF→LF→VD→ESR→(5TONS HAMMER) → Forged Annealed Turned : Φ 81-610mm; Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm; Cold Drawn/Centreless Ground : Φ 2.0 -14.4mm → ANNEALED CONDITION

Flat Bar:

EAF→LF→VD →FORGED →HOT ROLLED (910)→ ANNEALED CONDITION

UT STANDARD:
SEP 1921, (DEC.84)E/e

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
In Annealed Condition

SIZE : Rounds

Cold Drawn/Centreless Ground Bar	Hot Rolled Annealed & Peeled	Forged Annealed Turned
Φ 2.0-14.4mm	Φ14.5-80.0mm	Φ81.0-610.0mm

SIZE : Flats

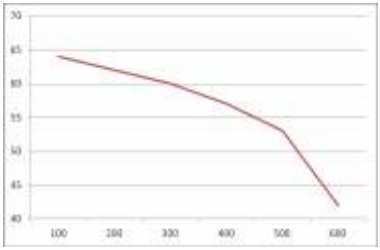
Thickness	Width
5mm-150mm	5mm-810mm

SIZE : Sheets

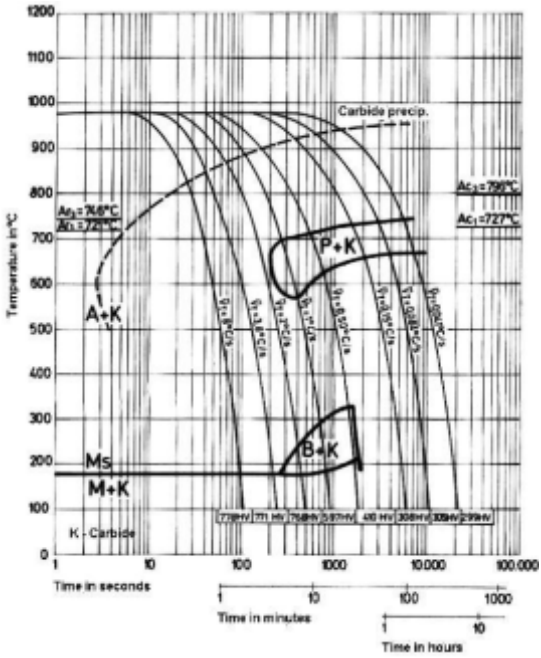
Thickness	Width	Length
0.5mm to 12mm	810mm	2500mm

Steel grade (TG D-3 (DIN-1.2080)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 830~880ºC for heat insulation and cooling slowly	950~980ºC quenching, oil cooling	180~200ºC twice tempering, HRC60~62



Tempering temperature and hardness relation curve



CCT curve

Steel grade (O1)

Smelting method: (1) EAF +LF+VD; (2) electric arc furnace +LF+VD+ESR

Main characteristics:

Favorable thermal treatment deformation resistance, favorable tenacity under high temperature, favorable machining, extremely stable dimension under hardening, as well as extremely high hardness and relatively high tenacity on surfaces.

Major applications:

- ✧ Widely used in cutting, cold pressing and forming tools;
- ✧ Applicable to cold pressing, line cutting die, outfits and shearing dies.

Chemical constituent %:

C	Si	Mn	Cr	Mo	W	V	P	S
1.0	0.25	1.1	0.6	≤0.3	0.6	0.1	≤0.030	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.85	-	30	-	12.9	14

Ultrasonic flaw detection:

Electric furnace steel: flaw detection standard: as per SEP1921- D/d flaw detection or GB/T6402-2008 Class 3, or as per customer requirements.

Electroslag steel: flaw detection standard: as per SEP1921- E/e flaw detection or GB/T6402-2008 Class 4, or as per customer requirements.

Purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Electroslag steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.0	1.0	1.	1.0	1.5	1.0

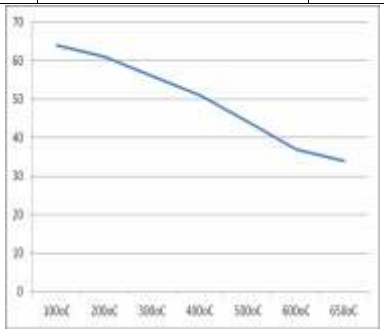
Delivery state: (1) delivery under annealing state, delivery hardness ≤220HB;
(2) Pearlite organization shall be evaluated as Class 1~5 as per standard drawing A.3 in GB/T1299-2014.

Supply specification:

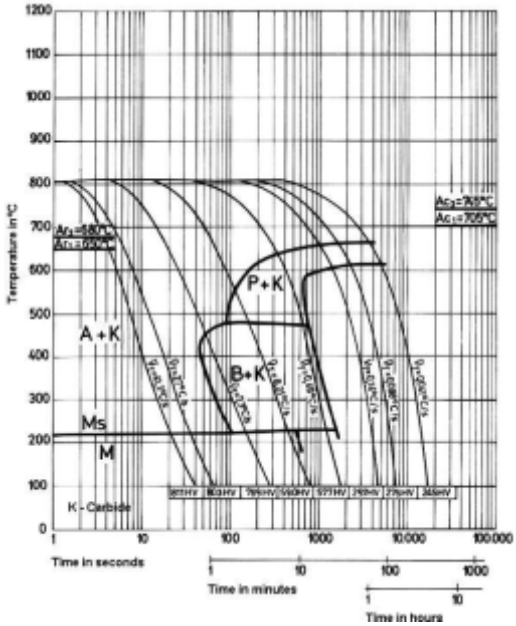
Product name	Supply specification of electric furnace steel/mm	Supply specification of electroslag steel/mm
Forged round bar	Φ70~300	Φ70~300
Rolled round bar	Φ16~70	Φ16~70
Rolled flat bar	(6.5~120)* (200~810)	(6.5~120)* (200~810)
Small flat steel	Small flat steel of various specifications with thickness under 30mm and width of 150mm	
Sheet metal	Sheet metal with thickness under 12mm	

Steel grade (O1)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 780ºC for heat insulation; cooling to 650ºC at 15ºC/h for air cooling	800~850ºC quenching, oil cooling	Minimum tempering temperature 180ºC, selecting tempering temperature as per hardness requirements and tempering for twice



Tempering temperature and hardness relation curve



CCT curve

Steel grade (O2)

Smelting method: (1) EAF+LF+VD; (2) electric arc furnace +LF+VD+ESR

Main characteristics:

Extremely high dimension stability during heat treatment, quite high crack resistance, high machining performance and medium abrasion performance.

Major applications:

- ✧ Mainly used for production of measuring implements;
- ✧ Used for producing woodworking tools and cutting blades;
- ✧ Mainly used for producing cutting tools, cold shearing blades, screw cutting tools, etc.

Chemical constituent %:

C	Si	Mn	Cr	Mo	W	V	P	S
0.	0 25	2.0	0.35	-	-	0.1	≤0.030	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.85	460	30	210,000	13.3	14.3

Ultrasonic flaw detection:

Electric furnace steel: flaw detection standard: as per SEP1921- D/d flaw detection or GB/T6402-2008 Class 3, or as per customer requirements.

Electroslag steel: flaw detection standard: as per SEP1921- E/e flaw detection or GB/T6402-2008 Class 4, or as per customer requirements.

Purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Electroslag steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.	1.0

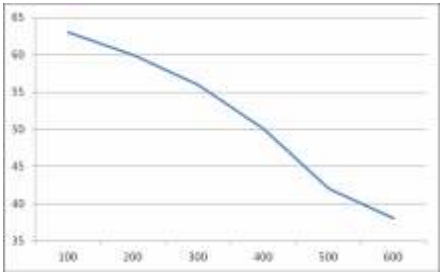
Delivery state: (1) delivery under annealing state, delivery hardness ≤220HB;
(2) Pearlite organization shall be evaluated as Class 1~5 as per standard drawing A.3 in GB/T1299-2014.

Supply specification:

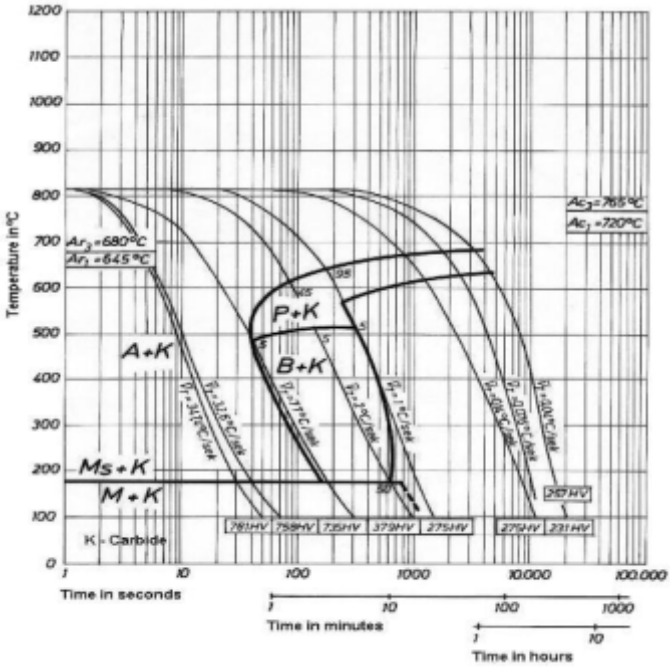
Product name	Supply specification of electric furnace steel/mm	Supply specification of electroslag steel/mm
Forged round bar	Φ70~300	Φ70~300
Rolled round bar	Φ16~70	Φ16~70
Rolled flat bar	(12~70)* (200~610)	(12~120)* (200~810)
Small flat steel	Small flat steel of various specifications with thickness under 30mm and width of 150mm	
Sheet metal	Sheet metal with thickness under 10mm	

Steel grade (O2)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 690~720ºC for heat insulation and cooling slowly in the furnace	790~820ºC quenching, oil cooling	Selecting tempering temperature as per hardness; times of tempering: twice



Tempering temperature and hardness relation curve



CCT curve

Steel grade (A2) 1.2363

Smelting method: (1) EAF+LF+VD; (2) electric arc furnace +LF+VD+ESR

Main characteristics:

Air-cooling quenching chromium steel, certain impact tenacity, favorable abrasion performance, favorable air-cooling quenching dimension deformation, even and small carbides, favorable tenacity and high abrasion performance.

Major applications:

- ✧ Stretching dies, edge curling dies and embossing dies;
- ✧ Stamping dies and cold forming dies;
- ✧ Abrasive plastic forming dies;
- ✧ Cutting tools.

Chemical constituent %:

C	Mn	Cr	Mo	W	V	P	S
1.0	0.7	5.1	1.15	-	0.3	≤0.030	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
7.7	460.5	26	203,000	12.9	13.8

Ultrasonic flaw detection:

Electric furnace steel: flaw detection standard: as per SEP1921- D/d flaw detection or GB/T6402-2008 Class 3, or as per customer requirements.

Electroslag steel: flaw detection standard: as per SEP1921- E/e flaw detection or GB/T6402-2008 Class 4, or as per customer requirements.

Purity: Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5
Electroslag steel:							
Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.

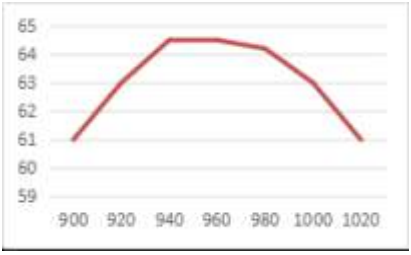
Delivery state: (1) delivery under annealing state, delivery hardness ≤245HB.

Supply specification:

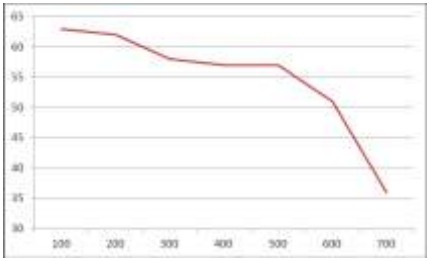
Product name	Supply specification of electric furnace steel/mm	Supply specification of electroslag steel/mm
Forged round bar	Φ70~200	Φ70~513
Rolled round bar	Φ16~70	Φ16~70
Rolled flat bar	(12~70)* (200~610)	(12~120)* (200~810)
Small flat steel	Small flat steel of various specifications with thickness under 30mm and width of 150mm	
Sheet metal	Sheet metal with thickness under 10mm	

Steel grade (A2) 1.2363

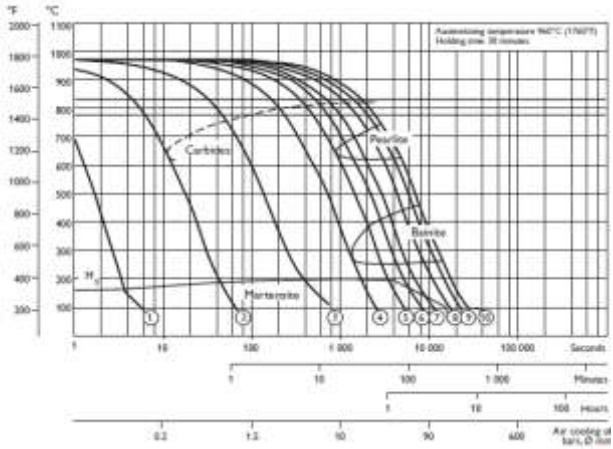
Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 850ºC for heat insulation; cooling to 650ºC at 10ºC/h for air cooling	940~960ºC quenching; gas cooling; small simple workpieces; capable of oil cooling	Minimum tempering temperature 180ºC, selecting tempering temperature as per hardness requirements and tempering for twice



Quenching temperature and hardness relation curve



Tempering temperature and hardness relation curve



CCT curve

Steel grade (TGX6) DC53

Smelting method: (1) EAF+LF+VD; (2) electric arc furnace +LF+VD+ESR

Main characteristics:

Relatively high tenacity, high abrasion performance, little heat treatment dimension deformation, improved coarse carbides and excellent processing performance.

Major applications:

- ✧ Mainly used for precision cold pressing molds: precision punching and cutting of line cutting processing, stamping dies of various applications, etc.
- ✧ Long-life automobile covered piece molds: inlaid molds of key parts.
- ✧ cut-off dies, edge rolling dies, wire drawing dies and screw dies.

Chemical constituent %:

C	Si	Mn	Cr	Mo	W	V	P	S
0.93	0.95	0.40	7.8	1.90	-	0.25	≤0.03	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.85	0.45	20.5	218,000	11.9	12.3

Ultrasonic flaw detection:

Electric furnace steel: flaw detection standard: as per SEP1921- D/d flaw detection or GB/T4162 Class B, or as per customer requirements.

Electroslag steel: flaw detection standard: as per SEP1921- E/e flaw detection or GB/T4162 Class A, or as per customer requirements.

Purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Electroslag steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

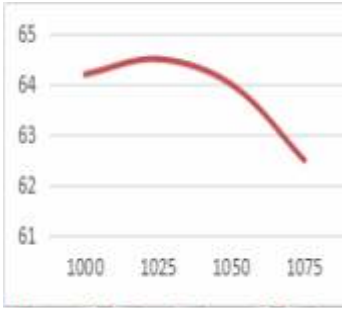
Delivery state: (1) Delivery hardness: delivery under annealing state, ≤255HB;
(2) Unevenness of eutectic carbide shall comply with BÖHLER standard;

Supply specification:

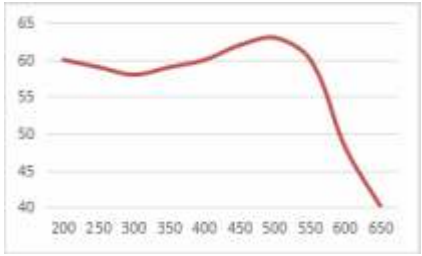
Round steel	Flat steel	Module
Φ 1~310mm	12~120×200~660mm	120~150×300~600mm

Steel grade (TGX6) DC53

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 850ºC for heat insulation; cooling to 650ºC at 10ºC/h for air cooling	1,030~1,050 quenching gas cooling and oil cooling (Simple shape)	Low temperature tempering: 180~200, tempering for twice High temperature tempering: 500~550, tempering for twice

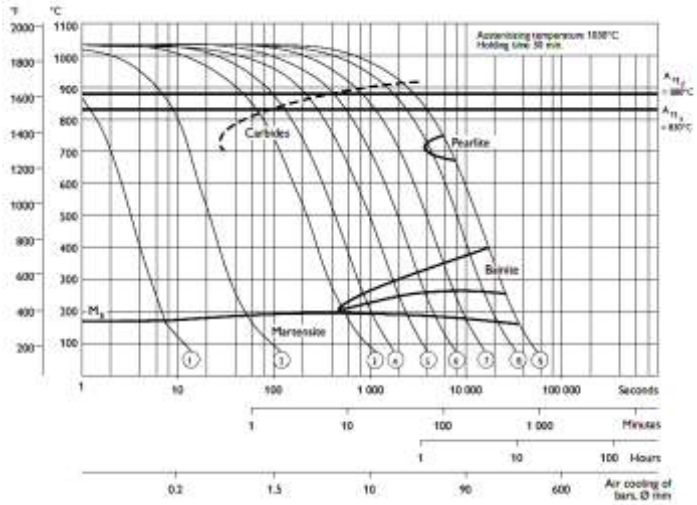


Quenching temperature and hardness relation curve



Tempering temperature and hardness relation curve

Austenite temperature: 1,030ºC, heat insulation for 30min



CCT curve

Steel grade (A8M)

Smelting method: (1) EAF+LF+VD; (2) EAF+LF+VD+ESR

Main characteristics:

Extremely high quenching, strong hardening, high abrasion performance and extremely high compression strength.

Major applications:

✧ Bearing small impact load during manufacturing, highly resistant cold punching, cold shearing cutting, drill sleeves, gages, wire drawing dies, screw plates, drawing dies, screw thread rolling dies, and other dies.

Chemical constituent %:

C	Si	Mn	Cr	Mo	W	V	P	S
2.05	0.25	0.3	11.5	-	-	-	≤0.030	≤0.010

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	Room temperature thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.67	460	20	210,000	12.0	12.9

Ultrasonic flaw detection:

Electric furnace steel: flaw detection standard: as per SEP1921- D/d flaw detection or GB/T6402-2008 Class 3, or as per customer requirements.

Electroslag steel: flaw detection standard: as per SEP1921- E/e flaw detection or GB/T6402-2008 Class 4, or as per customer requirements.Purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Electroslag steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

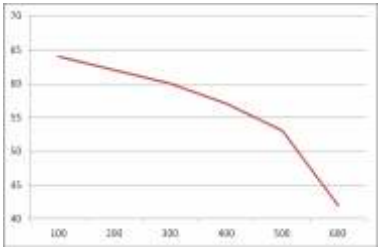
Delivery state: (1) Delivery hardness: delivery under annealing state, ≤255HB;
(2) Unevenness of eutectic carbide shall comply with BÖHLER standard.

Supply specification:

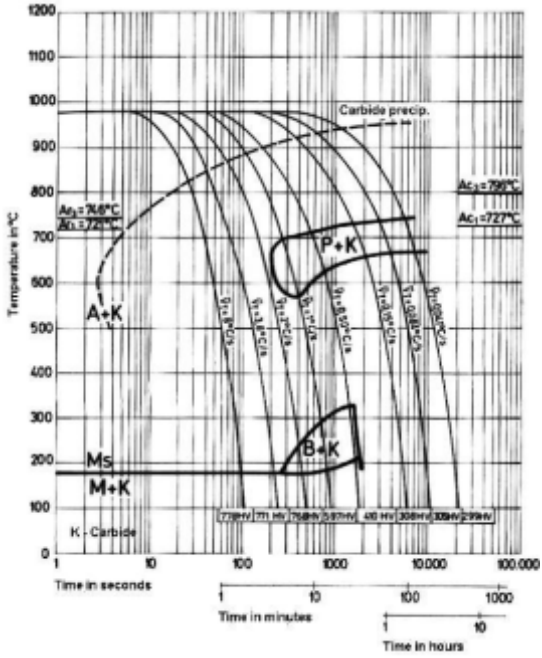
Product name	Supply specification of electric furnace steel/mm	Supply specification of electroslag steel/mm
Forged round bar	Φ70~500	Φ70~550
Forged module	(120~200)* (300~620)	(120~350)* (300~810)
Rolled round bar	Φ16~70	Φ16~70
Rolled flat bar	(12~120)* (200~630)	(12~120)* (200~810)
Small flat steel	Small flat steel of various specifications with thickness under 30mm and width of 150mm	
Sheet metal	Sheet metal with thickness under 10mm	

Steel grade (A8M)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 830~880ºC for heat insulation and cooling slowly	950~980ºC quenching, oil cooling	180~200ºC twice tempering, HRC60~62



Tempering temperature and hardness relation curve



CCT curve

Steel grade (S7 (SIHARD 2357 Steel)

Description: S7 is a general purpose air hardening tool steel having high impact and sock resistance. it has good resistance to softening at moderately high temperatures. This combination of properties makes it suitable for many hot-work and cold-work applications.

Applications : Chisels, rivet sets, punches, driver bolts. Hot punching and shearing.

Physical properties (average values) at ambient temperature : Density [gcm^3] : 7.86

Equivalent Grades

TG	RAVNE	MAT. NO.	DIN	EN	AISI/SAE
S7	OH253	1.2357	50CrMoV13-1	--	S7

Chemical Composition (in weight%)

C	Si	Mn	Cr	Mo	Ni	V	W	Others
0.50	0.50	3.25	3.25	1.50	--	0.25	--	--

Coefficient of Linear Thermal Expansion 10^{-6} $^0C^{-1}$

20-100^{0}C	20-200^{0}C	20-300^{0}C	20-400^{0}C	20-500^{0}C	20-600^{0}C	20-700^{0}C
11.7	12.9	13.3	13.8	14.1	14.3	14.6

Soft Annealing : Heat 810-850^{0}C, cool slowly in furnace. This will produce a maximum brinell hardness of 229.

Stress Relieving: To Relieve machining stresses for greater accuracy in hardening - first rough machine, then anneal below the critical 649/677^{0}C a minimum of one hour at temperature and cool slowly, then finish machine.

Hardening: Harden from a temperature 930-960^{0}C followed by air or oil quenching. Hardness after quenching is 59-61 HRC.

Tempering : Tempering temperature: 150-400^{0}C

Tempering Temperature(^{0}C) vs. Hardness (HRC)

100^{0}C	200^{0}C	300^{0}C	400^{0}C	500^{0}C	550^{0}C	600^{0}C	650^{0}C
59	57	54	53	52	52	48	41

Forging Hot forming temperature : 1060-1121^{0}C

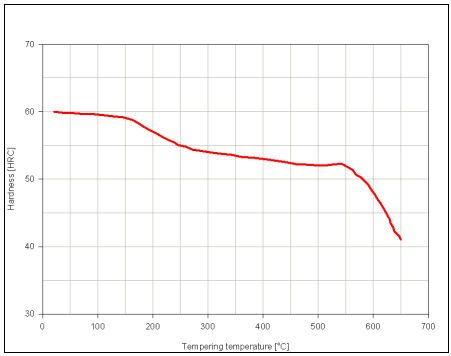
Machinability :
The machinability of S7 alloy may be rated at about 75/80 % of a 1% carbon tool steel.

Corrosion Resistance :
Corrosion resistance of this alloy is better than that of plain carbon steels. However it will rust unless given protective treatment.

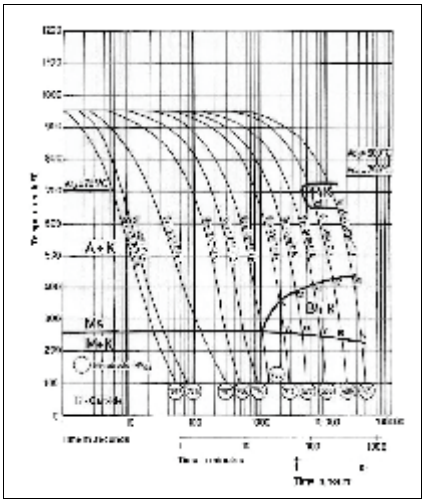
Forms manufactured : Please see Dimensional Sales Programe.

Steel grade (S7 (SIHARD 2357 Steel)

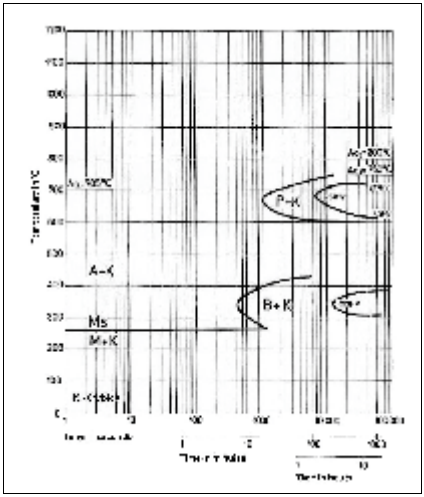
Tempering Diagram



Continuous Cooling Transformation (CCT) Diagram



Time-Temperature Transformation (TTT) Diagram



Disclaimer: The information and data presented herein are typical or average value and are not a guarantee of maximum or minimum values. Applications specify suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes. These is no representation that the recipient of this literature will receive updated editions as the become available.

Steel grade (1.2767)

Smelting process: (1) EAF+LF+VD, (2) EAF+LF+VD+ESR

Main characteristics:

Nickel cold work tool steel is characterized by good harden ability and toughness; good polishing performance and anti corrosion treatment ability.

Main application:

- Hot-forging die for metal processing and tool for extrusion;
- Molds with various shapes and dimensions;
- Mold, axis sleeve, core rod, etc.

Chemical component %:

C	Si	Mn	Cr	Mo	Ni	V	P	S
0.45	0.35	0.35	1.35	0.25	4.05	≤0.1	≤0.03	≤0.03

Physical property:

Density at room temperature (Kg/m^3)	Specific heat at room temperature (J/Kg·K)	Heat conductivity at the temperature of 200℃ (W/m•K)	Elasticity modulus (N/mm^2)	Coefficient of linear expansion ($\times 10^{-6}K$)	
				20~200℃	20~400℃
7.84	-	28	-	12.5	13.4

Ultrasonic flaw detection:

Electric furnace steel: detection standard: conduct flaw detection according to SEP1921-D/d grade, conduct grade assessment of 3 levels according to GB/T6402-2008 or conduct flaw detection according to clients' requirements.

Electro slag steel : detection standard: flow detection shall conform to SEP1921-E/e grade, conduct grade assessment of 4 levels according to GB/T6402-2008 or conduct flaw detection according to clients' requirements.

Degree of purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine series	Rough series	Fine series	Rough series	Fine series	Rough series	Fine series	Rough series
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Class A		Class B		Class C		Class D	
Fine series	Rough series	Fine series	Rough series	Fine series	Rough series	Fine series	Rough series
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

Electro-slag steel:

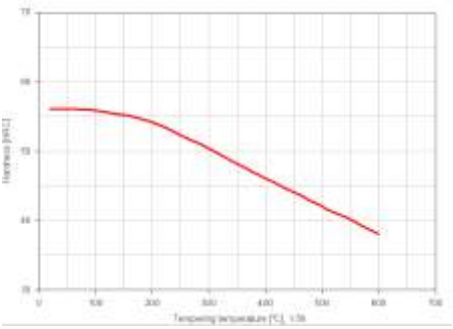
Delivery state: (1) delivery under annealing conditions, annealing hardness ≤260 HB.

Steel grade (1.2767)

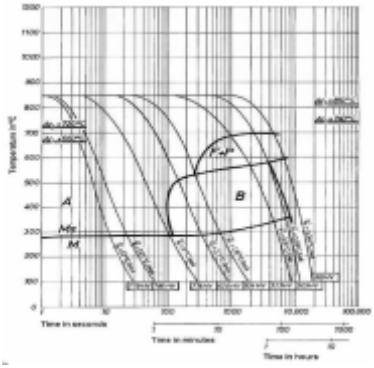
Specification of supply:

Round bar	module
≤500mm	Thickness ≤300mm, width ≤800mm

Heat treatment		
Softening annealing	Quenching	Tempering
Heat to 610℃ to 850℃, carry out heat preservation and cooling in furnace	Hardening temperature is 840℃ to 870℃, carry out air cooling	Select tempering temperature as per clients' requirement



Relation Curve Between Tempering Temperature and Hardness



CCT Curve

Steel grade (TSFD2)

Smelting Method: Intermediate Frequency Furnace → Ladle Furnace → Vacuum Degassing → Spray Forming

Main Features: High purity, small size and uniform distribution of carbides, high hardenability, small deformation in heat treatment, good toughness, excellent wear resistance, and long service life.

Main application:

- Long-life precision cold stamping die, cold shear die, thread rolling die, imprinting die;
- Precision measuring tools, such as advanced gauges;
- Long-life cold heading mold;
- Roller steel and parts with high segregation requirements.

Chemical Component wt. %:

C	Si	Mn	Cr	Mo	W	V	P	S
1.5	0.35	0.4	12.0	0.75	-	0.75	≤0.03	≤0.015

Physical property:

Density at (Kg/m^3)	Specific Heat (J/Kg·K)	Thermal Conductivity at 200℃ (W/m•K)	Elasticity Modulus (N/mm^2)	Coefficient of linear expansion (×10^{-6}K)	
				20~200℃	20~400℃
7.70	450	20	210000	11.3	12.1

Ultrasonic Flaw Detection:

Flaw Detection Standard: according to SEP 1921-E/e level of flaw detection and GB/T6502-2008 level 4 of assessment or upon customer-specific requirements.

Cleanlineness

Class A		Class B		Class C		Class D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.0

Delivery Status:

- Delivery in annealed state, hardness ≤ 255HB.
- The inhomogeneity of eutectic carbide is less than or equal to grade 2 or grade 3 for respectively diameter ≤ 200mm or for diameter ≤ 300mm.

Φ 115mm
Spray Ingot
Eutectic Carbide
Unevenness:
grade 1 →

Φ 120mm
Mold Ingot
Eutectic Carbide
Unevenness:
← **grade 3**

Steel grade (TSFD2)

Φ115mm Spray Ingot
Large Carbide Size: 22.4um

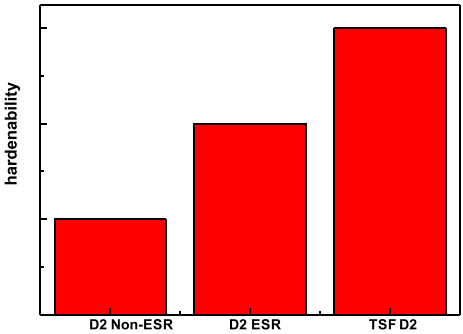
Φ120mm Mold Ingot
Large Carbide Size: 69um

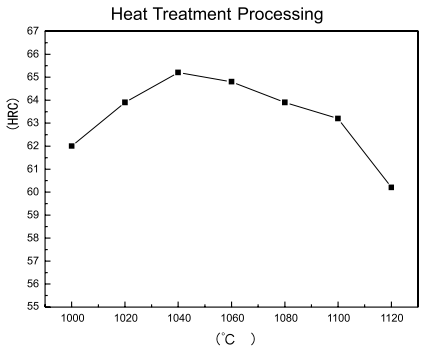
Φ263.5mm Spray Ingot
Eutectic Carbide Unevenness: grade 3

Φ280mm Mold Ingot
Eutectic Carbide Unevenness: grade 5

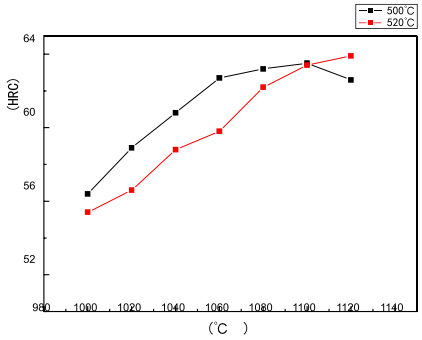
Specification

Product	Spray Ingot, mm
Forged Round Steel	Φ16~300





Quenching Hardness vs. Quenching Temperature of D2 Spray Ingot



Tempering Hardness vs. Quenching Temperature of D2 Spray Inot
Remark: The quenching and tempering temperature can be chosen depending on Customer's requirement.

Steel grade (TSFDC53)

Smelting Method: Intermediate Frequency Furnace (15ton) → Ladle Furnace → Vacuum Degassing → Spray Forming

Main Features:
Improve coarse carbides, small size deformation of heat treatment, high toughness, high wear resistance, superior processing performance.

Main application:
- Precision cold stamping des: precision blanking for wire cutting, stamping dies for various purposes;
- Long-life automobile panel mold: insert molds for key parts;
- Trimming, hemming, wire drawing, thread rolling die.

Chemical Component wt. %:

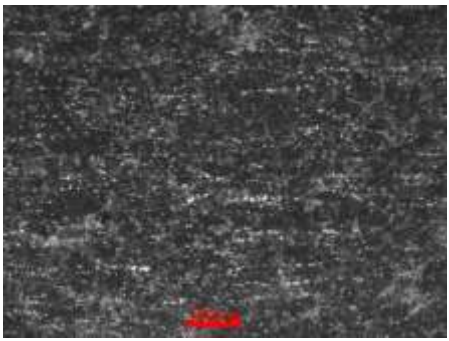
C	Si	Mn	Cr	Mo	W	V	P	S
0.93	0.95	0.40	7.8	1.90	-	0.25	≤0.03	≤0.010

Ultrasonic Flaw Detection:
Flaw Detection Standard: according to SEP 1921-E/e level of flaw detection and GB/T6502-2008 level 4 of assessment or upon customer-specific requirements.

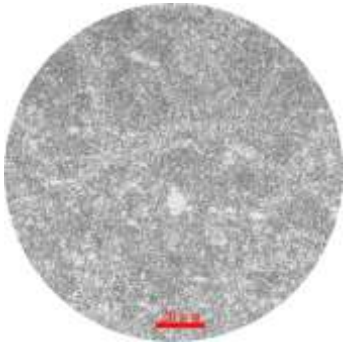
Cleanlineness

Class A		Class B		Class C		Class D	
Thin	Thick	Thin	Thick	Thin	Thick	Thin	Thick
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.0

Delivery Status:
- Delivery in annealed state, hardness ≤ 255HB.
- The inhomogeneity of eutectic carbide is less than or equal to grade 2 or grade 3 for respectively diameter ≤ 200mm or for diameter ≤ 300mm.

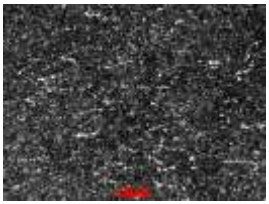


Φ241mm Spray Ingot
Eutectic Carbide Unevenness: grade 1.5

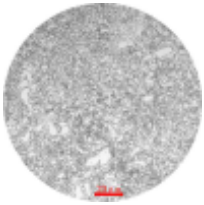


Φ241mm Spray Ingot
Large Carbide Size: 11.7um

Steel grade (TSFDC53)



210×410mm Spray Ingot
Eutectic Carbide Unevenness:
grade 2



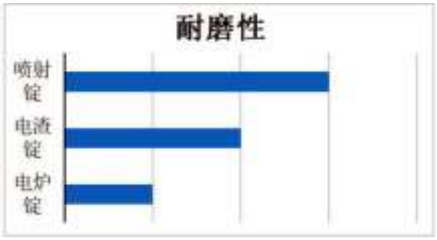
210×410mm Spray Ingot
Large Carbide Size:
14.2um

Φ 141mm Electroslag
Remelted Ingot
Eutectic Carbide
Unevenness: grade 4

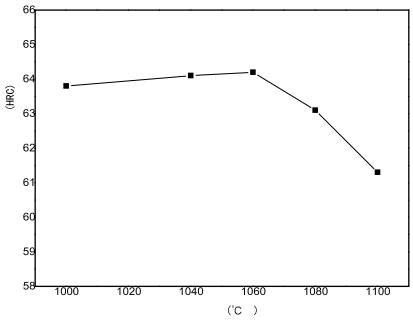
Φ 141mm Electroslag
Remelted Ingot
Large Carbide Size:
45um

Specification

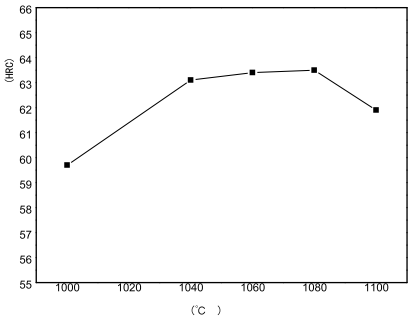
Product	Round Steel	Module
Specification	22-300	120×610~250×410



Heat Treatment Processing



Quenching Hardness vs. Quenching Temperature of DC53 Spray Ingot



Tempering Hardness vs. Quenching Temperature of DC53 Spray Ingot
Remark: The quenching and tempering temperatures can be chosen depending on customer's requirement.

Steel grade (TG H-13 DIN-1.2344) & (TG H-13M DIN-1.2345)

Steel Properties: High hot-wear resistance, high hot tensile strength and toughness. Good thermal conductivity and insusceptibility to hot cracking. Can be water-cooled to a limited extent.

Applications: Hot-work tool steel for universal use. Pressure casting dies and metal extrusion tools for processing light metals, forging dies, moulds, screws and barrels for plastic processing, nitrided ejectors, hot-shear blades. Suitable for Aluminium Extrusion Die & Aluminium Copper Forging Dies.

H13 has high hard resistance and hardness.

Suitable for Aluminium Extrusion Die, and Aluminium Copper forging Die.

Similar Steel Grade :

CHINA	BRAZIL	AUSTRIA	GERMANY		SLOVANIA	ITALY	JAPAN			S.KORIA	TAIWAN	CHEZ.REP
TG	VILLARES	BOHLER	DEW	GRODITZ	RAVNE	LUCCHINI	HITACHI	NIPPON	SANYO	DOOSAN	GLORIA	POLDI
H13	VH13IM	W302	1.2344	1.2344	UTOP M02-EFS	ESKY0S2344	DAC	KDA	QD61	STD 61	GMH13 (ESR)	TLI EFS

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
H13	0.35-0.42	≤ 0.030	≤ 0.030	0.80-1.20	0.25-0.50	***	4.80-5.50	1.20-1.50	0.85-1.15	***	***	Annealed	≤ HB235
H13M	0.47-0.52	≤ 0.030	≤ 0.030	0.80-1.20	0.25-0.50	***	4.80-5.50	1.20-1.50	0.85-1.15	***	***	Annealed	≤ HB235

PRODUCTION PROCESS:

Round Bar:

EAF→LF→VD→ESR→(5TONS HAMMER) → Forged Annealed Turned : Φ 81-810mm; Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm; Cold Drawn/Centreless Ground : Φ 2.0 -14.4mm — ANNEALED CONDITION

Flat Bar:

EAF→LF→VD →ESR →FORGED→ HOT ROLLED (850)→ ANNEALED CONDITION

UT STANDARD:
SEP 1921, (DEC.84)E/e

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
In Annealed Condition

SIZE : Rounds

Cold Drawn/Ground Bar	Hot Rolled Annealed & Peeled Bar	Forged + Annealed + Turned Bar
Φ 2.0-14.4mm	Φ14.5-80.0mm	Φ81.0-810.0mm

SIZE : Hot Rolled Flat Bars / Sand Blasted & Machined Straight

Thickness	Width
5mm - 410mm	10mm - 810mm

Steel grade (TG H-13 DIN-1.2344) (TG H-13M DIN-1.2345)

HEAT TREATMENT CONDITION :

Quenching temperature	: 1020-1050°C
Cooling Medium	: air-cooling
Tempering temperature	: 550-650°C
Tempering times	: 2Times, the tempering temperature in the second time should be lower than in first time
Tempering Hardness	: 47-48HRC.

Tempering °C	500°C	550°C	600°C
HRC	HRC56	HRC54	HRC50

Steel grade (TGE13)

Smelting method: EAF+LF+VD+ESR

Main characteristics:

Excellent heat resistance and crack resistance, quite high tenacity, quite high ductility, favorable isotropic, favorable processability and polishability as well as favorable dimension stability during heat treatment.

Major applications:

- ✧ For various metal pressure casting molds, for example: automobile engine cylinder body, cylinder cover, gearbox shell molds;
- ✧ Hot extrusion molds, mainly for hot extrusion of aluminum profiles;
- ✧ High-quality plastic molds, for example, high abrasion resistance plastic molds for automobiles.

Chemical constituent %:

C	Si	Mn	Cr	Mo	V	P	S
0.38	0.90	0.35	5.0	1.35	0.95	≤0.015	≤0.002

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity (×10^{-6}K)	
				20~200ºC	20~400ºC
7.80	430	22	215,000	11.3	11.9

Ultrasonic flaw detection:

As per SEP1921: E/e flaw detection or GB/T4162 Class AA flaw detection, i.e., flat bottom hole ≤Φ 1mm, no flaw detection noise wave shall appear or please comply with customer regulations.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

Delivery state:

(1) Delivery hardness: delivery under annealing state, delivery hardness ≤229HB;
(2) Organization state and impact power requirement: the organization and segregation shall comply with North American Die Casting Association No. 207 criterion;
(3) Impact power sample: please sample according to the central part of steel. The samples shall be treated according to criteria in North American Die Casting Association, making sure that hardness of samples at 45±2HRC. Dimension of samples: 7*10*55. Gapless.

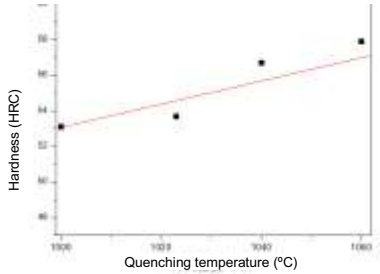
Specification (diameter, thickness mm)	Average impact power at the center part not less than (J)	Minimum impact power per sample not less than (J)
＞60～300	240	150
＞300	180	100

Supply specification:

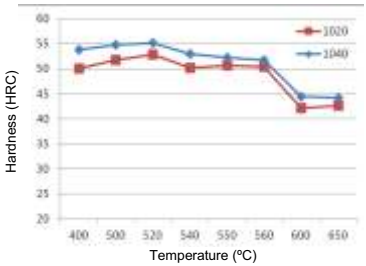
Product name	Specification/mm	Material
Forged round bar	Φ70～500	TGE13
Forged module	(120～400)× (300~800)	TGE13
Rolled round bar	Φ16～70	TGE13
Rolled flat bar	(12～120)× (200~810)	TGE13

Steel grade (TGE13)

Thermal treatment		
Softening annealing	**Quenching**	**Tempering**
Heating to 850ºC for heat insulation; cooling to 600ºC at 10ºC/h for air cooling	1020~1040ºC quenching; high speed gas quenching or hot oil cooling	Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 425~550ºC

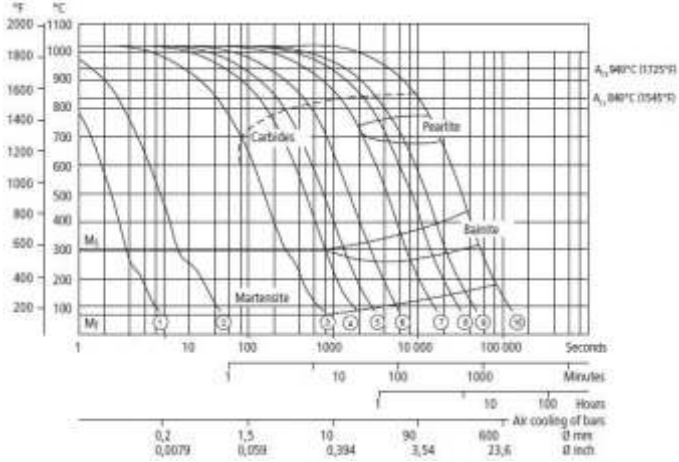


Quenching temperature and hardness relation curve



Tempering temperature and hardness relation curve

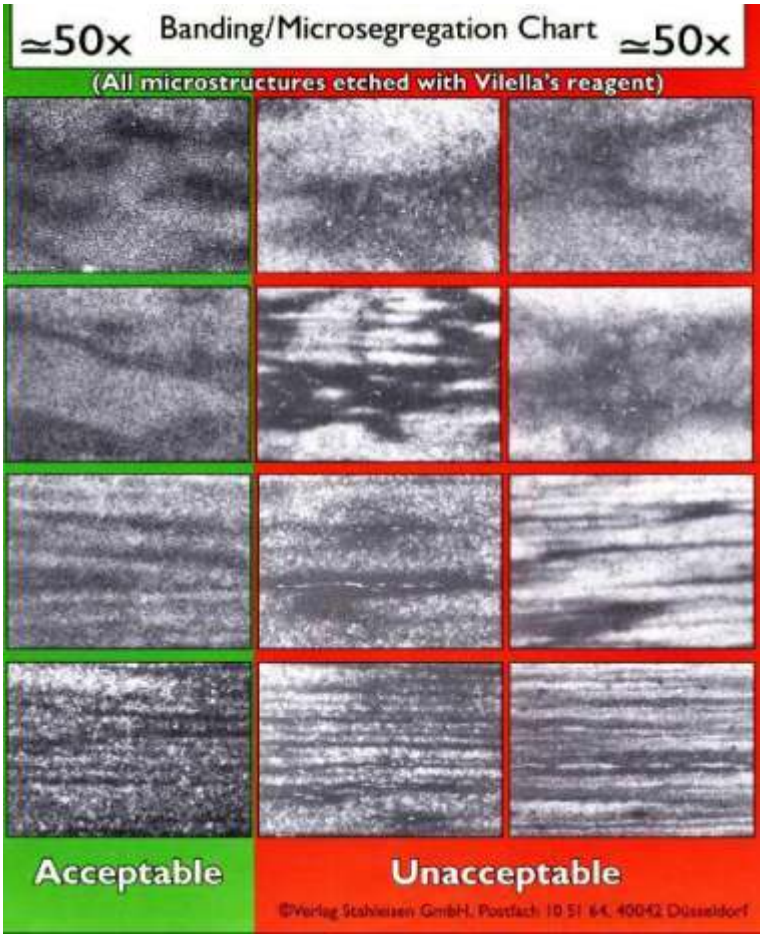
Austenite temperature: 1,020ºC, heat insulation for 30min



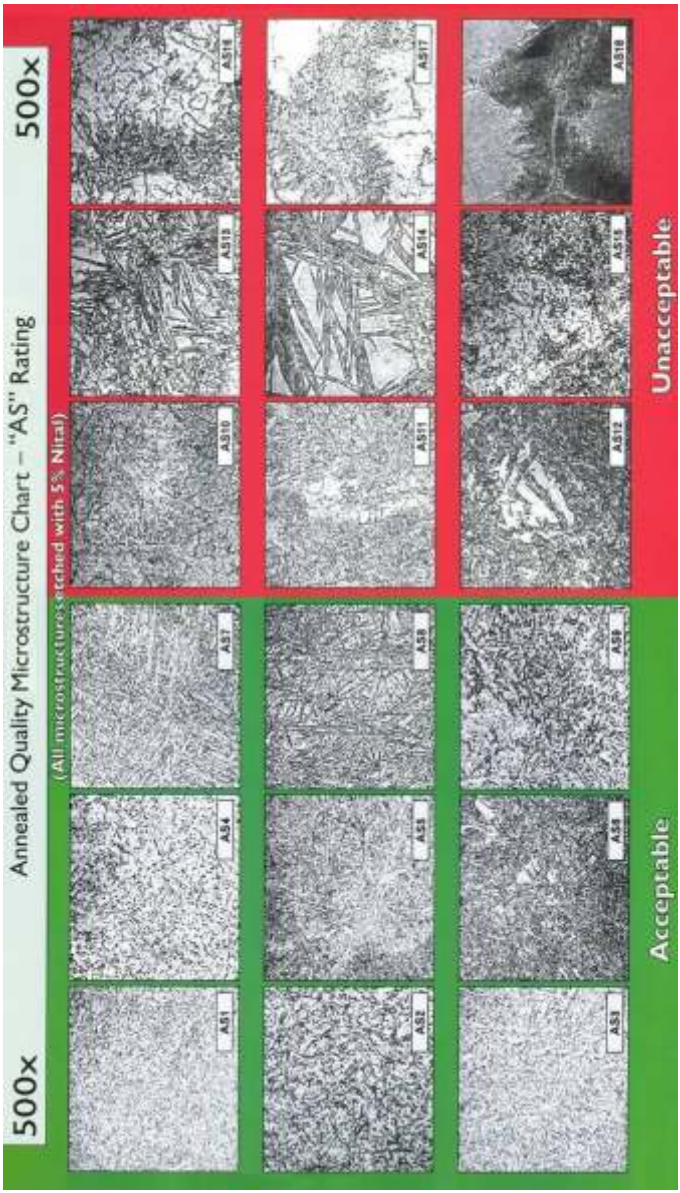
CCT curve

NADCA organization evaluation atlas

Banding microsegregation chart



Balling annealing microstructure chart



Steel grade (TGGP13)

Smelting method: EAF+LF+VD+ESR

Main characteristics:
High ductility, high thermal fatigue resistance, high thermal erosion resistance, high isotropic property, high purity and small heat treatment distortion.

Major applications:
- ✧ Long-life Al, Mg and Zn alloy pressure casting molds, for example: automobile engine cylinder body, cylinder cover, gearbox shell molds.
- ✧ Large-scale hot extrusion molds: for example, aluminum alloy hot extrusion molds for high-speed rails and metros.
- ✧ Precise hot forging molds: for example, automobile engine crankshaft and connecting rod molds; gear molds of gear boxes.

Chemical constituent %

C	Si	Mn	Cr	Mo	V	P	S
0.39	1.1	0.4	5.3	1.45	1.0	≤0.009	≤0.001

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity (×10 K)	
				20~200ºC	20~400ºC
7.80	430	22	215000	11.3	11.9

Ultrasonic flaw detection:
As per SEP1921: E/e flaw detection or GB/T4162 Class AA flaw detection, i.e., flat bottom hole ≤Φ 1mm, no flaw detection noise wave shall appear or please comply with customer regulations.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.	1.0	0.5	0.5	0	1.0	0.5

Delivery state:
(1) Delivery hardness: delivery under annealing state, delivery hardness ≤229HB;
(2) Organization state and impact power requirement: the organization and segregation shall comply with North American Die Casting Association No. 207 criterion;
(3) Impact power sample: please sample according to the central part of steel. The samples shall be treated according to criterions in North American Die Casting Association, making sure that hardness of samples at 45±2HRC. Dimension of samples: 7*10*55. Gapless.

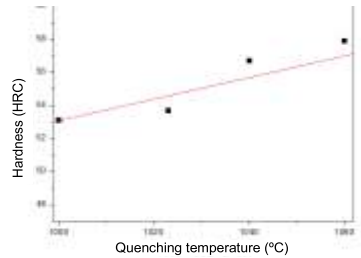
Specification (diameter, thickness mm)	Average impact power at the center part not less than (J)	Minimum impact power per sample not less than (J)
＞60～300	300	250
＞300	300	200

Supply specification:

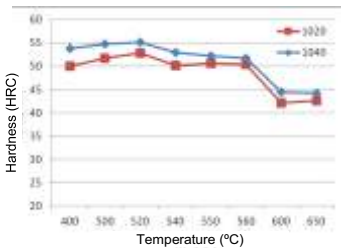
Product name	Specification/mm	Material
Forged round bar	Φ70～500	TGGP13
Forged module	(120～400)× (300~800)	TGGP13
Rolled round bar	Φ16～70	TGGP13
Rolled flat bar	(12～120)× (200~810)	TGGP13

Steel grade (TGGP13)

Thermal treatment		
Softening annealing	**Quenching**	**Tempering**
Heating to 850ºC for heat insulation; cooling to 600ºC at 10ºC/h for air cooling	1,020~1,040ºC quenching; high speed gas quenching or hot oil cooling	Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 425~550ºC

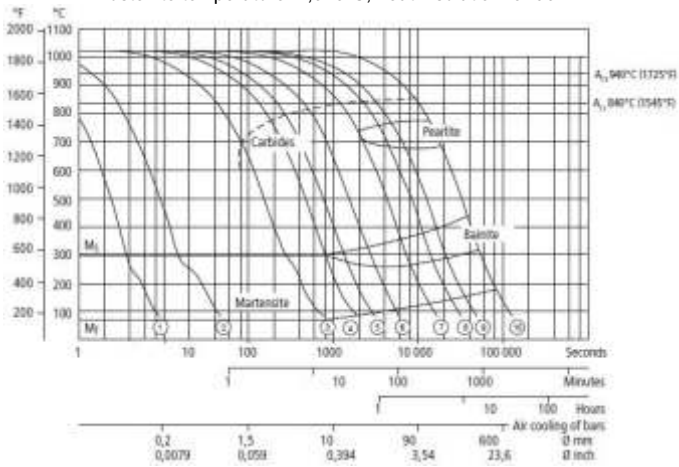


Quenching temperature and hardness relation curve



Tempering temperature and hardness relation curve

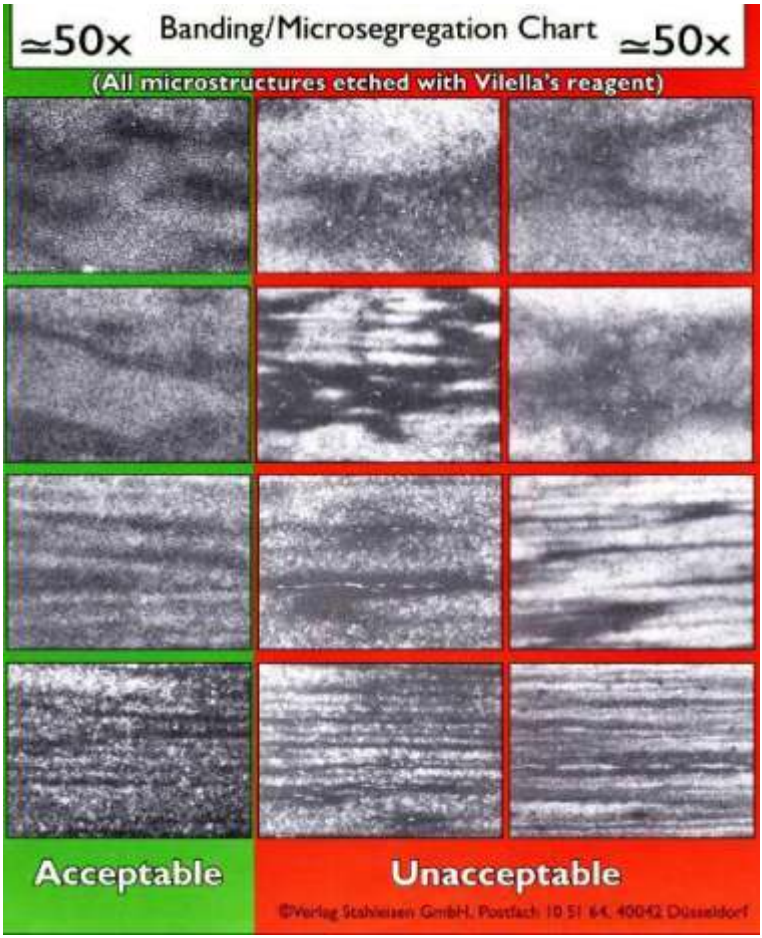
Austenite temperature: 1,020ºC, heat insulation for 30min



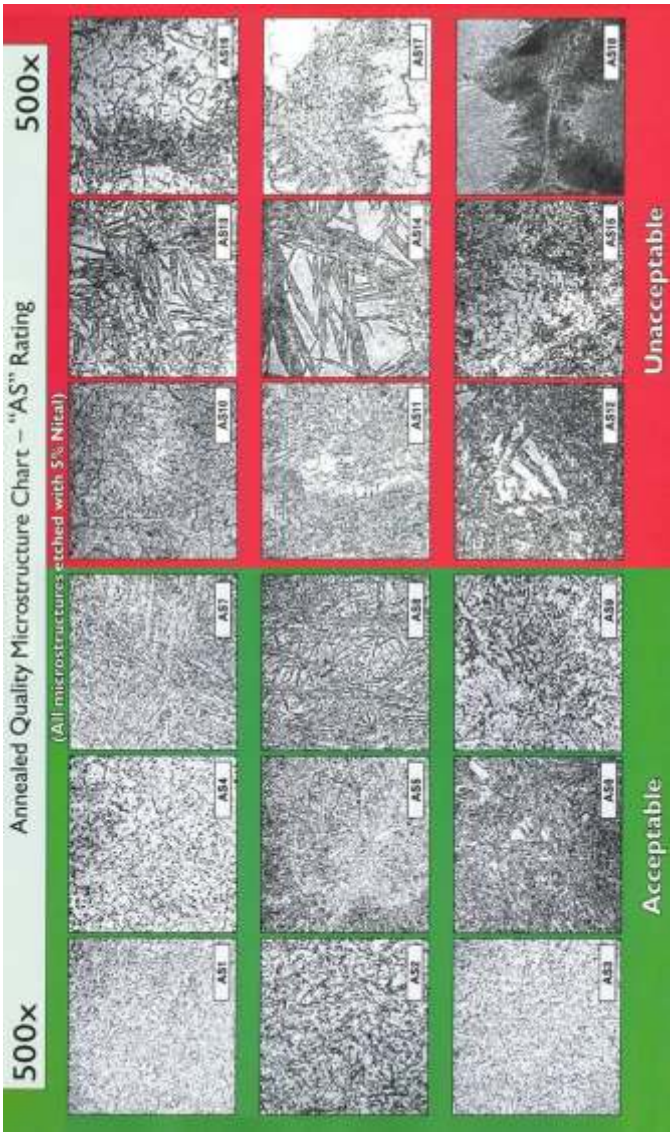
CCT curve

NADCA organization evaluation atlas

Banding microsegregation chart



Balling annealing microstructure chart



Steel grade (TGE23)

Smelting method: EAF+LF+VD+ESR

Main characteristics:
High ductility, high thermal fatigue resistance, high thermal erosion resistance, high isotropic property, high purity and small heat treatment distortion.

Major applications:
- ✧ Mainly used for processing of light alloy – metal pipes, rods, extruded carrier rods, molds, and extruded molds, etc.
- ✧ Pressure casting equipment, molded trimming die, compression moulding inserts, etc.
- ✧ Hot shearing blades, plastic molds, etc.

Chemical constituent %:

C	Si	Mn	Cr	Mo	V	P	S
0.37	0.3	0.4	5.0	2.2	0.45	≤0.015	≤ .001

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.85	460	29.7	215,000	12	12.5

Ultrasonic flaw detection:
As per GB/T4162 Class AA flaw detection, i.e., flat bottom hole ≤Φ 1mm, no flaw detection noise wave shall appear or please comply with customer regulations.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

Delivery state:
(1) Delivery hardness: delivery under annealing state, delivery hardness ≤229HB;
(2) Organization state and impact power requirement: the organization and segregation shall comply with North American Die Casting Association No. 207 criterion;
(3) Impact power sample: please sample according to the central part of steel. The samples shall be treated according to criterions in North American Die Casting Association, making sure that hardness of samples at 45±2HRC. Dimension of samples: 7*10*55. Gapless.

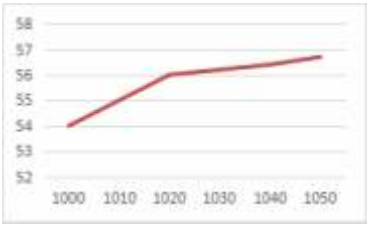
Specification (diameter, thickness mm)	Average impact power at the center part not less than (J)	Minimum impact power per sample not less than (J)
≥60～200	380	350
≥201-300	350	300
≥ 01	300	250

Supply specification:

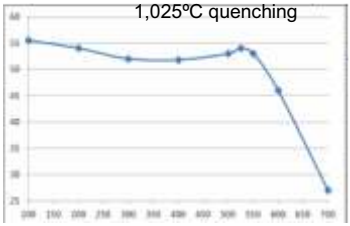
Product name	Specification/mm	Material
Forged round bar	Φ70～450	TGE23
Forged module	(120～400)× (300～800)	TGE23
Rolled round bar	Φ16-70	TGE23
Rolled flat bar	(12～120)× (200~810)	TGE23

Steel grade (TGE23)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 850ºC for heat insulation; cooling to 600ºC at 10ºC/h for air cooling	1,020~1,040ºC quenching; high-speed gas quenching or hot oil cooling	Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 450~550ºC

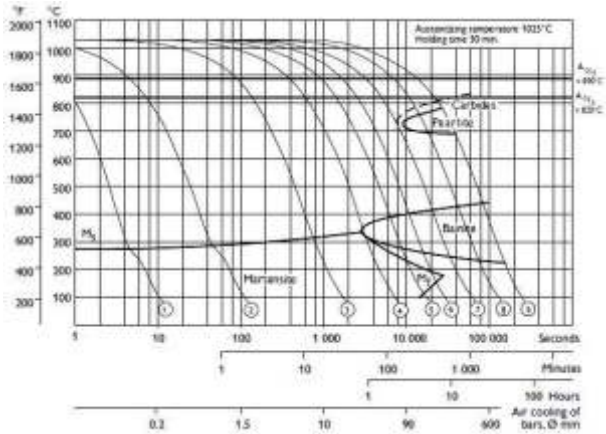


Quenching temperature and hardness relation curve



Tempering temperature and hardness relation curve

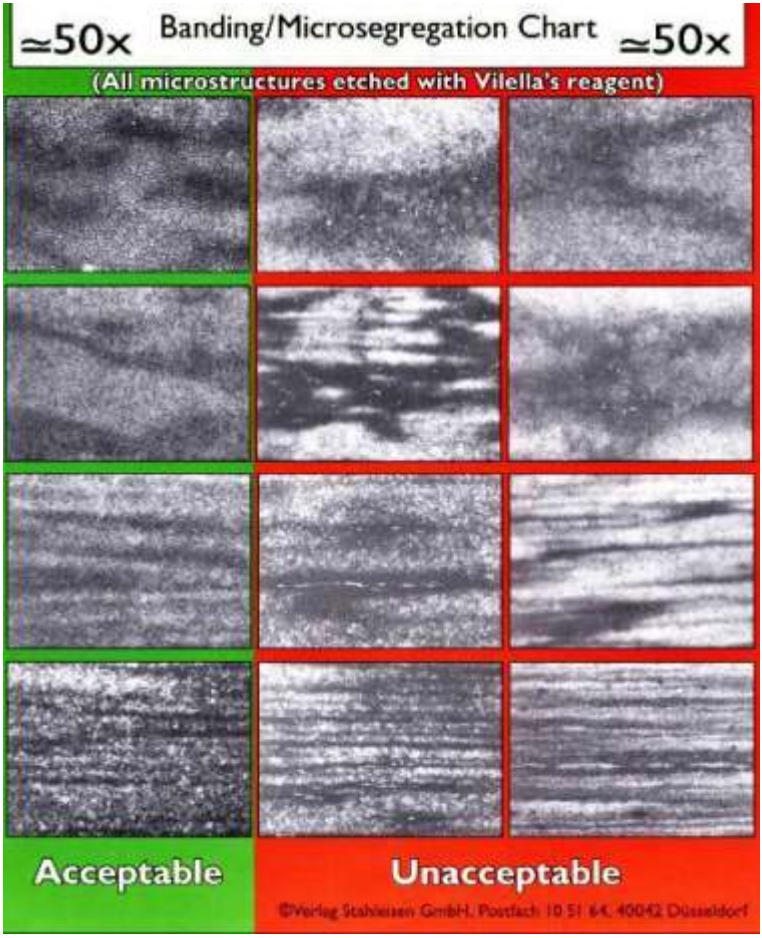
Austenite temperature: 1,025ºC, heat insulation for 30min



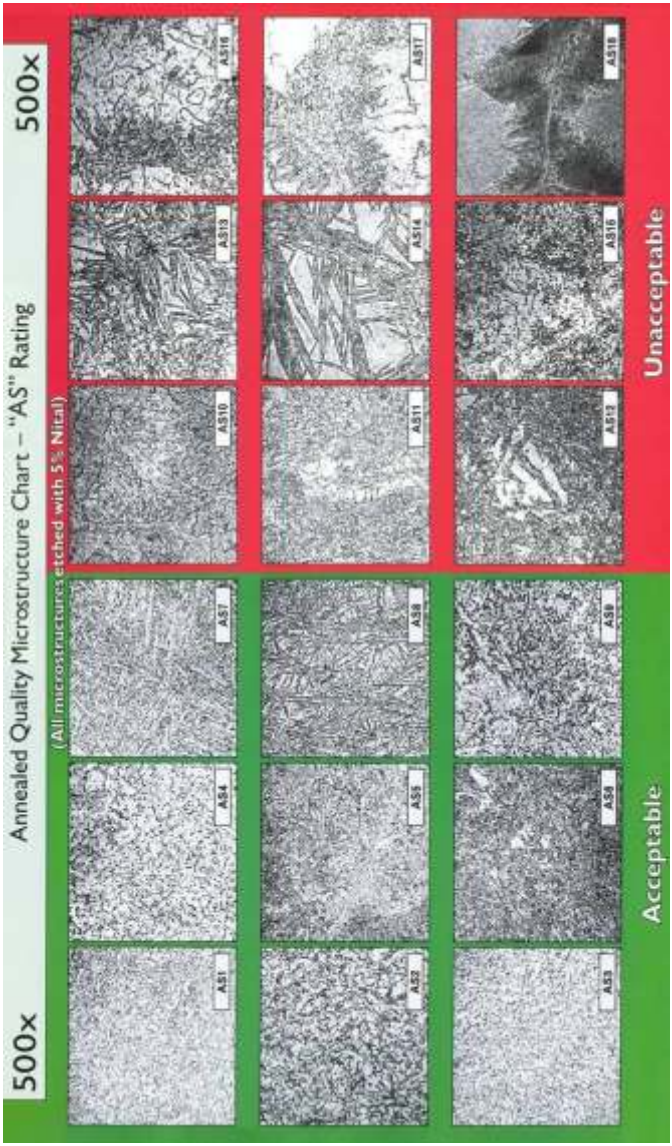
CCT curve

NADCA organization evaluation atlas

Banding microsegregation chart



Balling annealing microstructure chart



Steel Grage (TG H11 DIN-1.2343) & (TG H11M)

Steel Properties: High hot tensile strength and toughness. Good thermal to hot cracking. Can be water-cooled to a limited extent.

Applications: Hot-work tool steel for universal use. Pressure casting dies and metal extrusion tools for processing light metals, forging dies, moulds, screws and barrels for plastic processing, shrink rings, hot-shear blades.

Similar Steel Grade :

CHINA	BRAZIL	AUSTRIA	GERMANY		SLOVANIA	JAPAN	TAIWAN	CHEZ.REP
TG	VILLARES	BOHLER	DEW	GRODITZ	RAVNE	SANYO	GLORIA	POLDI
H11	TENAX 300	W300	1.2343	1.2343 VICTORY	UTOP M01-EFS	QDA61	GMH11	TLH EFS

Chemical Composition: (%)

Indian	Chemical Analysis Typical Value % (Min - Max)											Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
H11	0.33-0.41	≤0.030	≤0.030	0.80-1.20	0.20-0.50	***	4.80-5.50	4.70-5.20	1.10-1.50	***	***	Annealed	≤Hb235
H11M	0.47-0.52	≤0.030	≤0.030	0.80-1.20	0.20-0.50	***	4.80-5.50	4.70-5.20	1.10-1.50	***	***	Annealed	≤Hb235

PRODUCTION PROCESS:

Round Bar:

EAF→LF→VD→ESR→(5TONS HAMMER) → Forged Annealed Turned : Φ 81-810mm; Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm; Cold Drawn/Centreless Ground : Φ 2.0 -14.4mm — ANNEALED CONDITION

Flat Bar:

EAF→LF→VD →ESR →FORGED→ HOT ROLLED (850)→ ANNEALED CONDITION

UT STANDARD:
SEP 1921, (DEC.84)E/e

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
In Annealed Condition

SIZE : Rounds

Cold Drawn/Ground Bar	Hot Rolled Annealed & Peeled Bar	Forged + Annealed + Turned Bar
Φ 2.0-14.4mm	Φ14.5-80.0mm	Φ81.0-810.0mm

SIZE : Hot Rolled Flat Bars / Sand Blasted & Machined Straight

Thickness	Width
5mm - 410mm	10mm - 810mm

Steel Grage (TG H11 DIN-1.2343) & (TG H11M)

Heat Treatment Condition :

Quenching temperature : 1020-1050°C
Cooling Medium : air-cooling
Tempering temperature : 550-650°C
Tempering times : 2 Times, the tempering temperature in the second time should be lower than in first time
Tempering Hardness : 47-48HRC.

Tempering °C	500°C	550°C	600°C
HRC	HRC56	HRC54	HRC50

Steel grade (TGGP11)

Smelting method: EAF+LF+VD+ESR

Main characteristics:

Excellent tenacity and ductibility along all direction; high thermal fatigue resistance, favorable polishability, favorable dimension stability and favorable quenching.

Major applications:

- ✧ Pressure casting molds;
- ✧ Hot extrusion molds of aluminum, copper and magnesium ally;
- ✧ High-polishing plastic injection molds.

Chemical constituent %

C	Si	Mn	Cr	Mo	V	P	S
0.37	1.0	0.37	5.2	1.3	0.45	≤0.009	≤0.001

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.85	460	29.2	215,000	13.4	13.2

Ultrasonic flaw detection:

Flaw detection standard: as per SEP1921: E/e flaw detection or class 4 criterion in GB/T6402-2008, i.e., flat bottom hole ≤Φ 2mm or as per customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

Delivery state:

(1) Delivery hardness: delivery under annealing state, delivery hardness ≤229HB;

(2) Organization state and impact power requirement: comply with North American Die Casting Association No. 207 criterion;

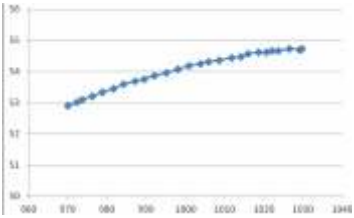
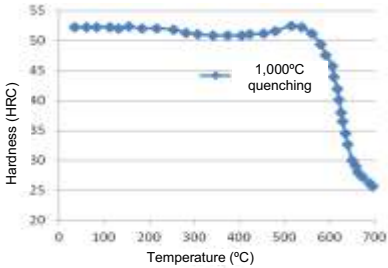
(3) Impact power sample: please sample according to the central part of steel. The samples shall be treated according to criterions in North American Die Casting Association, making sure that hardness of samples at 45±2HRC. Dimension of samples: 7*10*55. Gapless.

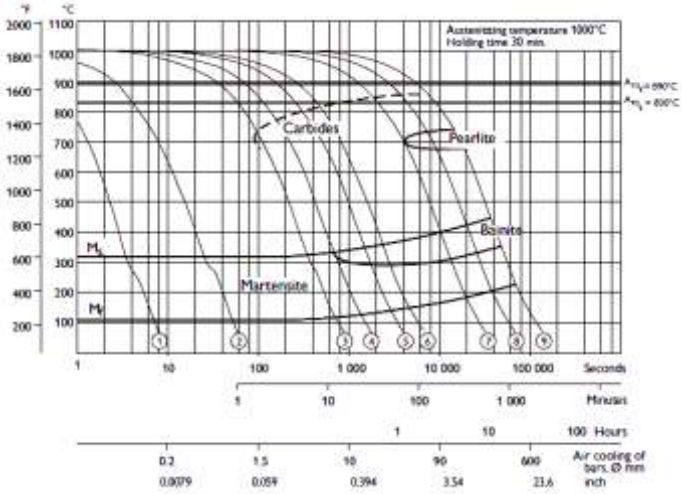
Specification (diameter, thickness mm)	Average impact power at the center part not less than (J)	Minimum impact power per sample not less than (J)
＞60～250	250	200
＞250	220	180

Supply specification:

Product name	Specification/mm	Material
Forged round bar	Φ70-500	TGGP11
Forged module	(120-400)* (300-1,000)	TGGP11
Rolled round bar	Φ16-70	TGGP11
Rolled flat bar	(12-120)* (200-810)	TGGP11

Steel grade (TGGP11)

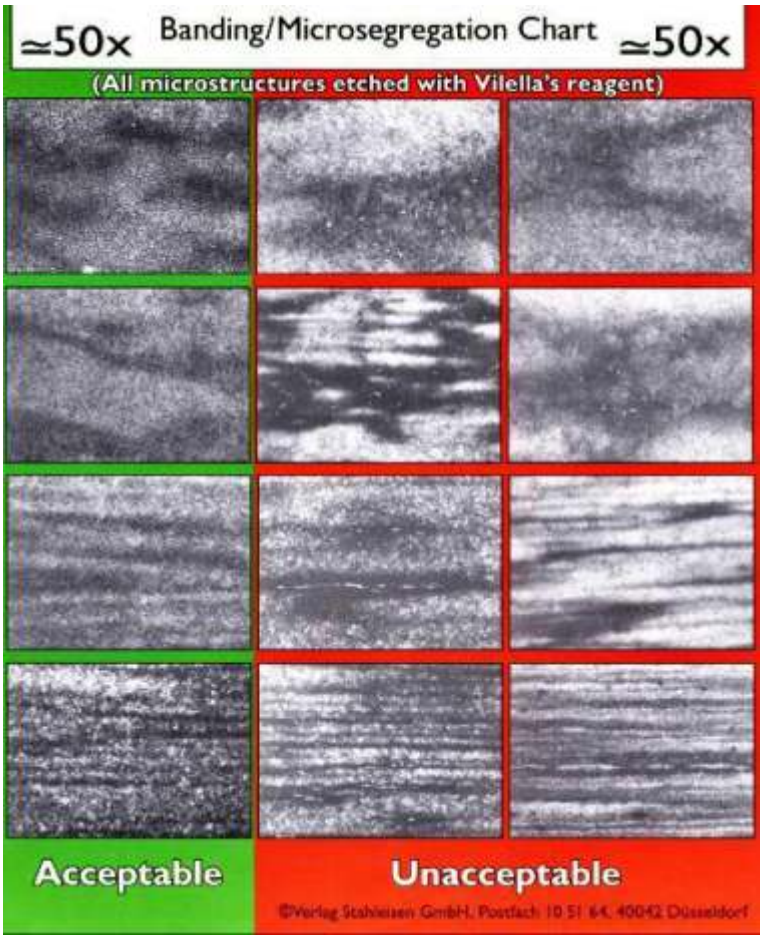
<table>
<tr><td colspan="3">Thermal treatment</td></tr>
<tr><td>Softening annealing</td><td>Quenching</td><td>Tempering</td></tr>
<tr><td>Heating to 850ºC for heat insulation; cooling to 650ºC at 10ºC/h for air cooling</td><td>980~1,000ºC quenching; high-speed gas quenching or hot oil cooling</td><td>Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 450~550ºC</td></tr>
<tr><td colspan="2"> 
Quenching temperature and hardness relation curve</td><td> 

Tempering temperature and hardness relation curve</td></tr>
<tr><td colspan="3">Austenite temperature: 1,000ºC, heat insulation for 30min
 

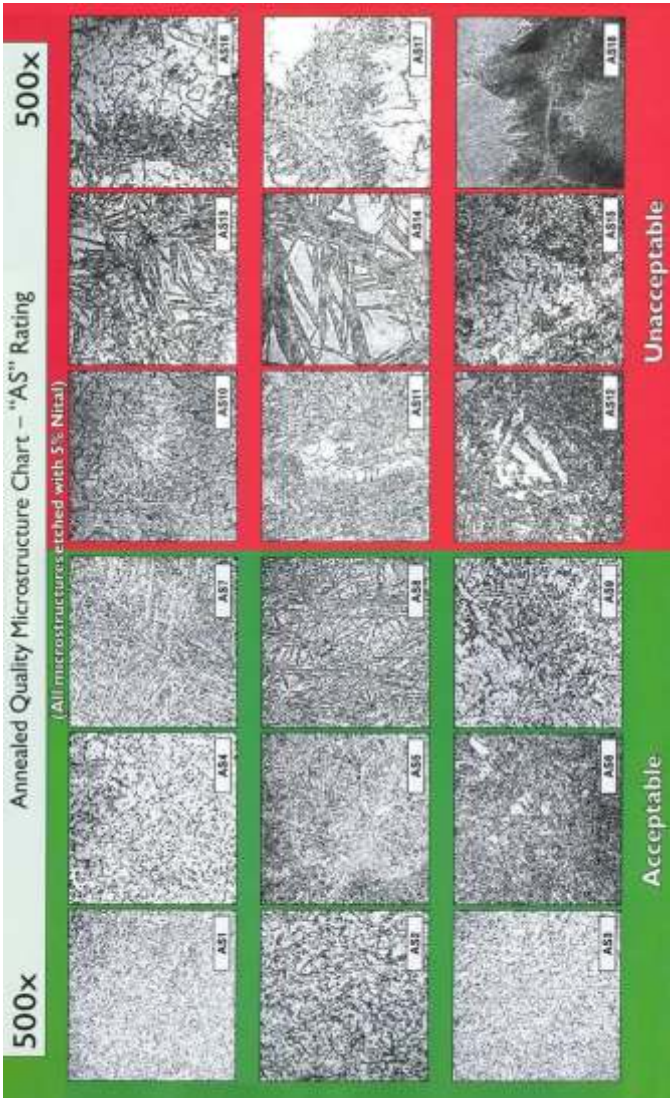
CCT curve</td></tr>
</table>

NADCA organization evaluation atlas

Banding microsegregation chart



Balling annealing microstructure chart



Steel grade (1.2367 SUP)

Smelting method: EAF+LF+VD+ESR

Main characteristics:
High heat resistance, favorable high-temperature tenacity, high thermal fatigue resistance and abrasion performance, little change in heat treatment size, nitridation treatment, favorable polishability and favorable isotropic.

Major applications:
- ✧ Long-life pressure casting molds;
- ✧ Forged molds and inserts;
- ✧ Hot extrusion molds.

Chemical constituent %:

C	Si	Mn	Cr	Mo	V	P	S
0.37	0.4	0.45	5.0	2.8	0.55	≤0.015	≤0.001

Physical property:

Room temperature density (Kg/m3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm2)	Linear expansivity (×10^{-6}K)	
				20~200ºC	20~400ºC
7.83	-	25.0	215,000	12	12.5

Ultrasonic flaw detection:
Flaw detection standard: as per Class A of GB/T4162, i.e., flat bottom hole ≤Φ 2mm, or as per customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

Delivery state:
(1) Delivery hardness: delivery under annealing state, delivery hardness ≤229HB;
(2) Organization state and impact power requirement: comply with North American Die Casting Association No. 207 criterion;
(3) Impact power sample: please sample according to the central part of steel. The samples shall be treated according to criterions in North American Die Casting Association, making sure that hardness of samples at 45±2HRC. Dimension of samples: 7*10*55. Gapless.

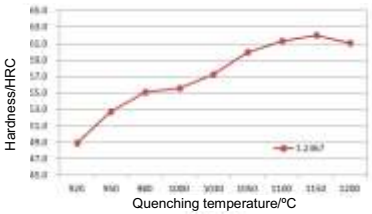
Specification (diameter, thickness mm)	Average impact power at the center part not less than (J)	Minimum impact power per sample not less than (J)
＞60～300	300	250
＞300	280	220

Supply specification:

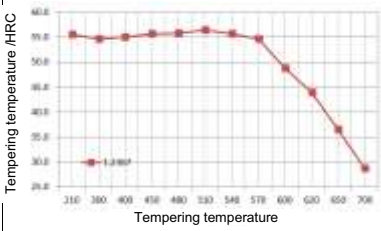
Product name	Specification/mm	Material
Forged round bar	Φ70~500	1.2367 SUP
Forged module	(120~400)* (300~800)	1.2367 SUP
Rolled round bar	Φ16~70	1.2367 SUP
Rolled flat bar	(12~120)* (200~810)	1.2367 SUP

Steel grade (1.2367 SUP)

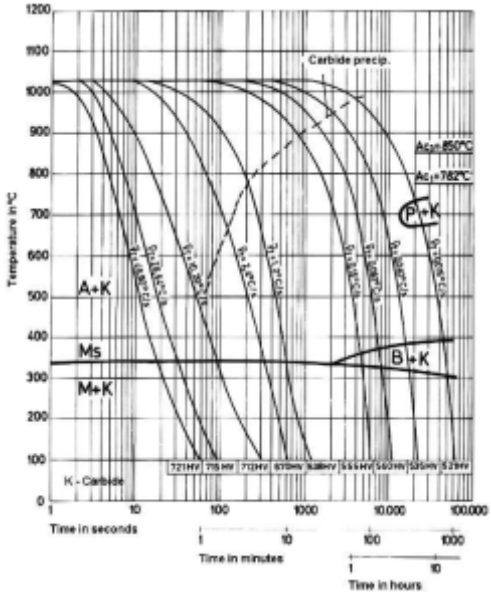
Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 820~840ºC for heat insulation; cooling to 600ºC at 10ºC/h for air cooling	1,030~1,060ºC high-speed gas quenching or hot oil cooling	Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 450~550ºC



Quenching temperature and hardness relation curve

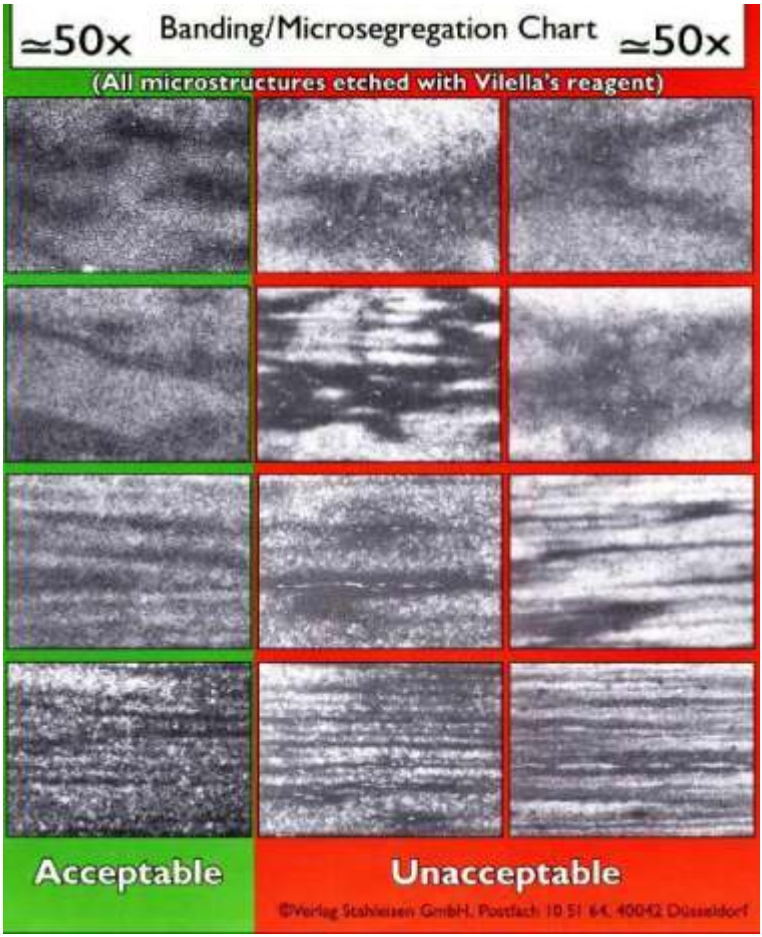


Tempering temperature and hardness relation curve

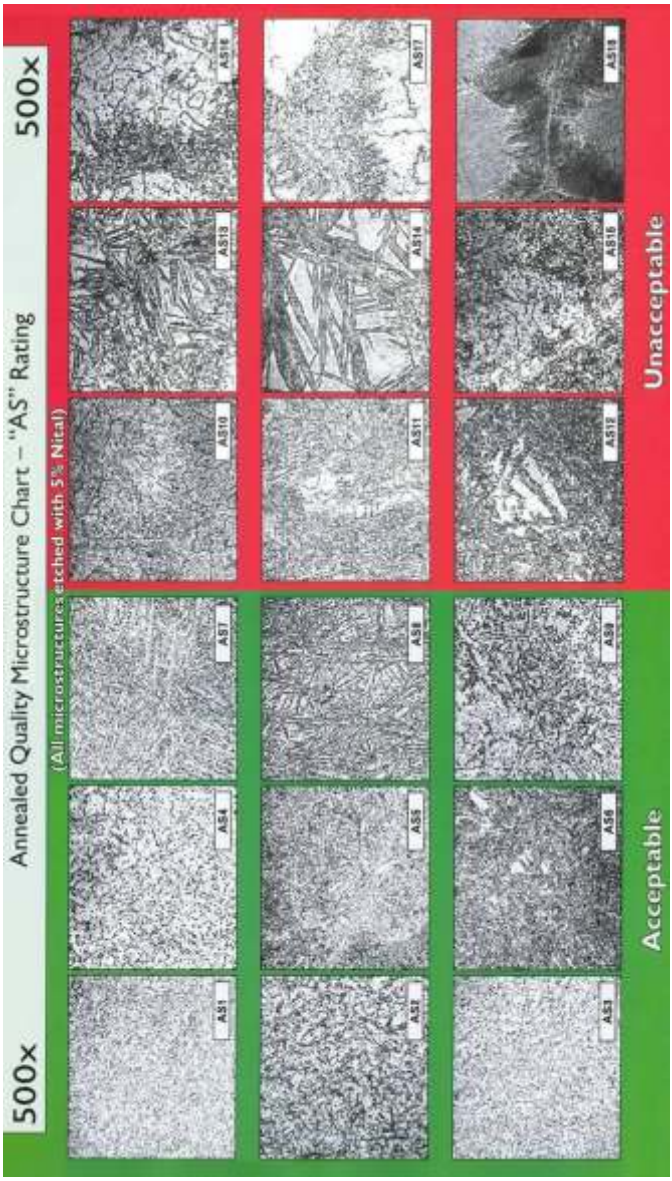


CCT curve

ADCA organization evaluation atlas
Banding microsegregation chart



Balling annealing microstructure chart



Steel grade (H10)

Smelting method: EAF+LF+VD+ESR

Main characteristics:

Favorable softening resistance under high temperature and high thermal fatigue cracks.

Major applications:

- ✧ Hot punch;
- ✧ Hot forging die;
- ✧ Hot shearing blade;
- ✧ Hot extrusion molds.

Chemical constituent %:

C	Si	Mn	Cr	Mo	V	P	S
0.32	0.25	0.3	3.0	2.7	0.5	≤0.025	≤0.008

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.88	460	30	207,000	13.3	14.2

Ultrasonic flaw detection:

Flaw detection standard: as per SEP1921- E/e flaw detection or GB/T6402-2008 Class 4, or as per customer requirements.

Purity:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

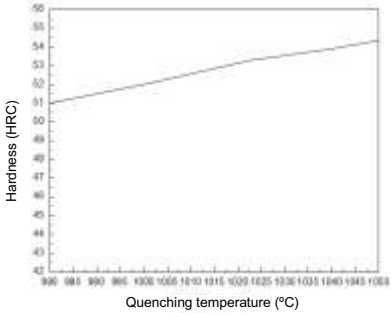
Delivery state: (1) Delivery hardness: delivery under annealing state, hardness ≤229HB;
(2) Organization state and impact power requirement: comply with North American Die Casting Association No. 207 criterion.

Supply specification:

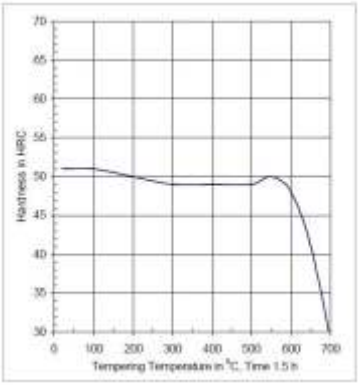
Product name	Specification/mm	Material
Forged round bar	Φ70~650	H10
Forged module	(120~350)* (300~800)	H10
Rolled round bar	Φ16~70	H10
Rolled flat bar	(12~120)* (200~810)	H10

Steel grade (H10)

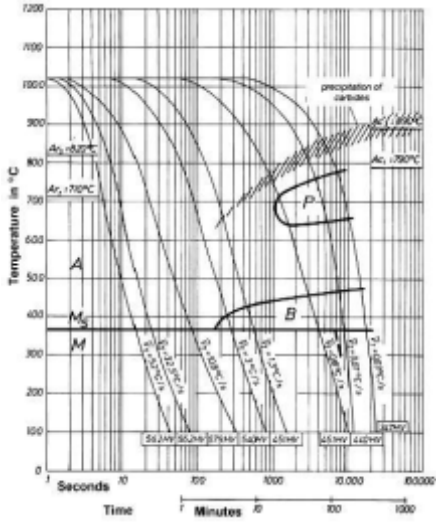
Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 780~810ºC for heat insulation and cooling in the furnace	1,030~1,060ºC high-speed gas quenching or hot oil cooling	Selecting tempering temperature according to hardness requirements; please conduct tempering for 3 times; prevent tempering under 450~550ºC



Quenching temperature and hardness relation curve



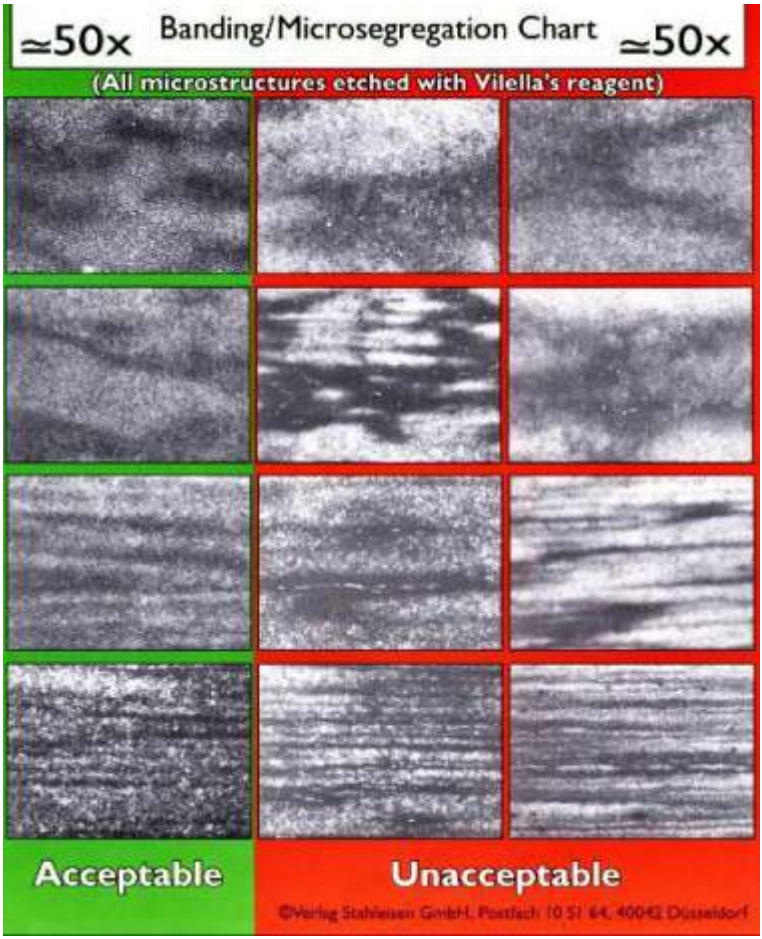
Tempering temperature and hardness relation curve



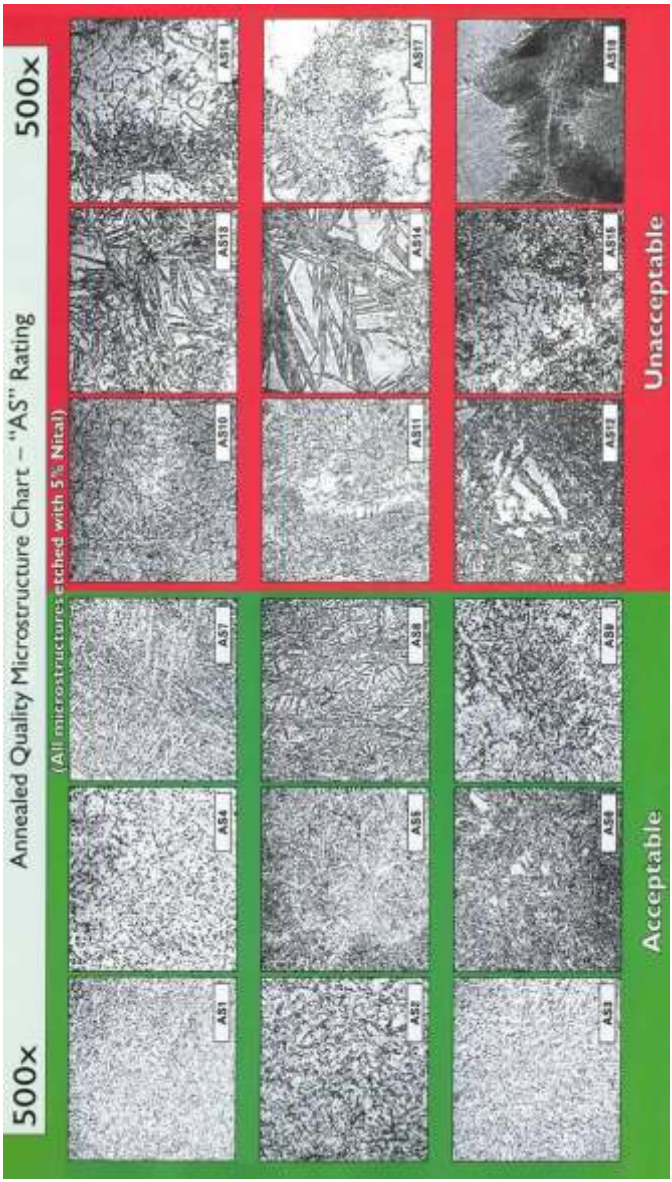
CCT curve

NADCA organization evaluation atlas

Banding microsegregation chart



Balling annealing microstructure chart



Steel grade (TG H-21 DIN-2581)

Steel Properties: Hot work steel with good toughness include tungsten Chromium Carbon Vanadium usually is working hardness is 40.0 to 55.0 HRC size available in round, flat and square.

Applications: The H21 tungsten hot-work tool steels are mainly used for hot-working dies and toolings, e.g., die casting, extrusion and hot-forming of parts.

Chemical Composition: (%)

	Chemical Analysis Typical Value % (Min - Max)										Delivery Condition		
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	W	other	Heat Treatment	Hardness
H21	0.26-0.36	***	***	0.15-0.50	0.15-0.40	***	3.00-3.75	***	0.30-0.60	***	***	Annealed	≤Hb240

PRODUCTION PROCESS:

Round Bar:

EAF→LF→VD→ESR→(5TONS HAMMER) → Forged Annealed Turned : Φ 81.0-310mm; Hot Rolled & Annealed Peeled : Φ 14.5-80.0mm; Cold Drawn/Centreless Ground : Φ 2.0 -14.4mm — ANNEALED CONDITION

Flat Bar:

EAF→LF→VD →ESR →FORGED→ HOT ROLLED (850)→ ANNEALED CONDITION

UT STANDARD:
AISI H21 AFNOR 32CDV 12-28

REDUCTION RATIO :
As 1:4 or 1:5

DELIVERY STATUS :
In Annealed Condition

SIZE : Rounds

Cold Drawn/Ground Bar	Hot Rolled Annealed & Peeled Bar	Forged + Annealed + Turned Bar
Φ 2.0-14.4mm	Φ14.5-80.0mm	Φ 81.0-810.0mm

SIZE : Hot Rolled Flat Bars / Sand Blasted & Machined Straight

Thickness	Width
5mm - 410mm	10mm - 810mm

Heat Treatment Condition :

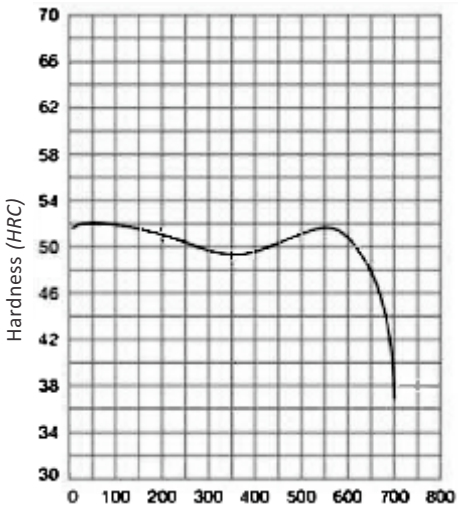
Soft annealing°C : 780 - 800°C

Hardening°C : max. 240°C

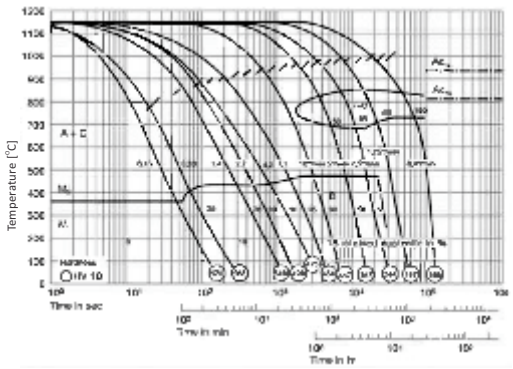
Quenching : Air, oil or warmbath, 600-650°C

Tempering °C	100°C	200°C	300°C	400°C	500°C	550°C	600°C	650°C	700°C
HRC	49HRC	49HRC	49HRC	49HRC	51HRC	51HRC	50HRC	46HRC	36HRC

Steel grade (TG H-21 DIN-2581)



Tempering temperature and hardness relation curve



CCT curve

Steel grade (DB6 - DIN 1.2714)

Characteristics : Classic die steel like grade 2713, but with better tempering properties and better through-hardening properties to a reference diameter of 450mm. For larger dimensions we recommend grade 2714 ISO-B MOD or hardening and tempering after contour roughing. For hardness up to 440 HB (≙ approx. 1500 MPa).

Applications : Large press dies for forming aluminium, forging dies for large quantities regardless of die size and shape of cut, die and mould holders, tool holders and cold forging die holders, tool cassettes. Hydroforming moulds (IHU).

Chemical Composition: (%)

Standards	Chemical Analysis Typical Value % (Min - Max)									Delivery Condition	
IS	C	S	P	Si	Mn	Ni	Cr	Mo	V	Heat Treatment	Hardness
55NiCrMoV 7	0.50-0.60	≤0.004	≤0.030	1.10-0.40	0.60-0.90	1.50-1.80	0.80-1.20	0.35-0.55	0.05-0.15	Quench & Tempered	≤ Hb 360-400

Physical Properties (reference value)

Thermal expansion coefficient (10^{-6}/K)	20-100 °C | 12.2	20-250 °C | 13.1	20-500 °C | 14.2
Thermal conductivity (W/mK)	20 °C | 36.0	250 °C | 37.5	500 °C | 34.5
Young's modulus (GPa)	20 °C | 215	250 °C | 198	500 °C | 175

High-temperature yield strength

Quenched and tempered state	0.2% yield strength in MPa at temperature			
	450°C	500°C	550°C	600°C
~ 1570 MPa	900	740	460	220
~ 1370 MPa	810	590	390	200
~ 1180 MPa	610	460	280	150

PRODUCTION PROCESS:

Rounds :

102 , 112 , 122, 132 , 142 , 152, 162, 172, 182, 202, 212, 222, 232, 242 , 252, 262 ,272, 282 , 302, 322, 330, 342, 352, 382, 392, 402 , 412, 435 , 452, 482, 512 , 532 , 603 , 653

Flat Bar:

EAF→LF→VD →HOT FORGED→ ANNEALED→ OIL QUENCH & TEMPERED→ 2 TIMES TEMPERED→ 6 SIDES MACHINED (Blocks) →TURNED BRIGHT (Rounds)

ULTRASONIC TEST :
OK According to SEP 1921, (DEC.84) D/d

CLEANLINESS STANDARD :
ASTM E-45-METHOD A

REDUCTION RATIO :
Min. 4/5 : 1

GRAIN SIZE ACC TO ASTM E112 :
6 AND FINER

DELIVERY STATUS :
In Quench & Tempered Condition

Steel grade (DB6 - DIN 1.2714)

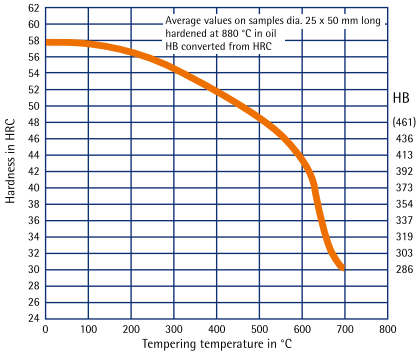
Heat Treatment

Stress relieving	Temperature : Approx. 650 °C in the annealed state Duration : 1 hour per 50 mm wall thickness Cooling : furnace
Soft annealing	Temperature : 700 °C Duration : 1 hour per 25mm wall thickness Cooling : furnace
Hardening	Temperature : 880 °C Duration : 1 minute per mm wall thickness
Quenching hardness	Max. 58 HRC : in water/oil, protective atmosphere/oil, oil, hot bath or vacuum
Tempering	Temperature : See tempering curve Duration : 1 hour per 25mm wall thickness Cooling : Air
Working hardness	300-440 HB depending on application

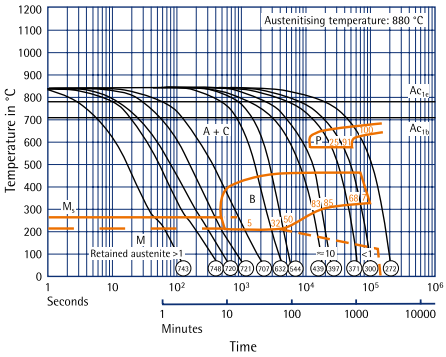
Note: Pre-heating of the tools to 250-280 °C is recommended.

Width / Thickness	210	260	310	360	410	460	510	560	610	660	710	810	1010	1500
210	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo
260		oo	oo	oooo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo
310			oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo
360				oo	oo	oo	oo	oo	oo	oo	oo	oo	oo	oo
410					oo	oo	oo	oo	oo	oo	oo	oo	oo	oo
460						oo	oo	oo	oo	oo	oo	oo	oo	oo
510														

Tempering curve



TTT curve (continuous



Steel grade (TGS136)

Smelting method: EAF+LF+VD+ESR

Main characteristics:

Extremely high mirroring performance, favorable corrosion resistance, high abrasion resistance and favorable machining performance.

Major applications:

- ✧ Super-mirror plastic molds: molds for optical lens and other transparent plastic pieces;
- ✧ Corrosion preventive high-resisting molds: Molds for fold vessels, cosmetics vessels, medical devices, light guiding plates, bottle covers, etc.
- ✧ Formed resin materials: PC, PVC, PP, PE, PF, PMMA, adding fire retardant resin, etc.

Chemical constituent %:

C	Si	Mn	Cr	Mo	Ni	V	P	S
0.4	1.05	0.55	13.5	0.3	0.22	0.3	≤0.03	≤0.015

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times10^{-6}K$)	
				20~200ºC	20~400ºC
7.80	465	23	241,000	11.2	11.5

Ultrasonic flaw detection:

Flaw detection standard: as per GB/T 6402-2008 Class 4 flaw detection standard or as per customer requirements.

Purity:

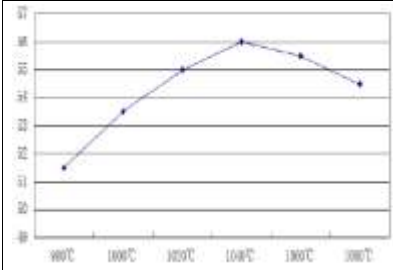
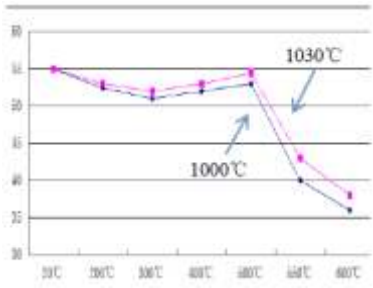
Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

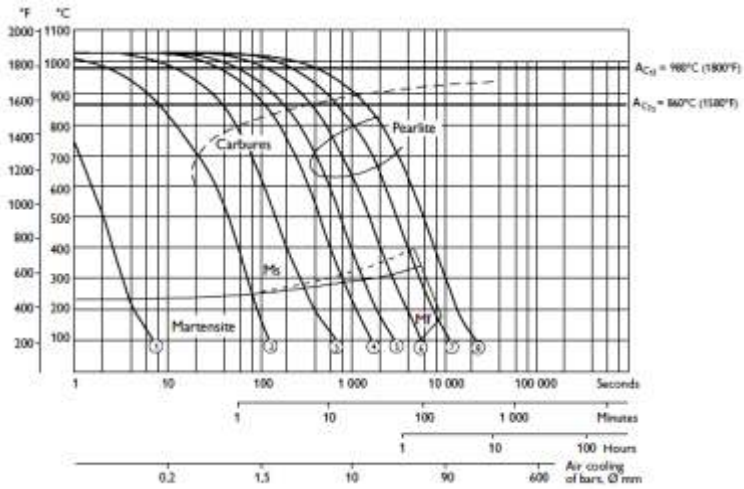
Delivery state: (1) Delivery hardness: delivery under annealing state, ≤255HB.

Supply specification:

Round steel	Flat steel	Module
Φ 16~500mm	16~120mm×200~610mm	120~300mm×300~1,000mm

Steel grade (TGS136)

<table>
<tr><td colspan="3">Thermal treatment</td></tr>
<tr><td>Softening annealing</td><td>Quenching</td><td>Tempering</td></tr>
<tr><td>Heating to 850ºC for heat insulation; cooling to 650ºC at 10ºC/h for air cooling</td><td>1020~1030ºC quenching, rapid air cooling</td><td>Tempering temperature 250ºC(favorable tenacity and corrosion resistance); selecting tempering temperature as per hardness requirements; tempering for twice</td></tr>
<tr><td colspan="2"> 
Quenching temperature
Quenching temperature and hardness relation curve</td><td> 

Quenching temperature
Tempering temperature and hardness relation curve</td></tr>
<tr><td colspan="3">Austenite temperature: 1,030ºC, heat insulation for 30min
 

CCT curve</td></tr>
</table>

Steel grade (TGP50)

Smelting method: EAF+LF+VD+ESR

Main characteristics:

Favorable corrosion resistance, abrasion resistance, quenching, cutting performance, and polishability as well as high surface fineness.

Major applications:

- ✧ Production of PVC molds;
- ✧ Long-life molds;
- ✧ Molds for disposable tableware;
- ✧ Production of optics parts, for example, cameras, sunglasses lens, medical vessels, etc.

Chemical constituent %

C	Si	Mn	Cr	Mo	W	V	P	S
0.42	≤1.00	≤1.00	13.5	-	-	-	≤0.03	≤0.005

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
7.8	460	24	220,000	10.9	11.6

Purity:

Electric furnace steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.5	1.0	2.0	1.5	1.5	1.0	1.5	1.5

Electroslag steel:

Class A		Class B		Class C		Class D	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
1.0	0.5	1.5	1.0	1.0	1.0	1.5	1.0

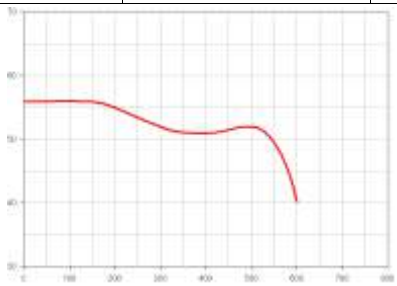
Delivery state: (1) delivery under annealing state, delivery hardness ≤235HB.

Supply specification

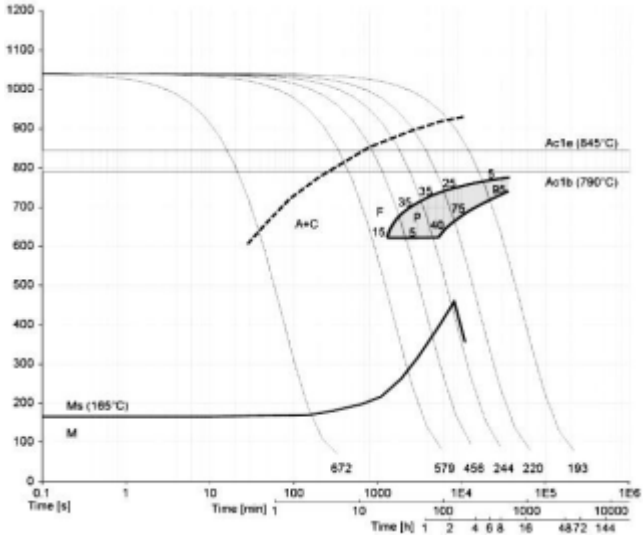
Round steel	Flat steel	Module
Φ 16~500mm	16~120mm×200~810mm	120~500mm×300~1,200mm

Steel grade (TGP50)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 850ºC for heat insulation; cooling to 650ºC at 10ºC/h for air cooling	1,020~1,030ºC quenching, rapid air cooling	Tempering temperature 250ºC(favorable tenacity and corrosion resistance); selecting tempering temperature as per hardness requirements; tempering for twice



Tempering temperature and hardness relation curve



CCT curve

Steel grade (TGP80)

Smelting method: EAF+LF+VD+ESR

Main characteristics: High mirroring performance, even hardness, excellent discharging processing performance and texture processing performance. Molds can be used upon processing and no heat treatment is required.

Major applications:

- ✧ Mirror plastic molds: Transparent plastic molds: optical instrument parts, compact disks, medical devices, etc.
- ✧ Molds underlining discharging processing surface quality.

Chemical constituent %:

C	Si	Mn	Cu	Mo	Ni	Al	P	S
0.15	≤0.45	1.55	1.0	0.35	3.1	0.95	≤0.025	≤0.003

Physical property:

Room temperature density (Kg/m^3)	Specific heat of room temperature (J/Kg·K)	200ºC thermal conductivity (W/m•K)	Elastic modulus (N/mm^2)	Linear expansivity ($\times 10^{-6}K$)	
				20~200ºC	20~400ºC
7.8	460	22	218,000	12.3	13.2

Ultrasonic flaw detection:

Flaw detection standard: as per GB/T 6402-2008 Class 4 flaw detection standard or as per customer requirements.

Purity:

Class A (sulfide)		Class B (aluminate)		Class C (Silicate)		Class D (oxide)	
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
0.5	0.5	1.0	1.0	1.0	1.0	1.5	1.0

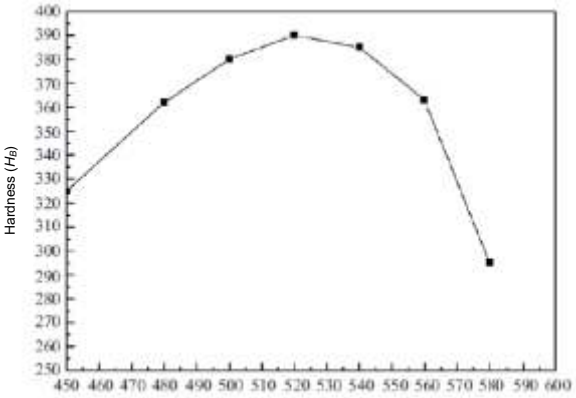
Delivery state: (1) delivery under pre-hardening state, delivery hardness 38~42HRC.

Supply specification:

Flat steel	Module
16~120mm×200~810mm	120~400mm×300~800mm

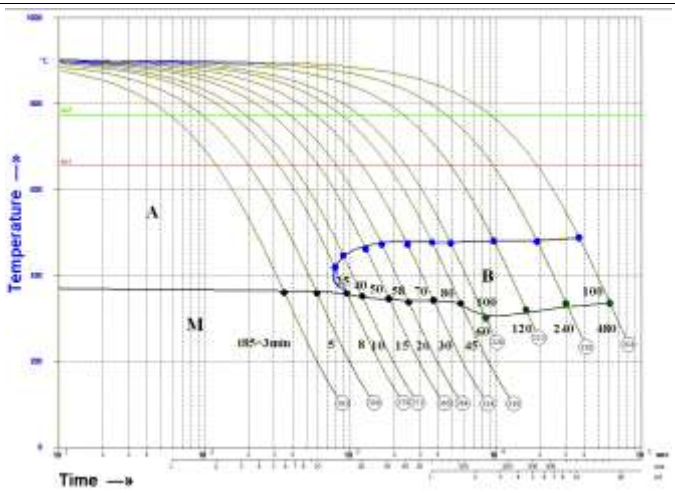
Steel grade (TGP80)

Thermal treatment		
Softening annealing	Quenching	Tempering
Heating to 760ºC for heat insulation and cooling to 600ºC at 40ºC/h	Delivery under pre-hardening state, no heat treatment, temperature of nitridation treatment: 520ºC	



Tempering temperature and hardness relation curve

Temperature/ºC



CCT curve

Steel grade TGP40 (1.2738 & 1.2738HH)

1 Main characteristics and applications

If features excellent hardening penetration, good workability, polishing and photoengraving properties.This steel is used for plastic moulds of medium and big size. It can be subject to a nitriding treatment to improve its wear resistance. Main application: injection and thermoplastic extrusion moulds, rubber moulds, moulds carrier frames, containers.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
	1.2738	40CrMnNiMo8-6-4	~40 CMND8	~P20 + Ni	~P20 + Ni

3 Chemical analysis

C	Mn	Si	Cr	Mo	Ni	P+S	
0.35	1.30	0.20	1.80	0.15	0.90		
0.45	1.60	0.40	2.10	0.25	1.20	0.030	

4 Critical points

Ac1	710°C
Ms	290°C

5 Supply Conditions

Hardened and Tempered Normal HB 300-340 & 360-400

6 Heat treatments

Annealing

- Heat to 710 - 740 ° , with hold at minimum rate for 3 hours
  Slow furnace cooling to 600 °C

Stress relieving

- To be carried out after machining and before the final heat treatment
- Heating to 530 -580 °C for 2 h

Hardening

- Preheating to 500-550 °C
- Austenitizing at 840 -880 ° C
- Oil or thermal bath cooling at 200-230°C, then oil cooling according to the steel shape size
- Quenched hardness 52-54 HRC

Tempering

- To be carried out soon after the hardening and when the steel is at 60-80 °C, at 500 - 600 ° C according to the required hardness and with permanence for at least 2 h
- Cooling in air

Steel grade (1.2311 Reference standard UNI EN ISO 4957)

1 Main characteristics and applications

Steel with excellent hardening penetration up to 400 mm. Generally supplied in hardened and tempered condition with excellent polishing and photoengraving Properties.This steel is suitable for nitriding (around 800 HV), chrome and nickel plating .

Used for plastic dies with excellent surface finish properties. It is also used for dies of light alloys with low melting point, plates, dies box, etc.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
	1.2311	X40CrMnMo7	40CMD8	~P20	~P20

3 Chemical analysis

C	Mn	Si	Cr	Mo	Ni	P+S
0.35 0.45	1.30 1.60	0.20 0.40	1.80 2.10	0.15 0.25		0.030

4 Critical points

Ac1	740°C
Ms	310°C

5 Supply Conditions

Hardened and Tempered HB 280-325 (950-1100N/mm^2)

6 Heat treatments

Annealing

- Heat to 720-750 °C for 2-4 h furnace cool

Stress relieving

- Up to 560 – 600 °C, hold for 2-4 h
- Furnace or steel air cooling

Hardening

- Preheating to 600-650 ° C
- Heat to hardening temperature to 840 - 870 ° C and hold at temperature
- Cooling in oil
- Hardness after hardening : HRC 51

Tempering

- To be carried out soon after the hardening in the range 580 - 650°C for 1 hour for 25 mm of thickness minimum 2h

TITANIUM

INGOT CASTING: The titanium bar we offer are using the domestic high-quality sponge as a raw mattly, forging and machining processes, products in full compliance with GB/T2965, ASTMB348 standard, chemical composition uniform and mechanical properties stable, meeting the user's application requirements. Products used in various types of titanium and titanium alloy tube manufacturers for hor-rolling, but also the chemical industry, energy, medical equipment and other related industries, typical applications: Titanium and titanium alloy bar for hot-rolling: composits rod with bar (the compound of titanium rods, etc.); Medical devices and surgical implants; Titanium and titanium alloys standard parts (screws, nuts, etc.) Leisure Products (golf success, etc.)

Commodity name	Designation number	Dimensions (mm)	Carries out the standard
Ingot casting	TA1-TA3, TA5-TA7, TA8-TA9, TA10, TC1-TC2, TC3-TC4, TC9, TC10, Gr1-Gr5, Gr7, Gr9, Gr11, Gr12, Gr13	Φ300 -Φ600	A9TM, JIS, AMS, MIL, GB/T36201

TITANIUM BAR: The titanium bar we offer are using the domestic high-quality titanium sponge as a raw mattly, strictly control and quality such as ingot, forging and machining processes, products in full compliance with GB/T2965, ASTMB348 standard, chemical composition Uniform and mechanical properties stable, meeting the user's application requirements. Products used in various types of titanium alloy tube manufacturers for hor-rolling, but also the chemical industry, energy, medical equipment and other related industries, typical applications: Titanium and titanium alloy bar for hot-rolling: composits rod with bar (the compound of titanium rods, etc.); Medical devices and surgical implants; Titanium and titanium alloys standard parts (screws, nuts, etc.) Leisure Products (golf success, etc.)

Commodity name	Designation number	Dimensions (mm)	Carries out the standard
Titanium Bar	TA1-TA3, TA5-TA7, TA8-TA9, TA10, TC1-TC2, TC3-TC4, TC9, TC10, Gr1-Gr5, Gr7, Gr9, Gr11, Gr12, Gr13	Φ8 -Φ600	A9TM, JIS, AMS, MIL, GB/T2965, GB/T13810

TITANIUM SHEET: The titanium sheet we offer are using the domestic high-quality titanium sponge as a raw mattly ricterial, strictly control the quality from raw materials selection, ingot, billet to forging eolling processes, products in full compliance with GB/T3621, ASTMB265 standard, related technical indicators have reached the advanced level in the industry, meeting the user's application requirements.

Product are widely used in petrochemical, sait, offshore industry, energy generation and other industries, typical applications include: Various types of titanium equipment; Ion-exchange membrane, divide slot; Titanium anodes of boards, basket; Leisure Products(Titanium Case, first-class golf); Used with other metals (copper) composite sheet; Titanium and titanium alloys in construction board.

Commodity name	Designation number	Dimensions (mm)	Carries out the standard
Titanium Sheet	TA1-TA3, TA5-TA7, TA8-TA9, TA10, TC3-TC4, TC9, TC10, Gr1-Gr5, Gr7, Gr9, Gr11, Gr12	(0.5-60) x (400-2000) x (1000-3000)	ASTM, JIS, GB/T3621, GB/T14845

TITANIUM

TITANIUM TUBE: Our company used high quality titanium rods as raw materials, strictly according to the production quality control standards, products in full compliance with GB/T3624, GB/T3625, ASTMB337, ASTMB338 standard, related technical indicators have reached the advanced level in the industry, meeting the user's application requirements.

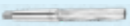
Products are widely used in petrochemical, salt, offshore industry, energy generation and other industries, typical applications include: Heat exchangers and condensers; All kinds of corrosive fluid transmission pipeline system; Titanium bicycle tube, automobile exhaust pipe; offshore aquaculture.

Commodity name	Designation number	Dimensions (mm)	Carries out the standard
Titanium Tube	TA1-TA3, TA5-TA7, TA8-TA9, TA10, Gr1-Gr2, Gr7, Gr9, Gr11, Gr12	(6-120) x (0.5-10) x (1000-15000)	ASTM, AMS, JIS, GB/T2624, GB/T3625

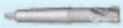
HSS CUTTING TOOLS

- HSS STRAIGHT SHANK TWIST DRILL
- HSS TAPER SHANK TWIST DRILL
- HSS TAPS
- HSS END MILL
- REAMERS
- OTHER GENERAL TOOLS
- CARBIDE TIP DRILLS
- HSS DRILL BLANKS
- DRILL SET

HSS CUTTING TOOLS

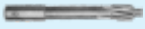
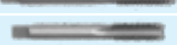
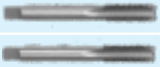
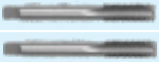
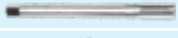
PRODUCT	DESCRIPTION	SPECIFICATION
	TWIST DRILLS	
	Parallel Shank Twist Drills (Stub Series)	IS 5100 : 2002 ISO 235 : 1980 BS 328 Part 1 : 1993 DIN 1897 : 1984
	Parallel Shank Twist Drills (Jobber Series)	IS 5101 : 2002 ISO 235 : 1980 BS 328 Part 1 : 1993 DIN 338 : 1984
	Parallel Shank Twist Drills (Long Series)	IS 5102 : 2002 ISO 494 : 1975 BS 328 Part 1 : 1993 DIN 340 : 1987
	Parallel Shank Twist Drills (Extra Long Series)	IS 7823 : 2005 ISO 3292 : 1995
	Taper Shank Twist Drills (With Standard Shank)	IS 5103 : 2002 ISO 235/1 : 1980 BS 328 Part 1 : 1993 DIN 345 : 1978
	Taper Shank Twist Drills (With Oversize Shank)	IS 5104 : 2002 ISO 235/1 : 1980 BS 328 Part 1 : 1993
	Taper Shank Twist (Long Series)	IS 8305 : 2002 DIN 341 : 1976
	Taper Shank Twist (Extra Long Series)	IS 7822 : 2005 ISO 3291 : 1995
	Taper Shank Core Drills	IS 5366 : 2002 ISO 7079 : 1981 BS 328 Part 3 : 1990 DIN 343 : 1981
	Shell Core Drills	IS 7772 : 2002 ISO 3314 : 1975 BS 328 Part 4 : 1990
	Centre Drill Type 'A'	IS 6708 : 2002 ISO 866 : 1975 DIN 333 : 1986
	Centre Drill Type 'B'	IS 6709 : 2002 ISO 2540 : 1972 DIN 333 : 1986
	Centre Drill Type 'R'	IS 6710 : 2002 ISO 2541 : 1972 DIN 333 : 1986
	Centre Drill B. S.	BS 328 Part 2 : 1990
	Parallel Shank Subland Twist Drill	IS 12691 : 1999 ISO 3439 : 1975 DIN 8378 : 1981
	Taper Shank Subland Twist Drill	IS 12687 : 1999 ISO 3438 : 1975 DIN 8379 : 1981
	Taper Shank Twist Drills For Taper Pin Holes	IS 5364 : 2002
	Masonry Drills-Carbide Tipped	Specifications conforms to : ITM Standard
	Technical Section	
	**REAMERS**	
	Parallel Hand Reamers	IS 5444 : 2002 ISO 236/1 : 1976 BS 328 Part 4 : 1990 DIN 206 : 1979
	Long Fluted Machine Reamers	IS 5445 : 2002 ISO 236/2 : 1976 BS 328 Part 4 : 1990
	Parallel Machine Reamers	BS 328 Part 4 : 1990
	Machine Chucking Reamers with Parallel Shank	IS 5446 : 2002 ISO 521 : 1975 BS 328 Part 4 : 1990
	Machine Chucking Reamers with Taper Shank	IS 5447 : 2002 ISO 521 : 1975 BS 328 Part 4 : 1990
	Machine Jig Reamers with Taper Sahank	Dimensions are in mm Specifications conform to: IS 11002 : 1999
	Shell Reamers	IS 5926 : 2002 ISO 2402 : 1976 DIN 219:1981(Type A) BS 328 Part 4 : 1990
	Socket Reamers with Parallel Shank	IS 5882 : 2002 ISO 2250 : 1972 BS 328 Part 4 : 1990

HSS CUTTING TOOLS

PRODUCT	DESCRIPTION	SPECIFICATION
	Socket Reamers with Taper Shank	IS 5907 : 2002 BS 328 Part 4 : 1990
	Taper Pin Hand Reamers	IS 5881 : 1991 DIN 9 : 1975 ISO 3465 : 1975 BS 122 Part 2:1964 BS 328 Part 4:1990
	Taper Pin Machine Reamers	IS 5918 : 1999 DIN 2180 : 1975 ISO 3467 : 1975 BS 122 Part 2:1964 BS 328 Part 4:1990
	Machine Bridge Reamers	IS 5919 : 2002 ISO 2238 : 1972 BS 328 Part-4 : 1990 BS 122 Part-2 : 1964
	Hole Mills-Unguided Type 'A' (Roughing)	IS 5989 : 2002
	Hole Mills-guided Type 'B' (Roughing/Finishing)	IS 5989 : 2002
	Taper Pipe Reamers	ASA B 94.2 : 1964
	Technical Section	
	**MILLING CUTTERS (BORE TYPE)**	
	Cylindrical Miling Cutter	IS 5309 : 2002 ISO 2584 : 1972 DIN 884 : 1976 BS 122 Part-1 : 1989
	Side and Face Cutter (Straight Teeth & Staggered Teeth)	IS 6308 : 2002 ISO 2587 : 1972 DIN 1885 : 1976 BS 122 Part-1 : 1989
	Shell End Mills	IS 6257 : 2002 ISO 2586 : 1973 DIN 1880 : 1976 BS 122 Part-1 : 1989
	Single Angle Cutters	IS 6324 : 2001 BS 122 Part-1 : 1989
	Double Angle Cutters	IS 6325 : 2001 BS 122 Part-1 : 1989
	Equal Angle Cutters	IS 6326 : 2001 ISO 6108 : 1978 BS 122 Part-1 : 1989
	Shell End Single Angle Milling Cutters	IS 6256 : 2000 DIN 842 (P-1) : 1984
	Face Cutters	BS 122 Part-1 : 1989
	Slotting Cutters	BS 122 Part-1 : 1989
	Keyway Milling Cutters	IS 6355 : 2002 ISO 2585 : 1972 DIN : 1890 : 1976
	Hollow Mills	BS 122 Part-1 : 1989
	Convex MIlling Cutters	IS 6323 : 2002 ISO 3860 : 1976 DIN 856 (Teil 1) : 1978 BS 122 Part-1 : 1989
	Concave Milling Cutters	IS 6322 : 2002 ISO 3850 : 1976 DIN 855 (Teil 1) : 1978 BS 122 Part-1 : 1989
	Single Corner Rounding Cutter	IS 6314 : 2002 ISO 3860 : 1976 DIN 6513 (Teil 1) : 1978 BS 122 Part-1 : 1989
	Double Corner Rounding Cutters	BS 122 Part-1 : 1989
	**MILLING CUTTERS (SHANK TYPE)**	
	Parallel Shank Milling Cutters	IS 6352 : 2001 ISO 164/1 : 1978 BS 122 Part 1 : 1989
	Taper Shank Slot Milling Cutters	IS 6388 : 2001 ISO 164/2 : 1978 BS 122 Part 1 : 1989
	Parallel Shank End Mills	IS 6353 : 2001 ISO 1641/1 : 1978 DIN 844 (Part 1) : 1978 BS 122 Part 1 : 1989
	Taper Shank End MIlls	IS 6354 : 2001 ISO 1641/2 : 1978 DIN 845 (Part 1) : 1981 BS 122 Part 1 : 1989

Descriptions and data in the file are typical cases. We will not make guarantee for them. Besides, we reserve the final right to interpret improvement in materials, quality and/or performance.

HSS CUTTING TOOLS

PRODUCT	DESCRIPTION	SPECIFICATION
	Screwed Shank Slot Drills (Short Series, Long Series)	BS 122 Part 4 : 1980
	Screwed Shank End Mills (Short Series, Long Series)	BS 122 Part 4 : 1980
	T' Slot Cutters with Parallel Shank	IS 2668 : 2004 ISO 3337 : 2000
	T' Slot Cutters with Taper Shank	IS 2668 : 2004 ISO 3337 : 2000 BS 122 Part-1 : 1989
	Dove - Tail Milling Cutters	IS 6255 : 2000 ISO 3859 : 1977 DIN:1833 (Tail I):1983
	Woodruff Keyslot Milling Cutters with Parallel Shank	IS 2669 : 2001 BS 122 Part-1 : 1989
	Countersinks 90° with Parallel Shank & Solid Pilot	IS 5693 : 2002 ISO 4205 : 1991 BS 122 Part-1 : 1989 BS 328 Part-6 : 1992
	Countersinks 90° with MT Shank & Detachable Pilot	IS 5703 : 2002 ISO 4204 : 1977 DIN 1867 : 1975
	Counterbores with Parallel Shank & Solid Pilot	IS 5704 : 2002 ISO 4206 : 1977 DIN 373 : 1975
	Counterbores with Taper Shank & Detachable Pilot	IS 5710 : 2002 ISO 4207 : 1977 BS 328 Part-5 : 1991 DIN 375 : 1975
	Countersinks with included angle 60°, 90° & 120° with parallel Shank	IS 13304 : 2002 DIN 334 : 1979 ISO 3294 : 1975 DIN 335 : 1979 DIN 347 : 1962
	Countersinks with included angle 60°, 90° & 120° with Taper Shank	IS 13303 : 2002 DIN 334 : 1979 ISO 3294 : 1975 DIN 335 : 1979 DIN 347 : 1962
	Technical Section	
	**SCREWING TAPS**	
	Hand & Short Machine Taps Coarse Pitch	IS 6175 Part 2:2002 ISO 529 : 1975 BS 949 Part 1:1992
	Hand & Short Machine Taps Fine Pitch	IS 6175 Part 2:2002 ISO 529 : 1975 BS 949 Part 1:1992
	Hand & Short Machine Taps Coarse Pitch	IS 6175 Part 3:2002 ISO 529 : 1975 BS 949 Part 1:1992
	Hand & Short Machine Taps Fine Pitch	IS 6175 Part 3:2002 ISO 529 : 1975 BS 949 Part 1:1992
	Hand & Short MAchine Taps BSW	BS 949 Part 1 : 1992
	Hand & Short MAchine Taps BSF	BS 949 Part 1 : 1992
	Hand & Short MAchine Taps UNC	BS 949 Part 1 : 1992
	Hand & Short MAchine Taps UNF	BS 949 Part 1 : 1992
	Long Shank Machine Taps Coarse Pitch	IS 6175 Part 4 : 2001 ISO 2283 : 1972 BS 949 Part 1:1992
	Long Shank Machine Taps Fine Pitch	IS 6175 Part 4 : 2001 ISO 2283 : 1972 BS 949 Part 1:1992
	NUT Taps Coarse Pitch	IS 6175 Part 5 : 2001
	NUT Taps - BSW	BS 949 : 1969
	NUT Taps - BSF	BS 949 : 1969
	NUT Taps - UNC	BS 949 : 1969
	NUT Taps - UNF	BS 949 : 1969

HSS CUTTING TOOLS

PRODUCT	DESCRIPTION	SPECIFICATION
	Hand Taps - BSCY	BS 949 Part 1 : 1992
	Hand Taps - BS (conduit)	BS 949 Part 1 : 1992
	Hand Taps - BA	BS 949 Part 1 : 1992
	Parallel Pipe Hand taps BSP	BS 949 : 1969
	Parallel Pipe Taps - 'G' Series	IS 6175 Part 6 : 2002 ISO 2284:1987 BS 949 Part 3:1993
	Parallel Pipe Hand Taps - 'RP' Series	IS 6175 Part 7 : 2002 ISO 2284:1987 BS 949 Part 3:1993
	Taper Pipe Hand Taps - 'RC' Series	IS 6175 Part 8 : 2002 ISO 2284:1987 BS 949 Part 3:1993
	Taper Pipe Hand Taps - BSPT	BS 949 Part : 1969
	American National Straight Pipe Hand Taps - NPS	BS 949 Part : 1969
	American National Taper Pipe Hand Taps - NGT	BS 949 Part : 1969 ANSI B 494 : 1971
	American National Taper Pipe Hand Taps (Gas) - NPT	ITM Std.
	NIB Taps - Metric (Coarse)	ITM Std.
	NIB Taps - BSW	ITM Std.
	Technical Section	
	Ground Tools Bits	ITM Std.

CARBIDE CUTTING TOOLS

The world leading supporting production line for cemented carbide cutting tools is introduced into Taifeng International for the purpose of producing special cutting tools featuring strong market competitiveness, efficiency, precision and quality, thus Taifeng International can produce the cemented carbide products, including and mill, drill, reamer, molding knife and other cutting tools. The cemented carbide cutting tools produced have been widely applied in aviation, aerospace, shipbuilding, automobile, medical apparatus and instruments, chemical engineering. molding, IT mobile telephone shell and other fields.

With the most advanced German Walter five-axis linkage grinding machine and Walter six-axis full-automatic CNC measuring instrument is adopted, with the measuring precision reaching 0.001mm. The measuring instrument shows more prominent performance in measurement of non-standard cutting tools, which can scan the outline of the profile cutting tool produced and then compare with the profile required by clients after profile scanning to ensure no error between the profile precision and the actual precision of the products processed.

In recent years the production of cemented carbide cutting tool in China has witnessed rapid development, but such tool only occupies about 40% of the market share; the medium and low end cutting tools are the majority, and the imported cutting tools are mainly used for military industry and automobile processing industry. Taifeng International seizes this opportunity and develops imported on itself to bring “Chinese” cutting tools to the world.

DRILL SERIES
• NC Centre Drills
• DC2MU Twist Drills for General Purpose
• DS2MU Twist Drills for Stainless Steel
• DH2MU Twist Drills for Hardened Steel
• DZ2MN Inner Straight Flute Drills for Cast Iron

ENDMILLS SERIES
• Endmills for Stainless and Cast Iron
• Endmills for Hardened Steels
• Endmills for Stainless Steels
• Endmills for Aluminium Alloys
• Endmills for Graphite


兰石重工
LS HEAVY INDUSTRY
70MN自由锻液压机组
2022.11

TGK
SPECIAL STEEL PVT. LTD.

Mr. Nitin Doshi
Managing Director
Tel.: +91-22-6852 0014 - 39

Mr. Kushal Doshi
Director
Cell.: +91 99204 75123
kushal@tgkssl.com
kushal_812@me.com

Mr. L. K. Pandey
Sales Representative
Cell.: +91 93216 04504/00
kushal@tgkssl.com

Mr. Sahil Shah
Cell.: +91 99200 38787
E-mail: spshah44@gmail.com

REGD. OFFICE :
8th Floor, Majestic Shopping Centre,
144 JSS Road, Girgaon, Mumbai-400 004.
Boardline : +91-22- 6852 0014-39

UNIT - I
Plot No-13-A, Gala No - 3/4/5,
Magazine Street, Near Devidayal Compound,
Darukhana, Reay Road [E], Mumbai-400 010.
Maharashtra, INDIA.
Tel.: +91-22-6852 0014 - 39

UNIT - II
Gala No. 3A/3B, Build 188, Gala No. 3,
Build No. 183, C/o. Indian Corporation,
Mouje Gundavli (Mankholi Phata),
Taluka Bhiwandi, Dist: Thane. (Maharashtra)
Tel.: 02522-661950 / 90222 66670

UNIT - III
Mr. Keval Shah
Cell.: +91 92246 40506
kushalmetal07@gmail.com

H-21/P, Nr. New Water Tank,
Next to R. Kumar And Metals Road No. 32,
Odhav GIDC, Odhav, Ahmedabad - 382 415.

SCAN ME