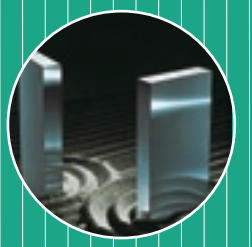
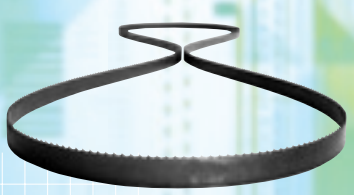
YSS
HIGH SPEED TOOL STEELS





Chemical compositions

(mass%)

		Grade	JIS equivalent	AISI equivalent	C	Cr	W	Mo	V	Co
Conventional High Speed Steels	Molybdenum High Speed Steel	**YXM1**	SKH51	M2	0.80~0.90	3.80~4.50	6.00~7.00	4.80~5.80	1.80~2.30	–
		YXM4	SKH55	M35	0.85~0.95	3.80~4.50	6.00~7.00	4.80~5.80	1.80~2.30	4.50~5.50
		YXMT	–	M1	0.75~0.85	3.50~4.50	1.30~1.80	8.00~9.00	0.90~1.30	–
		YXM42	SKH59	M42	1.00~1.10	3.50~4.25	1.25~2.00	9.00~10.00	1.00~1.50	7.75~8.75
		YXM60	Original Steel	–	1.00~1.10	3.80~4.50	5.00~6.00	6.00~7.00	1.50~1.80	7.50~8.50
	Vanadium High Speed Steel	**XVC5**	SKH57	–	1.20~1.30	3.80~4.50	9.00~11.00	3.00~4.00	3.20~3.70	9.50~10.50
	Tungsten High Speed Steel	YHX2	SKH2	T1	0.73~0.83	3.80~4.50	17.00~19.00	–	0.80~1.20	–
	Matrix High Speed Steel	**YXR33**	–	–						
		YXR3	Original Steel	–						
		YXR7	Original Steel	–						
P/M High Speed Steels		**HAP5R**	–	–						
		HAP10	–	–	1.30~1.40	4.50~5.50	2.50~3.50	5.50~6.50	3.60~4.00	–
		HAP40	SKH40	–	1.27~1.37	3.70~4.70	5.60~6.40	4.60~5.40	2.80~3.30	7.50~8.50
		HAP50	–		1.54~1.64	3.70~4.70	7.50~8.50	5.50~6.50	3.80~4.30	7.50~8.50
		HAP72	Patented Steel	–	2.02~2.32	3.70~4.70	9.00~10.00	8.00~8.50	4.80~5.10	9.00~10.00

Applications and YSS grade Features

Grade	Applications	Features
YXM1	Drill, Reamer, Broach, Chaser, Metal saw, Cutters, Cold punch, Dies	Standard Molybdenum high speed steel with superior toughness
YXM4	Hob, Drill, Reamer, Chaser, Cutters, Heading tool for stainless, Endmill	Standard Cobalt alloyed Molybdenum high speed steel with superior heat resistance
YXMT	Tap, Roller dies	Molybdenum high speed steel with superior grindability and toughness
YXM34	Hob, Cutters	Cobalt alloyed Molybdenum high speed steel suitable for intermittent cutting
YXM42	Drill, Cutters, Hob, Tap, Wood working tools	Super-hard high speed steel suitable for cutting for hard materials
YXM60	Endmill, Hob, Broach, Cutters, Drill, Tap, Heading tool for stainless	High-performance high speed steel with superior durability, toughness and grindability
XVC5	Tool bit, Cutters, Hob, Endmill, Cold punch, Dies	High-performance Cobalt alloyed Vanadium high speed steel with wear/heat resistance
YHX2	Cutters, Broach	Standard Tungsten high speed steel
YXR33	Warm forging dies, Hot forging dies, Cold forging dies, Al-die cast insert pin	Matrix high speed steel for forging tools with most superior toughness
YXR3	Warm forging dies, Cold heading punch, Trimming dies, Cold forging punch and die	Matrix high speed steel for forging tools with superior toughness
YXR7	Cold punch and die, Fine blanking die, Thread roller die	Matrix high speed steel for forging tools with superior strength/toughness
HAP5R	Severe forming tools, cold/warm forging dies, fine blanking dies	Toughest P/M high speed steel
HAP10	Heavy duty working tools as fine blanking dies, Lower speed cutting tools as taps	Superior toughness effective to avoid chipping
HAP40	Cutters, Dies	Most standard grade with good balance of hardness, toughness and wear resistance
HAP50	Heavy duty cutting tools for hard material	Higher hardness, good heat and wear resistance
HAP72	Heavy duty cutting tools, Dies	Good heat wear resistance and highest obtainable hardness of 70HRC

Recommended grade by application

●Cutting tools

( ) shows standard employed hardness/HRC.

Application	Recomended Grade		
	For general use	For hard material cutting	For high speed heavy duty cutting
Tool bit	**XVC5** (65~68) **HAP72** (69~71)		
Drill	**YXM1** (63~66)	**YXM60**, **YXM42** (66~68) HAP50 (66~68), **HAP72** (68~70)	(65~67) HAP40, **HAP50** (66~68)
Tap	**YXM1** (63~66)	**YXM20**, **YXM30** (65~67) **HAP10**, HAP40 (65~67)	**YXM30** (65~67) HAP45 (65~67)
Reamer	**YXM1** (63~66)	YXM4, YXM60 (65~67)	YXM4 (64~67)
Milling cutter	**YXM1** (63~66)	**YXM42**, **YXM60** (65~67) HAP40 (66~68)	**YXM4**, XVC5 (65~67) HAP40, HAP50 (66~68)
End mill	YXM1, YXM4 (64~66) **YXM60** (67~69)	YXM60 (67~69) **HAP72** (69~71)	XVC5 (66~68) HAP50 (66~69), **HAP72**
Broach	**YXM1** (63~66) **YXM4** (64~67)	YXM60 (66~68) HAP10, **HAP40** (66~68)	(69~71) **YXM30** (65~67)
Hob	**YXM4**, YXM1 (64~69)	YXM60 (67~69) HAP50 (67~69)	HAP10, **HAP40** (66~68) **HAP40**, **HAP50** (66~68)
Pinion cutter	**YXM1**, **YXM4** (63~65)	**HAP40** (65~67)	**HAP10**, **HAP40** (64~66)
Shaving cutter	**YXM1** (64~66)	YXM30 (65~67) **YXM42**, **YXM60** (66~68)	
Rack cutter	YXM1 (63~66)	YXM4 (65~67)	YXM4 (65~67)
Chaser	**YXM1** (62~65)	YXM30 (65~67) HAP10 (65~67)	YXM4, YXM30 (65~67)
Metal saw	**YXM1** (63~66)		YXM42, YXM60 (65~67) YXM4 (65~67)
Hack saw	**YXM1** (62~65)	YXM42 (66~68) HAP40 (66~68)	YXM42 (66~68) HAP40 (66~68)
Metal band saw	**YXM1** (64~66)	**YXM42** (66~68) HAP40 (66~68)	HAP40 (66~68)
Wood cutter	**YXR3** (58~61) **YXM1**, YHX2 (62~65)	**YXM42** (66~68)	YXM4 (65~67)

●Cold working tools

Application		Required hardness range HRC	For general use	Recommended YSS steel	
				For mass production use	
				For abrasion resistance	For impact resistance
Blanking die		58~62	SLD, SLD8, ARK1	XVC5, HAP40	YXM1, YXR7, HAP10
Cold heading die	Male die	58~62	SLD, SLD8, ARK1	HAP40	YXM1, YXR7, YXR3
	Female die	55~60	YSM	SLD, SLD8	YXM1, YXR7, YXR3
Shearing blade (Straigh tooth)	For sheet service	55~60	SLD, SLD8, ARK1	YXM1, YXR7	YXR3
	For medium plate	55~58	SLD, SLD8, ARK1		YXR33
	For heavy plate	48~53	DM, DAC		
Rotary shear slitter		54~60	SLD, SLD8, ARK1	YXM1, HAP40	YXR7, YXR3
Trimming dies	For sheet use	55~60	SLD, SLD8, ARK1	YXM1, HAP40	YXR7, YXR3
	For heavy plate use	50~55	DM, DAC		
Bender Swaging dies		58~62	SLD, CRD, ARK1	XVC5	YXM1, YXR7
Cold working dies	Male die	58~62	SLD, SLD8, ARK1	YXM1, HAP40	YXR7, YXR3, HAP10, HAP5R
	Female die	55~63	SLD, SLD8, ARK1	YXM1, YXR7	YXR3, HAP5R
Drawing dies		57~62	YXM1, CRD	XVC5	
Cold working rolls		≧80HS	SLD	YXM1, HAP40	
Thread rolling dies		58~64	SLD, SLD8	SLD10, YXM1, YXR7	
Coining dies		57~62	SLD	YXM1, YXR7	
Cold hobbing dies		55~60	SLD	YXM1, YXR7	
Thead cutting dies		60~64	SGT, SAT	YXM1, YXR7	

Heat Treatment Conditions

Standard heat treatment conditions

●Annealing

1. All material is delivered as spheroidized annealed condition.
2. When used after reforging, spheroidized annealing is to be done before hardening.
3. Stress relief annealing is to be done in order to remove stress occured by cold working such as cold drawing, cold rolling or cutting and machining.

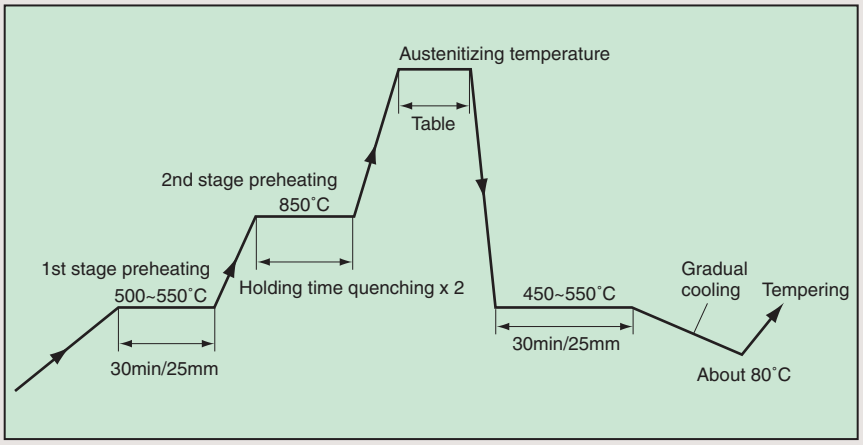
- Heating temperature : 650~750˚C
  (to aim higher temperature when softening required)
- Holding time:1h/25mm thickness

●Holding time of austenitizing

Preheat 1st 500-550˚C 30minutes/25mm thickness
2nd 850˚C 2 X figure of following table
3rd 1,050˚C 2 X figure of following table

When the object is of simple shape with thickness less than 50mm or when facilities are restricted, 2nd and 3rd steps are combined to one step with 850~900˚C X 2 X table-1. When the object is small, 1st step may be skipped.

●Tools of ordinary shape



(Remarks)
As for simple figure tools, 1st stage preheating can be skipped and oil quenching can be applied instead of hot salt bath quenching.
For complex figure tools, 3rd stage preheat (1,050˚C) applying is preferable.

●Holding time at austenitizing temperature

Heating furface	Thickness (mm) / Time	5	10	20	30	40	50	60	70	80	90
Salt bath	Holding time (sec)	60	90	160	240	280	350	390	420	440	495
	Magnification(Holding time/Thickness)	X12	X9	X8	X8	X7	X7	X6.5	X6	X5.5	X5.5

(Remarks) Holding time in salt bath = dipping time

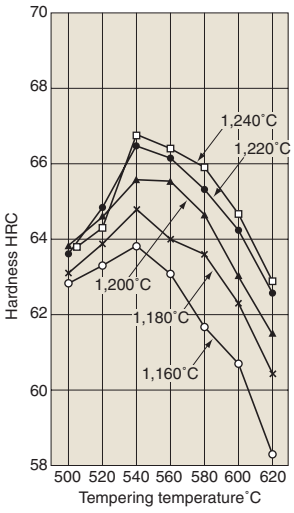
●Holding time at tempering temperature

Thickness	≤ 2.5	26-35	36-64	65-84	85-124	125-174	175-249	250-349	350-499
Tempering holding time (hour)	1	1.5	2	3	4	5	6	7	8

(Remarks) Tempering is needed more than 2 times for grades contain no cobalt and needed more than 3 times for grades cobalt alloyed in order to make it tough enough.

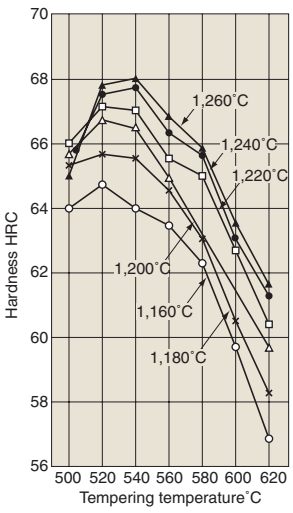
Quenched and tempered hardness curve

YXM1



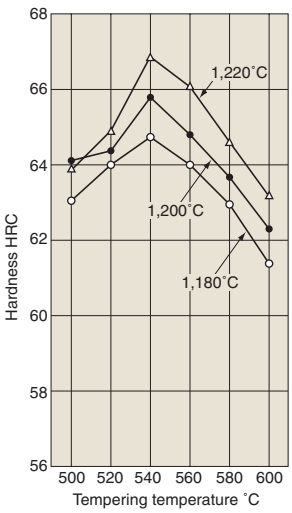
YXM1 Tempered hardness

YXM4



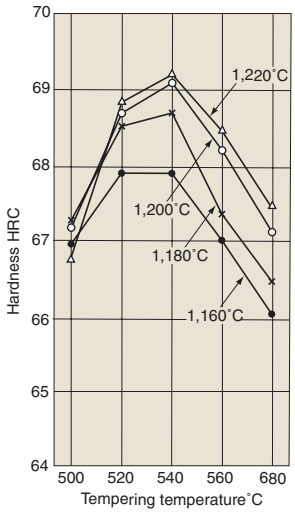
YXM4 Tempered hardness

YXMT



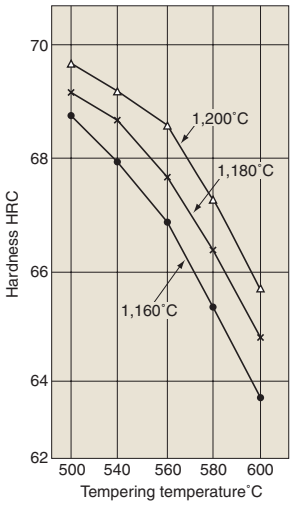
YXMT Tempered hardness

YXM42



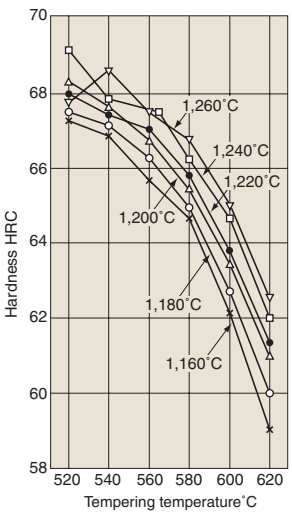
YXM42 Tempered hardness

YXM60



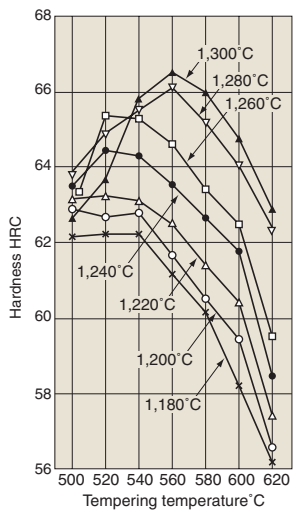
YXM60 Tempered hardness

XVC5



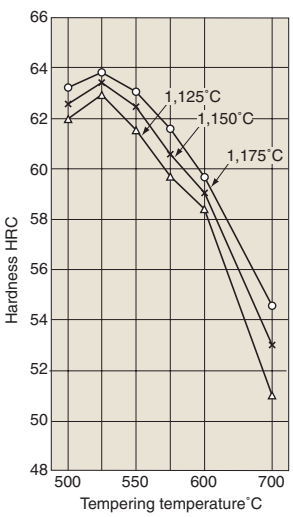
XVC5 Tempered hardness

YHX2



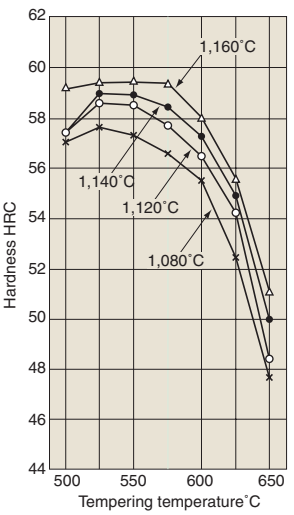
YHX2 Tempered hardness

YXR3



YXR3 Tempered Hardness

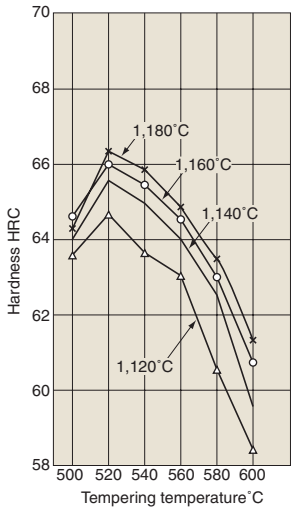
YXR33



YXR33 Tempered hardness

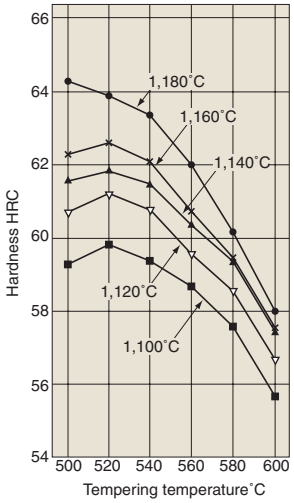
Quenched and tempered hardness curve

YXR7



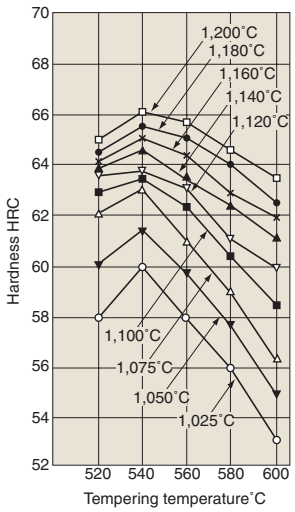
YXR7 Tempered hardness

HAP5R



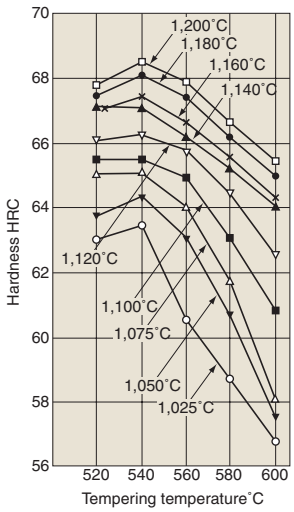
HAP5R Tempered hardness

HAP10



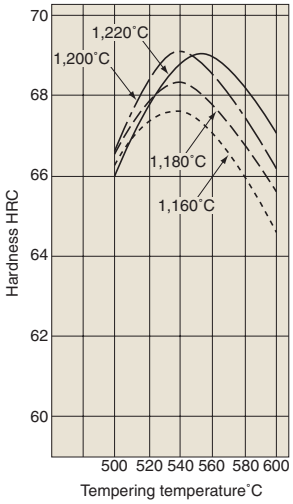
HAP10 Tempered hardness

HAP40



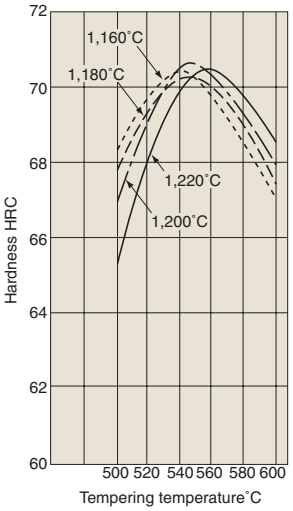
HAP40 Tempered hardness

HAP50



HAP50 Tempered hardness

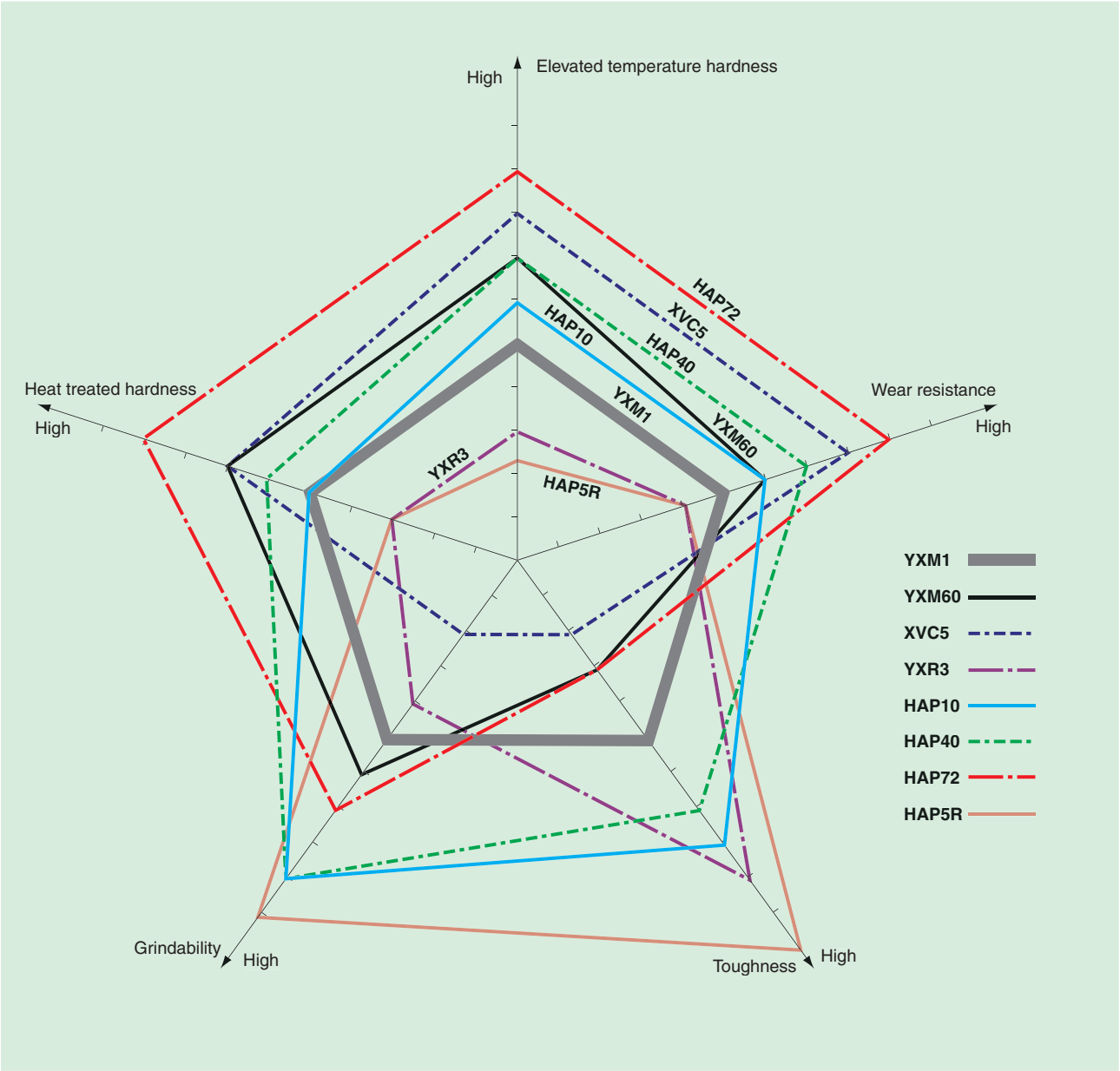
HAP72



HAP72 Tempered hardness

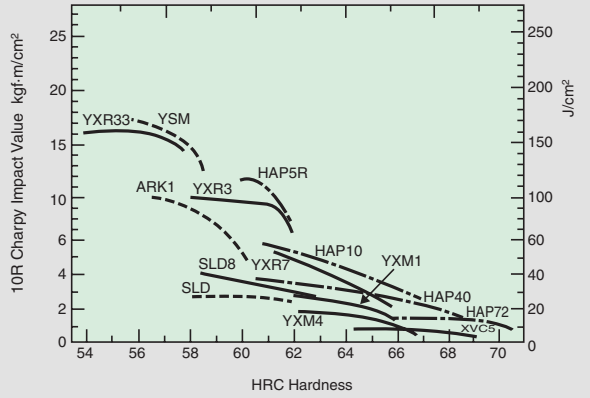
Properties

Comparison of Properties (Based on YXM1 properties)

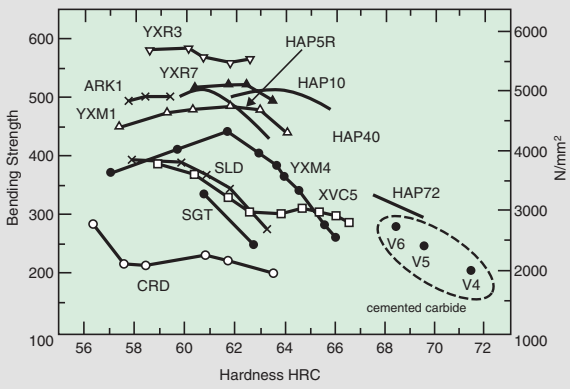


Properties

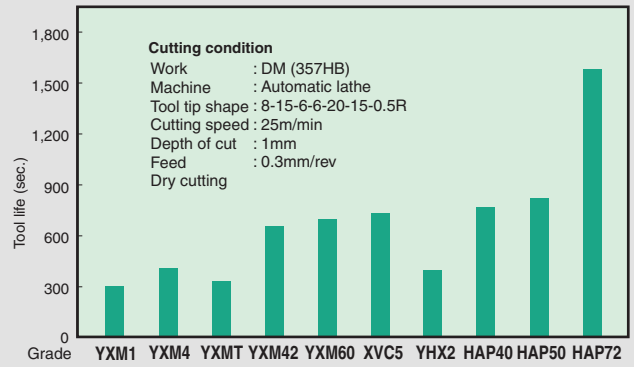
Charpy impact value



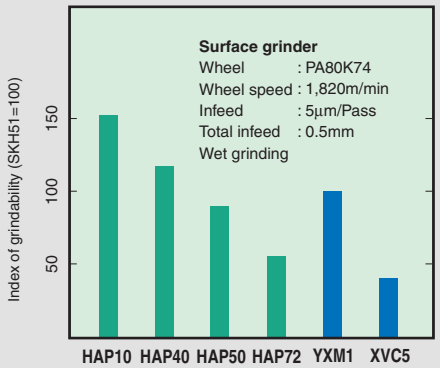
Bending strength



Continuous Cutting test by turning tool



Grindability



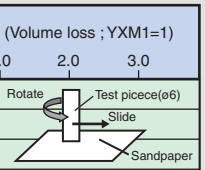
Wear resistance (Ogoshi method)

Grade	Hardness (HRC)	Specific wear ($mm^3/(mm^2 \cdot mm) \times 10^{-7}$)
YXM1	65.5	
YXM4	65.0	
XVC5	67.0	
YXR33	58.0	
YXR3	59.0	
YXR7	65.0	
HAP10	64.0	
HAP40	67.2	
HAP72	70.0	
SKD11	60.5	
SKD61	55.5	1.85

Co-friction material Friction length Load Friction speed

Wear resistance (Abrasive Wear)

Grade	Hardness (HRC)	Wear (Volume loss ; YXM1=1)
YXM1	65	
YXM4	65	
XVC5	67	
YXR3	61	
YXR33	58	
HAP10	65	
HAP72	70	
SKD11	59	



Test condition
Sandpaper: Al_2O_3 #500
Revolution: 980rpm
Friction length: 1000mm
Lubricant dry
Load: 49N (5kgf)

Hitachi Metals, Ltd. http://www.hitachi-metals.co.jp/

Head Office	SEAVANS North Building, 1-2-1, Shibaura, Minato-ku, Tokyo 105-8614, Japan Specialty Steel Company	Tel. +81-3-5765-4410 Fax. +81-3-5765-8317

Hitachi Metals America, Ltd.

Head Office	2 Manhattanville Road, Suite 301, Purchase, NY 10577, U.S.A.	Tel. +1-914-694-9200 Fax. +1-914-694-9279
Other Office	Chicago, Detroit, Charlotte, San Jose	

Hitachi Metals Europe GmbH

Head Office	Immermannstrasse 14-16,40210 Duesseldorf, Germany	Tel. +49-211-16009-0 Fax. +49-211-16009-29

Hitachi Metals Singapore Pte. Ltd.

	12 Gul Avenue, Singapore 629656	Tel. +65-6861-7711 Fax. +65-6861-1519

Hitachi Metals (Shanghai) Ltd.

	11F, Tian An Center, No.338 NanJing Road (West), Shanghai, 200003, China	Tel. +86-21-6358-6368 Fax. +86-21-6358-6327

Hitachi Metals(Dong Guan)Specialty Steel Co.,Ltd.

Guangzhou Liaison Office	Cha Shan Town, Dong Guan City, 522380 China	Tel. +86-769-640-6726 Fax. +86-769-640-6716
Dalian Branch	3-2, Koushin Mould Industrial Park Ⅲ B-1-1-1F. T. Z. Dalian, China	Tel. +86-411-8718-1011/1022 Fax. +86-411-8718-1033
Tianjin Branch	No.13 Workshop, Wenxin Industrial Park, Jingxiang Road, Xiaodian Town, Beichen Economic Development Zone, Tianjin, China	Tel. +86-22-8699-3101/3102 Fax. +86-22-8699-3103

Hitachi Metals, Ltd.

Beijing Liaison Office	Room No.1418, Beijing Fortune Building,5 Dong San Huan Bei-Lu, Chaoyang District, Beijing, 100004 China	Tel. +86-10-6590-8775 Fax. +86-10-6590-8776
Guangzhou Liaison Office	R3303, Metro plaza,183 Tianhebei Road Tianhe District, Guangzhou city, Guangdong, 510075 China	Tel. +86-20-8755-3649 Fax. +81-20-8755-3650

- The characteristics listed in this catalog are representative average values which may differ from actual product characteristics.
- This catalog and its contents are subject to change without notice.
- Do not duplicate this catalog without permission from Hitachi Metals,Ltd.
- Please contact a representative of our Specialty Steel Division if there are any questions or problems.

Our address and contact indicated in this catalog are those as of November 2007.
If you cannot put a call through, please contact our Corporate Communication Group. in Tokyo below.
Tel:+81-3-5765-4076
Fax:+81-3-5765-8312
E-mail : hmcc@hitachi-metals.co.jp

January 2008 (PDF)