











NISSHIN STEEL

**HOT ROLLED
SPECIAL STEEL
SHEET AND STRIP**

NISSHIN STEEL QUALITY PRODUCTS

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Foreword

The accurate choice of steel type is a determining factor in the effective use of special steel. Nisshin Steel has long been manufacturing optimum products and has developed hot-rolled special steel sheet and strip that meet the demands of the customers in the best possible way by employing a steelmaking process utilizing blast furnaces, converters, and vacuum degassing apparatuses.





Features

1

Uniform quality due to an integrated production system

2

Availability of a wide range of sizes, types, and finishes; steel ranging from 1.6 mm to 6.0 mm in thickness is extremely popular with our customers.

3

Excellent surface

4

Precise dimensions

5

Excellent hardenability and toughness

1.Special Steel Strip

In the production of special steel strip, we use a computerized integrated production process from blast furnace, converter, and continuous casting to hot rolling at our melting center, the Kure Works. Various sizes and finishes are available upon request.

Finishes

- Hot rolled
- Pickled·····hot rolled and pickled
- Annealed···hot rolled, pickled, and annealed

2.Special Steel Sheet

Special steel sheet, which is manufactured in tandem hot-strip mills according to a highly efficient system, is available in various sizes and finishes.

Finishes

- Hot rolled
- Pickled·····hot rolled and pickled
- Annealed···hot rolled, pickled, and annealed



Applications

(1) Carbon steel for machine structural use (S-C)

Washers, skate edges, sewing machine parts, machetes, agricultural disks, chains, materials for cold-rolled steel strip, clutch plates, automobile parts, sprockets, gears, washers, chains, shovels, agricultural disks

(2) Carbon tool steel (SK)

Cutlery, materials for cold-rolled steel strip, clutch plates, automobile parts, agricultural machine parts, circular saws

(3) Alloy tool steel (SKS)

Cutlery, materials for cold-rolled steel strip, circular saws

(4) Alloy steel for structural use (SCr, SCM, SNC, SNCM, SMn)

Cutlery, chain bush rollers, circular saws, gears, chains

(5) Other types (SUP, SUJ, etc.)

Springs, bearing parts, among others, bearing and automobile parts, etc.



washers



chains



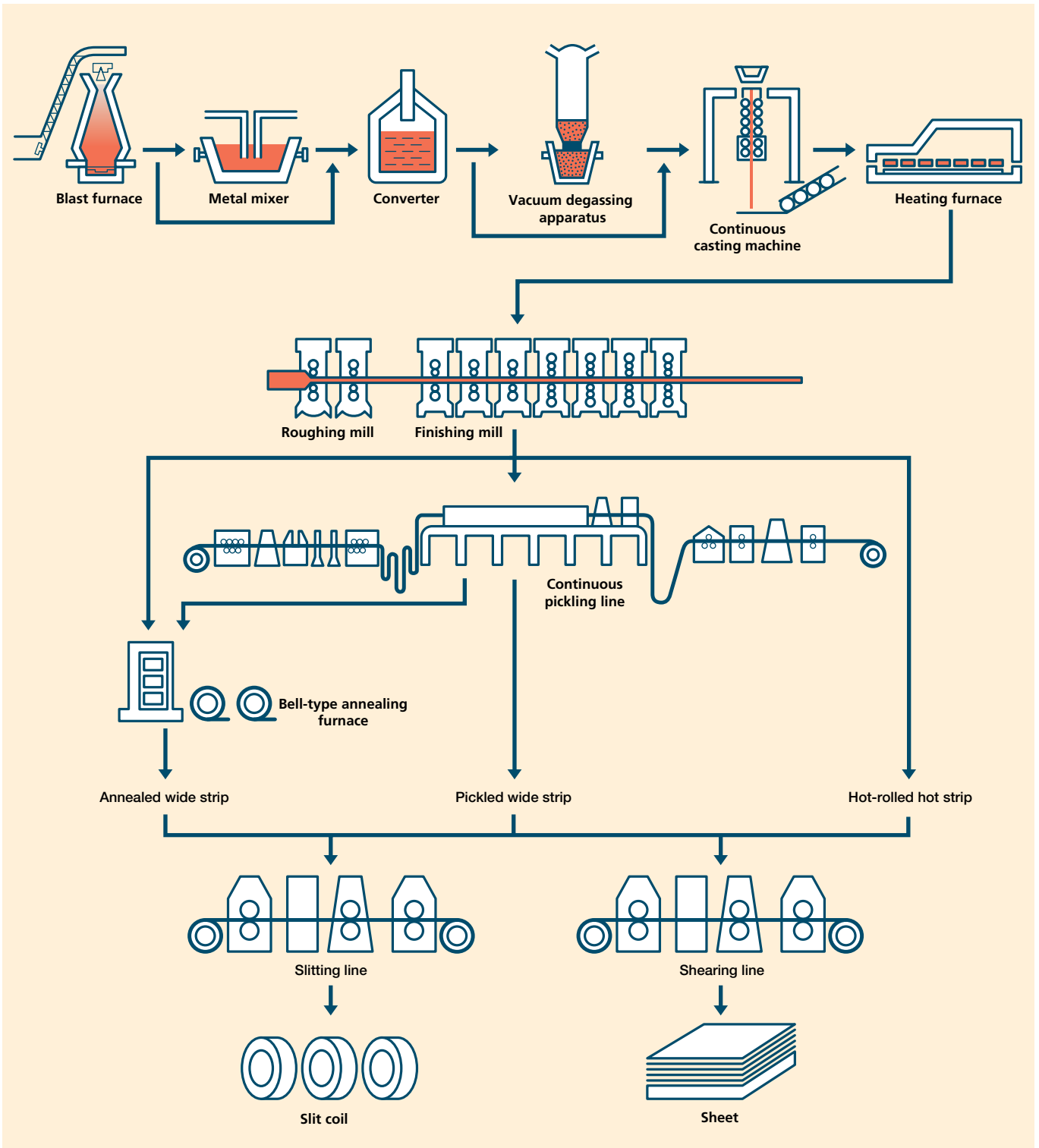
chain bush rollers



bearing parts



Manufacturing Process



Types of Steel

The following tables show representative types of steel produced by Nisshin Steel. Other types are also available on order.

1. Carbon Steel and Carbon Steel for Machine Structural Use

	Type of steel	Chemical Composition (%)					
		C	Si	Mn	P	S	
JIS	S10C	0.08~0.13	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S12C	0.10~0.15	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S15C	0.13~0.18	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S17C	0.15~0.20	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S20C	0.18~0.23	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S22C	0.20~0.25	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S25C	0.22~0.28	0.15~0.35	0.30~0.60	0.030 max.	0.035 max.	
	S28C	0.25~0.31	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S30C	0.27~0.33	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S33C	0.30~0.36	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S35C	0.32~0.38	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S38C	0.35~0.41	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S40C	0.37~0.43	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S43C	0.40~0.46	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S45C	0.42~0.48	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S48C	0.45~0.51	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S50C	0.47~0.53	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S53C	0.50~0.56	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S55C	0.52~0.58	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S58C	0.55~0.61	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
	S09CK	0.07~0.12	0.10~0.35	0.30~0.60	0.025 max.	0.025 max.	
	S15CK	0.13~0.18	0.15~0.35	0.30~0.60	0.025 max.	0.025 max.	
	S20CK	0.18~0.23	0.15~0.35	0.30~0.60	0.025 max.	0.025 max.	
	Nisshin standards	N15CK	0.10~0.15	0.15~0.35	0.30~0.60	0.025 max.	0.025 max.
		N45B	0.43~0.50	0.15~0.30	0.40~0.65	0.030 max.	0.035 max.
		NCL1	0.45~0.50	0.15~0.30	0.60~0.90	0.030 max.	0.040 max.
		N50S	0.45~0.55	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.
		N50B	0.48~0.55	0.15~0.30	0.40~0.65	0.030 max.	0.035 max.
NU52		0.50~0.58	0.15~0.35	0.60~0.90	0.030 max.	0.035 max.	
N60C		0.55~0.65	0.15~0.30	0.60~0.90	0.030 max.	0.035 max.	
N63C		0.60~0.65	0.15~0.30	0.70~0.90	0.030 max.	0.035 max.	
N65C		0.60~0.70	0.15~0.30	0.60~0.90	0.030 max.	0.035 max.	
N66C		0.62~0.70	0.17~0.37	0.90~1.20	0.030 max.	0.035 max.	
N70C		0.65~0.75	0.15~0.30	0.60~0.90	0.030 max.	0.035 max.	
N75C		0.70~0.80	0.15~0.30	0.60~0.90	0.030 max.	0.035 max.	
SAE		SAE1015	0.13~0.18	0.15~0.30	0.30~0.60	0.040 max.	0.050 max.
	SAE1018	0.15~0.20	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1019	0.15~0.20	0.15~0.30	0.70~1.00	0.030 max.	0.050 max.	
	SAE1020	0.18~0.23	0.15~0.30	0.30~0.60	0.030 max.	0.050 max.	
	SAE1022	0.18~0.23	0.15~0.30	0.70~1.00	0.030 max.	0.050 max.	
	SAE1023	0.20~0.25	0.15~0.30	0.30~0.60	0.030 max.	0.050 max.	
	SAE1030	0.28~0.34	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1035	0.31~0.38	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1040	0.37~0.44	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1045	0.43~0.50	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1050	0.48~0.55	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1055	0.50~0.60	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1060	0.55~0.65	0.15~0.30	0.60~0.90	0.040 max.	0.050 max.	
	SAE1064	0.59~0.70	0.15~0.30	0.50~0.80	0.040 max.	0.050 max.	
	SAE1065	0.60~0.70	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1566	0.60~0.71	0.15~0.30	0.85~1.15	0.040 max.	0.050 max.	
	SAE1070	0.65~0.75	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
	SAE1074	0.70~0.80	0.15~0.30	0.50~0.80	0.030 max.	0.050 max.	
	SAE1075	0.69~0.80	0.15~0.30	0.40~0.70	0.040 max.	0.050 max.	
	SAE1080	0.75~0.88	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.	
SAE1085	0.80~0.93	0.15~0.30	0.70~1.00	0.030 max.	0.050 max.		
SAE1090	0.85~0.98	0.15~0.30	0.60~0.90	0.030 max.	0.050 max.		

Types of Steel

2. Carbon Tool Steel

	Type of steel	Chemical Composition (%)				
		C	Si	Mn	P	S
JIS	SK120 (SK2)	1.15~1.25	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
	SK105 (SK3)	1.00~1.10	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
	SK95 (SK4)	0.90~1.00	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
	SK85 (SK5)	0.80~0.90	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
	SK75 (SK6)	0.70~0.80	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
	SK65 (SK7)	0.60~0.70	0.10~0.35	0.10~0.50	0.030 max.	0.030 max.
Nisshin standards	NCL2	0.65~0.73	0.35 max.	0.50 max.	0.030 max.	0.030 max.
SAE	SAE1078	0.72~0.85	0.15~0.30	0.30~0.60	0.030 max.	0.050 max.
	SAE1086	0.80~0.93	0.15~0.30	0.30~0.50	0.030 max.	0.050 max.
	SAE1095	0.90~1.03	0.15~0.30	0.30~0.50	0.030 max.	0.050 max.

3. Alloy Tool Steel

	Type of steel	Chemical Composition (%)								
		C	Si	Mn	P	S	Ni	Cr	W	V
JIS	SKS5	0.75~0.85	0.35 max.	0.50 max.	0.030 max.	0.030 max.	0.70~1.30	0.20~0.50	—	—
	SKS51	0.75~0.85	0.35 max.	0.50 max.	0.030 max.	0.030 max.	1.30~2.00	0.20~0.50	—	—
Nisshin standards	NKS32	0.77~0.83	0.35 max.	0.50 max.	0.030 max.	0.030 max.	2.00~2.50	0.25 max.	—	—
	NKS36	0.85~0.95	0.35 max.	0.40~0.60	0.030 max.	0.030 max.	0.40~0.70	0.25~0.45	—	—
	NKS37	0.85~0.95	0.35 max.	0.50 max.	0.030 max.	0.030 max.	0.70~1.30	0.50 max.	—	—
	NKS39	1.10~1.20	0.35 max.	0.50 max.	0.030 max.	0.030 max.	0.70~1.30	0.50 max.	—	—
	NKS41	0.75~0.85	0.35 max.	0.50 max.	0.030 max.	0.030 max.	1.30~2.00	0.50 max.	—	0.20~0.30
	NKS49	0.90~1.00	0.35 max.	0.50 max.	0.030 max.	0.030 max.	—	0.20~0.40	—	—
	NKS52	0.90~1.04	0.35 max.	0.60~0.90	0.030 max.	0.030 max.	—	0.20~0.40	—	—
	NKS56	1.10~1.30	0.35 max.	0.50 max.	0.030 max.	0.030 max.	—	0.20~0.50	—	—
	NKS59	0.80~0.90	0.35 max.	0.80~1.00	0.030 max.	0.030 max.	—	0.40~0.60	—	—
	NKS60	0.80~0.87	0.35 max.	0.50 max.	0.030 max.	0.030 max.	—	0.40~0.60	—	0.25~0.35
	NKS62	0.58~0.65	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	—	0.80~1.10	—	0.15~0.25

4. Alloy Steel for Structural Use

●Chromium Steel

	Type of steel	Chemical Composition (%)					
		C	Si	Mn	P	S	Cr
JIS	SCr415	0.13~0.18	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
	SCr420	0.18~0.23	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
	SCr430	0.28~0.33	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
	SCr435	0.33~0.38	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
	SCr440	0.38~0.43	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
	SCr445	0.43~0.48	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20
Nisshin standards	NCR247	0.44~0.51	0.15~0.35	0.75~1.00	0.035 max.	0.035 max.	0.30~0.60

●Chromium Molybdenum Steel

	Type of steel	Chemical Composition (%)						
		C	Si	Mn	P	S	Cr	Mo
JIS	SCM415	0.13~0.18	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.25
	SCM418	0.16~0.21	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.25
	SCM420	0.18~0.23	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.25
	SCM421	0.17~0.23	0.15~0.35	0.70~1.00	0.030 max.	0.030 max.	0.90~1.20	0.15~0.25
	SCM430	0.28~0.33	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.30
	SCM432	0.27~0.37	0.15~0.35	0.30~0.60	0.030 max.	0.030 max.	1.00~1.50	0.15~0.30
	SCM435	0.33~0.38	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.30
	SCM440	0.38~0.43	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.30
	SCM445	0.43~0.48	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.15~0.30
	SCM822	0.20~0.25	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.90~1.20	0.35~0.45
SAE	SAE4130	0.28~0.33	0.15~0.35	0.40~0.60	0.030 max.	0.040 max.	0.80~1.10	0.15~0.25

●Nickel Chromium Steel

	Type of steel	Chemical Composition (%)						
		C	Si	Mn	P	S	Ni	Cr
JIS	SNC236	0.32~0.40	0.15~0.35	0.50~0.80	0.030 max.	0.030 max.	1.00~1.50	0.50~0.90
	SNC415	0.12~0.18	0.15~0.35	0.35~0.65	0.030 max.	0.030 max.	2.00~2.50	0.20~0.50
	SNC631	0.27~0.35	0.15~0.35	0.35~0.65	0.030 max.	0.030 max.	2.50~3.00	0.60~1.00
	SNC815	0.12~0.18	0.15~0.35	0.35~0.65	0.030 max.	0.030 max.	3.00~3.50	0.70~1.00
	SNC836	0.32~0.40	0.15~0.35	0.35~0.65	0.030 max.	0.030 max.	3.00~3.50	0.60~1.00

Types of Steel

●Nickel Chromium Molybdenum Steel

	Type of steel	Chemical Composition (%)							
		C	Si	Mn	P	S	Ni	Cr	Mo
JIS	SNCM220	0.17~0.23	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	0.40~0.70	0.40~0.60	0.15~0.25
	SNCM240	0.38~0.43	0.15~0.35	0.70~1.00	0.030 max.	0.030 max.	0.40~0.70	0.40~0.60	0.15~0.30
	SNCM415	0.12~0.18	0.15~0.35	0.40~0.70	0.030 max.	0.030 max.	1.60~2.00	0.40~0.60	0.15~0.30
	SNCM420	0.17~0.23	0.15~0.35	0.40~0.70	0.030 max.	0.030 max.	1.60~2.00	0.40~0.60	0.15~0.30
	SNCM431	0.27~0.35	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	1.60~2.00	0.60~1.00	0.15~0.30
	SNCM439	0.36~0.43	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	1.60~2.00	0.60~1.00	0.15~0.30
	SNCM447	0.44~0.50	0.15~0.35	0.60~0.90	0.030 max.	0.030 max.	1.60~2.00	0.60~1.00	0.15~0.30
	SNCM616	0.13~0.20	0.15~0.35	0.80~1.20	0.030 max.	0.030 max.	2.80~3.20	1.40~1.80	0.40~0.60
	SNCM625	0.20~0.30	0.15~0.35	0.35~0.60	0.030 max.	0.030 max.	3.00~3.50	1.00~1.50	0.15~0.30
	SNCM630	0.25~0.35	0.15~0.35	0.35~0.60	0.030 max.	0.030 max.	2.50~3.50	2.50~3.50	0.50~0.70
SNCM815	0.12~0.18	0.15~0.35	0.30~0.60	0.030 max.	0.030 max.	4.00~4.50	0.70~1.00	0.15~0.30	
SAE	SAE8615	0.16~0.18	0.15~0.35	0.70~0.90	0.030 max.	0.040 max.	0.40~0.70	0.40~0.60	0.15~0.25
	SAE8617	0.15~0.20	0.15~0.35	0.70~0.90	0.030 max.	0.040 max.	0.40~0.70	0.40~0.60	0.15~0.25
	SAE8620	0.18~0.23	0.15~0.35	0.70~0.90	0.030 max.	0.040 max.	0.40~0.70	0.40~0.60	0.15~0.25
	SAE8622	0.20~0.25	0.15~0.35	0.70~0.90	0.030 max.	0.040 max.	0.40~0.70	0.40~0.60	0.15~0.25
	SAE8660	0.56~0.64	0.15~0.35	0.75~1.00	0.035max.	0.040 max.	0.40~0.70	0.40~0.60	0.15~0.25

●Manganese Steel

	Type of steel	Chemical Composition (%)				
		C	Si	Mn	P	S
JIS	SMn420	0.17~0.23	0.15~0.35	1.20~1.50	0.030 max.	0.030 max.
	SMn443	0.40~0.46	0.15~0.35	1.35~1.65	0.030 max.	0.030 max.
SAE	SAE1524	0.19~0.25	0.15~0.30	1.35~1.65	0.030 max.	0.050 max.
	SAE1536	0.30~0.37	0.15~0.30	1.20~1.50	0.030 max.	0.050 max.
	SAE1541	0.36~0.44	0.15~0.30	1.35~1.65	0.030 max.	0.050 max.
	SAE1552	0.47~0.55	0.15~0.30	1.20~1.50	0.030 max.	0.050 max.

5.Spring Steel

	Type of steel	Chemical Composition (%)						
		C	Si	Mn	P	S	Cr	V
JIS	SUP6	0.56~0.64	1.50~1.80	0.70~1.00	0.035 max.	0.035 max.	—	—
	SUP7	0.56~0.64	1.80~2.20	0.70~1.00	0.035 max.	0.035 max.	—	—
	SUP9	0.52~0.60	0.15~0.35	0.65~0.95	0.035 max.	0.035 max.	0.65~0.95	—
	SUP10	0.47~0.55	0.15~0.35	0.65~0.95	0.035 max.	0.035 max.	0.80~1.10	0.15~0.25

6.High-Carbon Chromium Bearing Steel

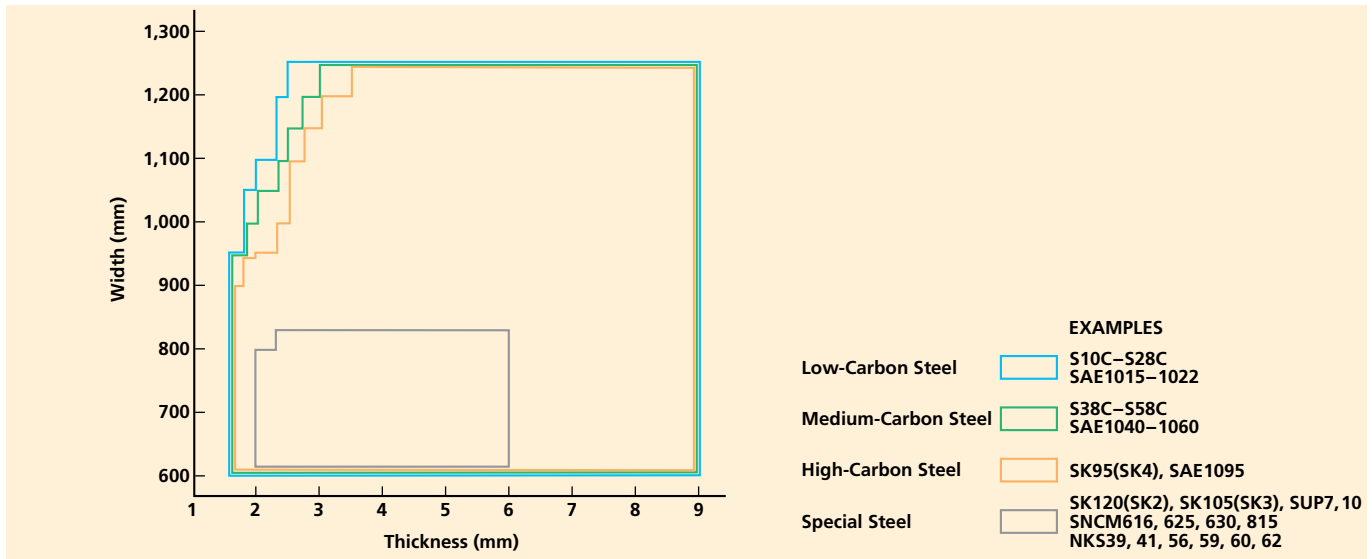
	Type of steel	Chemical Composition (%)					
		C	Si	Mn	P	S	Cr
JIS	SUJ2	0.95~1.10	0.15~0.35	0.50 max.	0.025 max.	0.025 max.	1.30~1.60

Manufacturable Range

General production dimensions for low-carbon, medium-carbon, and high-carbon steel and special steel are indicated below. Please consult Nisshin regarding the dimensions for specific types of steel not mentioned here.

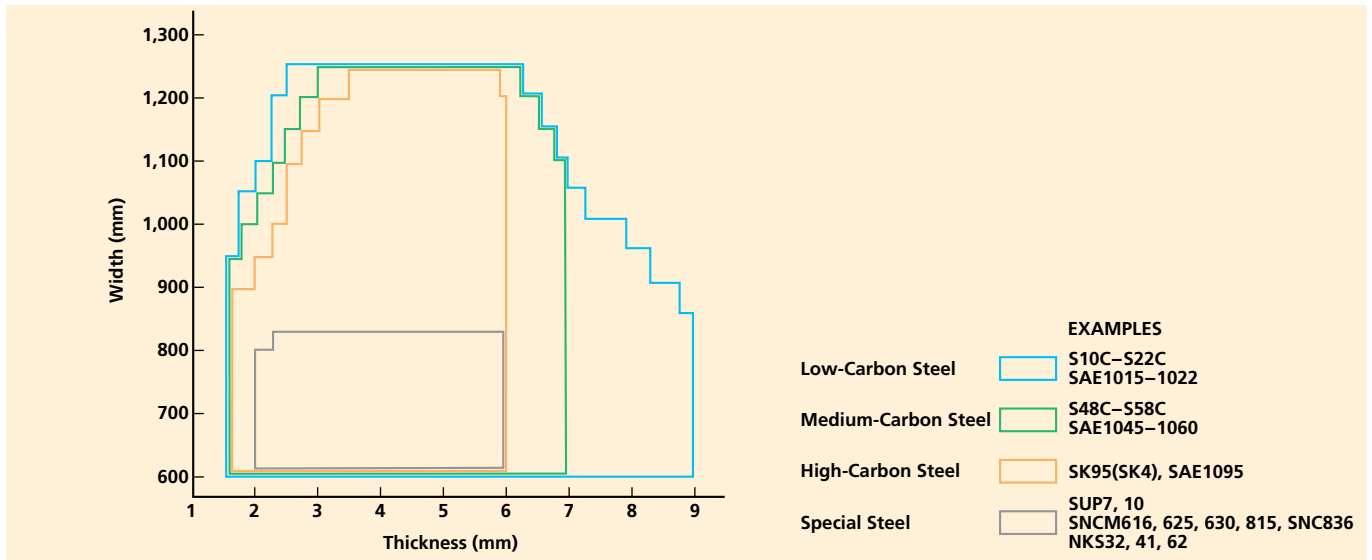
1. Hot-Rolled Steel

Figure-1



2. Pickled and Annealed Steel

Figure-2



Dimensions and Configurations

Dimensional tolerances and tolerance values of shapes are listed below. Others are available on order. It is essential that the supplier and the user reach an agreement after sufficient discussions on the steel types and specifications. Nisshin Steel is trying its best to maintain complete quality and process control and our customers are cordially requested to perform careful quality and process control per lot.

1. Thickness Tolerance

Thickness tolerance for sheet and strip is given on the right. Thickness is measured at an arbitrary point at least 20 mm from both edges.

(Unit: mm)

Thickness	Tolerance	
	A	B
1.40 up to 2.50 (excl.)	±0.16	±0.16
2.50 up to 3.15 (excl.)	±0.19	±0.19
3.15 up to 4.00 (excl.)	±0.20	±0.20
4.00 up to 5.00 (excl.)	±0.25	±0.25
5.00 up to 6.00 (excl.)	±0.30	±0.30
6.00 up to 7.00 (excl.)	±0.30	±0.35
7.00 up to 8.00 (excl.)	±0.35	±0.40
8.00 up to 9.00 (incl.)	±0.40	±0.45

Note : A···Other than B

General materials

B···SKS2, 21, SKS7, NKS39

2. Width Tolerance

(1) Width tolerance for wide strip and sheet

(Unit: mm)

Width	Tolerance	
	Hot-Rolled	Slit Edge
630 up to 1,000 (excl.)	+20 -0	+3.0 -0
1,000 up to 1,250 (incl.)	+25 -0	+3.0 -0

(2) Width tolerance for slit strip

(Unit: mm)

Width	Thickness	Tolerance	
		1.40~4.50 (excl.)	4.50~6.00
42 up to 100 (excl.)		±0.3	±0.3
100 up to 250 (excl.)		±0.3	±0.5
250 up to 400 (excl.)		±0.5	±0.5
400 up to 620 (incl.)		±0.5	±0.5

3. Length Tolerance

Length tolerance for steel sheet

(Unit: mm)

Width	Tolerance
Up to 1,000 (excl.)	+20 -0
1,000 up to 2,000 (excl.)	+20 -0
2,000 up to 3,000 (excl.)	+20 -0
3,000 up to 4,000 (excl.)	+20 -0
Over 4,000 (incl.)	+25 -0

4. Camber Tolerance

(1) Camber tolerance for steel strip

(Unit: mm)

Width	Tolerance (per arbitrary length of 2,000)
42 up to 70 (excl.)	8
70 up to 1,250 (incl.)	5

(2) Camber tolerance for steel sheet

(Unit: mm)

Length	Tolerance	
	630 up to 1,000 (excl.)	1,000 up to 1,250 (incl.)
1,000 up to 2,500 (excl.)	5	5
2,500 up to 4,000 (excl.)	10	10
4,000 up to 6,300 (excl.)	15	15
6,300 up to 10,000 (incl.)	25	25

(Unit: mm)

Thickness	Length	Tolerance	
		1,000 up to 2,000	2,001 up to 4,000
1.40 up to 1.60 (excl.)		15	19
1.60 up to 4.00 (excl.)		14	18
4.00 up to 6.30 (excl.)		12	15
6.30 up to 9.00 (incl.)		10	15

5. Flatness Tolerance Values

Flatness tolerance values of steel sheet

- Flatness tolerance is obtained by deducting the thickness of the sheet from the maximum strain value and is applicable to the top side of the steel sheet.
- Tolerance values for sheets over 4,000 mm in length are determined on a case-by-case basis.

Mechanical Properties

Hardness of steel sheet and strip as hot rolled, anneal hardened and tempered within the temperature ranges given in the tables is as follows. Hardened and tempered hardness have been obtained from samples.

1. Carbon Steel for Machine Structural Use ①

	Type of steel	Hot-rolled hardness HRB	Annealed hardness HRB	Hardening		Tempering	
				Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	S09CK	76 max.	—	—	—	—	—
	S15CK	83 max.	—	—	—	—	—
	S20CK	86 max.	—	—	—	—	—
	S10C	76 max.	—	—	—	—	—
	S12C	81 max.	—	—	—	—	—
	S15C	83 max.	—	—	—	—	—
	S17C	85 max.	—	—	—	—	—
	S20C	86 max.	—	—	—	—	—
	S22C	88 max.	—	—	—	—	—
	S25C	90 max.	—	—	—	—	—
	S28C	91 max.	—	—	—	—	—
	S30C	93 max.	85 max.	850~900 water quenched	46 min.	150~200 air cooled	42 min.
	S33C	97 max.	85 max.	840~890 water quenched	46 min.	150~200 air cooled	42 min.
	S35C	98 max.	88 max.	840~890 water quenched	46 min.	150~200 air cooled	43 min.
	S38C	99 max.	88 max.	830~880 water quenched	46 min.	150~200 air cooled	43 min.
	S40C	99 max.	90 max.	830~880 oil quenched	51 min.	150~200 air cooled	45 min.
	S43C	100 max.	90 max.	830~880 oil quenched	51 min.	150~200 air cooled	45 min.
	S45C	101 max.	91 max.	830~880 oil quenched	51 min.	150~200 air cooled	45 min.
	S48C	102 max.	91 max.	810~860 oil quenched	53 min.	150~200 air cooled	48 min.
	S50C	104 max.	92 max.	810~860 oil quenched	53 min.	150~200 air cooled	48 min.
S53C	106 max.	92 max.	810~860 oil quenched	53 min.	150~200 air cooled	48 min.	
S55C	107 max.	93 max.	810~860 oil quenched	53 min.	150~200 air cooled	50 min.	
S58C	108 max.	93 max.	800~850 oil quenched	56 min.	150~200 air cooled	50 min.	

Mechanical Properties

2. Carbon Steel for Machine Structural Use ②

	Type of steel	Hot-rolled hardness	Annealed hardness HRB	Hardening		Tempering	
				Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
SAE	SAE1015	HRB 85 max.	—	—	—	—	—
	SAE1018	HRB 90 max.	—	—	—	—	—
	SAE1019	HRB 90 max.	—	—	—	—	—
	SAE1020	HRB 86 max.	—	—	—	—	—
	SAE1022	HRB 93 max.	—	—	—	—	—
	SAE1023	HRB 88 max.	—	—	—	—	—
	SAE1030	HRB 98 max.	86 max.	850~900 water quenched	45 min.	150~200 air cooled	42 min.
	SAE1035	HRB 99 max.	88 max.	850~900 water quenched	46 min.	150~200 air cooled	43 min.
	SAE1040	HRB 100 max.	90 max.	830~880 oil quenched	51 min.	150~200 air cooled	45 min.
	SAE1045	HRB 104 max.	91 max.	830~880 oil quenched	54 min.	150~200 air cooled	45 min.
	SAE1050	HRC 35 max.	92 max.	810~860 oil quenched	54 min.	150~200 air cooled	48 min.
	SAE1055	HRC 35 max.	93 max.	810~860 oil quenched	54 min.	150~200 air cooled	48 min.
	SAE1060	HRC 38 max.	94 max.	790~850 oil quenched	57 min.	150~200 air cooled	52 min.
	SAE1064	HRB 107 max.	94 max.	790~850 oil quenched	57 min.	150~200 air cooled	52 min.
	SAE1065	HRB 108 max.	94 max.	790~850 oil quenched	57 min.	150~200 air cooled	52 min.
	SAE1566	HRC 34 max.	97 max.	790~850 oil quenched	57 min.	150~200 air cooled	52 min.
	SAE1070	HRC 37 max.	96 max.	790~850 oil quenched	57 min.	150~200 air cooled	54 min.
	SAE1074	HRC 38 max.	96 max.	790~850 oil quenched	57 min.	150~200 air cooled	54 min.
	SAE1075	HRC 38 max.	96 max.	790~850 oil quenched	57 min.	150~200 air cooled	54 min.
SAE1080	HRC 40 max.	96 max.	790~850 oil quenched	60 min.	150~200 air cooled	58 min.	
SAE1085	HRC 42 max.	97 max.	790~850 oil quenched	60 min.	150~200 air cooled	59 min.	
SAE1090	HRC 43 max.	97 max.	790~850 oil quenched	60 min.	150~200 air cooled	59 min.	
Nisshin standards	N15CK	HRB 81 max.	—	—	—	—	—
	N45B	HRB 102 max.	91 max.	830~880 oil quenched	51 min.	150~200 air cooled	45 min.
	NCL1	HRB 102 max.	91 max.	810~860 oil quenched	54 min.	550~650 air cooled	14 min.
	N50S	HRB 108 max.	91 max.	810~860 oil quenched	54 min.	150~200 air cooled	52 min.
	N50B	HRB 108 max.	92 max.	810~860 oil quenched	54 min.	150~200 air cooled	52 min.
	NU52	HRB 105 max.	92 max.	810~860 oil quenched	54 min.	150~200 air cooled	48 min.
	N60C	HRC 34 max.	94 max.	790~850 oil quenched	56 min.	150~200 air cooled	52 min.
	N63C	HRC 34 max.	94 max.	780~840 oil quenched	56 min.	150~200 air cooled	52 min.
	N65C	HRC 35 max.	94 max.	780~840 oil quenched	56 min.	150~200 air cooled	52 min.
	N66C	HRC 38 max.	97 max.	780~840 oil quenched	56 min.	150~200 air cooled	52 min.
	N70C	HRC 37 max.	96 max.	780~840 oil quenched	56 min.	150~200 air cooled	52 min.
N75C	HRC 38 max.	96 max.	780~840 oil quenched	56 min.	150~200 air cooled	52 min.	

3. Carbon Tool Steel

	Type of steel	Hot-rolled hardness HRC	Annealed hardness HRB	Hardening		Tempering	
				Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	SK120 (SK2)	46 max.	98 max.	770~830 oil quenched	60 min.	150~200 air cooled	60 min.
	SK105 (SK3)	45 max.	98 max.	770~830 oil quenched	60 min.	150~200 air cooled	60 min.
	SK95 (SK4)	44 max.	97 max.	770~830 oil quenched	60 min.	150~200 air cooled	59 min.
	SK85 (SK5)	43 max.	97 max.	770~830 oil quenched	60 min.	150~200 air cooled	59 min.
	SK75 (SK6)	40 max.	96 max.	770~840 oil quenched	60 min.	150~200 air cooled	59 min.
	SK65 (SK7)	32 max.	96 max.	770~840 oil quenched	57 min.	150~200 air cooled	54 min.
SAE	SAE1078	43 max.	96 max.	780~840 oil quenched	60 min.	150~200 air cooled	59 min.
	SAE1086	44 max.	97 max.	770~830 oil quenched	60 min.	150~200 air cooled	59 min.
	SAE1095	45 max.	98 max.	770~830 oil quenched	60 min.	150~200 air cooled	59 min.
Nisshin stan.	NCL2	33 max.	94 max.	770~850 oil quenched	57 min.	150~200 air cooled	55 min.

4. Alloy Tool Steel

	Type of steel	Annealed hardness HRB	Hardening		Tempering	
			Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	SKS5	98 max.	800~850 oil quenched	61 min.	400~500 air cooled	45 min.
	SKS51	98 max.	800~850 oil quenched	61 min.	400~500 air cooled	45 min.
Nisshin standards	NKS32	95 max.	800~850 oil quenched	61 min.	400~500 air cooled	45 min.
	NKS36	97 max.	800~850 oil quenched	61 min.	400~500 air cooled	45 min.
	NKS37	97 max.	800~850 oil quenched	62 min.	150~200 air cooled	60 min.
	NKS39	97 max.	800~850 oil quenched	64 min.	150~200 air cooled	63 min.
	NKS41	96 max.	790~850 oil quenched	58 min.	150~200 air cooled	56 min.
	NKS49	100 max.	790~850 oil quenched	61 min.	150~200 air cooled	59 min.
	NKS52	100 max.	790~850 oil quenched	62 min.	150~200 air cooled	60 min.
	NKS56	98 max.	790~850 oil quenched	64 min.	150~200 air cooled	63 min.
	NKS59	100 max.	790~850 oil quenched	62 min.	150~200 air cooled	60 min.
	NKS60	100 max.	790~850 oil quenched	62 min.	150~200 air cooled	65 min.
	NKS62	100 max.	790~850 oil quenched	62 min.	150~200 air cooled	65 min.

5. Alloy Steel for Structural Use

● Chromium Steel

	Type of steel	Hot-rolled hardness	Annealed hardness HRB	Hardening			Tempering				
				Temperature °C	Hardness HRC			Temperature °C	Hardness HRC		
					Thickness mm				Thickness mm		
					below 3.15	3.15~6.00	6.01~9.00		below 3.15	3.15~6.00	6.01~9.00
JIS	SCr415 (SCr21)	HRB 105 max.	90 max.	850~900 oil quenched	31 min.	28 min.	25 min.	150~200 air cooled	20 min.	19 min.	18 min.
	SCr420 (SCr22)	HRB 106 max.	93 max.	850~900 oil quenched	34 min.	32 min.	28 min.	150~200 air cooled	24 min.	23 min.	22 min.
	SCr430 (SCr2)	HRC 34 max.	93 max.	830~880 oil quenched	45 min.	42 min.	39 min.	520~620 oil cooled	24 min.	22 min.	21 min.
	SCr435 (SCr3)	HRC 35 max.	94 max.	830~880 oil quenched	48 min.	47 min.	44 min.	520~620 oil cooled	28 min.	27 min.	26 min.
	SCr440 (SCr4)	HRC 36 max.	95 max.	830~880 oil quenched	51 min.	50 min.	48 min.	520~620 oil cooled	29 min.	28 min.	28 min.
	SCr445 (SCr5)	HRC 40 max.	95 max.	830~880 oil quenched	55 min.	54 min.	53 min.	520~620 oil cooled	31 min.	30 min.	30 min.
Nisshin standards	NCR247 (NCR5)	HRB 105 max.	95 max.	830~880 oil quenched	52 min.	50 min.	48 min.	300~350 oil cooled	40 min.	38 min.	36 min.

● Chromium Molybdenum Steel

	Type of steel	Hot-rolled hardness	Annealed hardness HRB	Hardening			Tempering				
				Temperature °C	Hardness HRC			Temperature °C	Hardness HRC		
					Thickness mm				Thickness mm		
					below 3.15	3.15~6.00	6.01~9.00		below 3.15	3.15~6.00	6.01~9.00
JIS	SCM415 (SCM21)	HRB 105 max.	90 max.	850~900 oil quenched	33 min.	30 min.	24 min.	150~200 air cooled	27 min.	24 min.	22 min.
	SCM418 (S—)	HRB 105 max.	90 max.	850~900 oil quenched	34 min.	32 min.	27 min.	150~200 air cooled	29 min.	27 min.	24 min.
	SCM420 (SCM22)	HRB 105 max.	90 max.	850~900 oil quenched	36 min.	34 min.	31 min.	150~200 air cooled	32 min.	30 min.	27 min.
	SCM421 (SCM23)	HRB 105 max.	92 max.	850~900 oil quenched	37 min.	36 min.	33 min.	150~200 air cooled	34 min.	33 min.	30 min.
	SCM430 (SCM2)	HRC 36 max.	93 max.	830~880 oil quenched	46 min.	45 min.	45 min.	530~630 oil cooled	24 min.	23 min.	23 min.
	SCM432 (SCM1)	HRC 35 max.	90 max.	830~880 oil quenched	47 min.	46 min.	45 min.	530~630 oil cooled	26 min.	26 min.	26 min.
	SCM435 (SCM3)	HRC 38 max.	93 max.	830~880 oil quenched	49 min.	48 min.	48 min.	530~630 oil cooled	29 min.	28 min.	28 min.
	SCM440 (SCM4)	HRC 39 max.	95 max.	830~880 oil quenched	52 min.	51 min.	50 min.	530~630 oil cooled	31 min.	30 min.	30 min.
	SCM445 (SCM5)	HRC 40 max.	95 max.	830~880 oil quenched	55 min.	54 min.	54 min.	530~630 oil cooled	33 min.	32 min.	32 min.
SAE	SAE4130	HRC 36 max.	93 max.	830~880 oil quenched	41 min.	40 min.	39 min.	150~200 air cooled	34 min.	33 min.	32 min.
				830~880 oil quenched	46 min.	45 min.	45 min.	550~650 oil quenched	24 min.	23 min.	23 min.

● Nickel Chromium Steel

	Type of steel	Hot-rolled hardness	Annealed hardness HRB	Hardening			Tempering				
				Temperature °C	Hardness HRC			Temperature °C	Hardness HRC		
					Thickness mm				Thickness mm		
					below 3.15	3.15~6.00	6.01~9.00		below 3.15	3.15~6.00	6.01~9.00
JIS	SNC236 (SNC1)	HRC 36 max.	93 max.	820~880 oil quenched	43 min.	41 min.	37 min.	550~650 oil cooled	22 min.	20 min.	18 min.
	SNC415 (SNC21)	HRC 32 max.	90 max.	850~900 oil quenched	30 min.	27 min.	24 min.	150~200 air cooled	27 min.	24 min.	22 min.
	SNC631 (SNC2)	HRC 39 max.	93 max.	820~880 oil quenched	48 min.	47 min.	46 min.	550~650 oil cooled	26 min.	25 min.	24 min.
	SNC815 (SNC22)	HRC 35 max.	90 max.	850~900 oil quenched	34 min.	33 min.	32 min.	150~200 air cooled	31 min.	30 min.	30 min.
	SNC836 (SNC3)	HRC 40 max.	95 max.	820~880 oil quenched	50 min.	50 min.	50 min.	550~650 oil cooled	28 min.	28 min.	28 min.

●Nickel Chromium Molybdenum Steel

	Type of steel	Hot-rolled hardness	Annealed hardness HRB	Hardening			Tempering				
				Temperature °C	Hardness HRC			Temperature °C	Hardness HRC		
					Thickness mm				Thickness mm		
					below 3.15	3.15~6.00	6.01~9.00		below 3.15	3.15~6.00	6.01~9.00
JIS	SNCM220 (SNCM21)	HRB 105 max.	88 max.	850~900 oil quenched	34 min.	30 min.	25 min.	150~200 air cooled	29 min.	27 min.	24 min.
	SNCM240 (SNCM6)	HRC 33 max.	93 max.	820~870 oil quenched	52 min.	51 min.	49 min.	580~680 oil cooled	27 min.	26 min.	26 min.
	SNCM415 (SNCM22)	HRC 106 max.	90 max.	850~900 oil quenched	35 min.	32 min.	29 min.	150~200 air cooled	28 min.	27 min.	26 min.
	SNCM420 (SNCM23)	HRC 33 max.	90 max.	850~900 oil quenched	37 min.	33 min.	31 min.	150~200 air cooled	34 min.	32 min.	31 min.
	SNCM431 (SNCM1)	HRC 33 max.	93 max.	820~870 oil quenched	46 min.	46 min.	46 min.	570~670 oil cooled	24 min.	24 min.	24 min.
	SNCM439 (SNCM8)	HRC 38 max.	98 max.	820~870 oil quenched	51 min.	51 min.	51 min.	580~680 oil cooled	31 min.	31 min.	31 min.
	SNCM447 (SNCM9)	HRC 39 max.	98 max.	820~870 oil quenched	55 min.	55 min.	55 min.	580~680 oil cooled	32 min.	32 min.	32 min.
	SNCM616 (SNCM26)	HRC 40 max.	98 max.	850~900 oil quenched	38 min.	38 min.	38 min.	150~200 air cooled	37 min.	37 min.	37 min.
	SNCM625 (SNCM2)	HRC 34 max.	102 max.	820~870 oil quenched	44 min.	44 min.	44 min.	570~670 oil cooled	28 min.	28 min.	28 min.
	SNCM630 (SNCM5)	HRC 41 max.	102 max.	850~950 oil quenched	48 min.	48 min.	48 min.	550~650 oil cooled	32 min.	32 min.	32 min.
SNCM815 (SNCM25)	HRC 39 max.	98 max.	830~880 oil quenched	36 min.	36 min.	36 min.	150~200 air cooled	33 min.	33 min.	33 min.	
SAE	SAE8615	HRB 104 max.	88 max.	850~900 oil quenched	33 min.	29 min.	24 min.	150~200 air cooled	28 min.	26 min.	23 min.
	SAE8617	HRB 105 max.	89 max.	850~900 oil quenched	33 min.	29 min.	24 min.	150~200 air cooled	28 min.	26 min.	23 min.
	SAE8620	HRB 105 max.	90 max.	850~900 oil quenched	34 min.	30 min.	25 min.	150~200 air cooled	29 min.	27 min.	24 min.
	SAE8622	HRB 106 max.	92 max.	850~900 oil quenched	35 min.	31 min.	26 min.	150~200 air cooled	30 min.	28 min.	25 min.
	SAE8660	HRC 38 max.	98 max.	820~870 oil quenched	57 min.	57 min.	57 min.	580~680 air cooled	37 min.	37 min.	37 min.

●Manganese Steel

	Type of steel	Hot-rolled hardness HRC	Annealed hardness HRB	Hardening		Tempering	
				Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	SMn420	93 max.	88 max.	850~900 oil quenched	15 min.	150~200 air cooled	14 min.
	SMn443	103 max.	93 max.	830~880 oil quenched	50 min.	550~650 oil cooled	21 min.
SAE	SAE1524	93 max.	88 max.	850~900 oil quenched	31 min.	150~200 air cooled	28 min.
	SAE1536	100 max.	91 max.	830~880 oil quenched	40 min.	550~650 oil cooled	15 min.
	SAE1541	103 max.	93 max.	830~880 oil quenched	45 min.	550~650 oil cooled	17 min.
	SAE1552	106 max.	95 max.	810~860 oil quenched	47 min.	550~650 oil cooled	18 min.

6.Spring Steel

	Type of steel	Hot-rolled hardness HRC	Annealed hardness HRB	Hardening		Tempering	
				Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	SUP6	45 max.	97 max.	830~860 oil quenched	54 min.	480~530 air cooled	39 min.
	SUP7	46 max.	97 max.	830~860 oil quenched	54 min.	490~540 air cooled	39 min.
	SUP9	38 max.	90 max.	830~860 oil quenched	55 min.	460~510 air cooled	39 min.
	SUP10	36 max.	90 max.	840~870 oil quenched	55 min.	470~540 air cooled	39 min.

7.High-Carbon Chromium Bearing Steel

	Type of steel	Annealed hardness HRB	Hardening		Tempering	
			Temperature°C	Hardness HRC	Temperature°C	Hardness HRC
JIS	SUJ2	98 max.	790~850 oil quenched	62 min.	150~200 air cooled	61 min.

Quality Characteristics

1. Carbon Steel for Machine Structural Use

Carbon steel for machine structural use is widely used for structural parts of automobiles and other machinery. Because of the comparatively low carbon content, its workability is excellent, and the comparatively high manganese content makes possible the control of mechanical properties by heat treatment.

Steel of grades lower than S25C has a lower hardenability and is generally used as normalized for products which do not require special strength.

S35C grade steel has somewhat higher hardenability and is used for small parts. Hardening and tempering are conducted according to the intended applications.

Steel of higher grades than S45C has even higher hardenability and is used for products that require special hardness and strength.

S-C steel intrinsically has low hardenability and is usually subjected to water hardening. Steel with more than 0.40% carbon content is sometimes subjected to oil hardening to prevent deformation and strain. The tempering temperature is arbitrarily selected depending on the strength or hardness required. At above 550°C, rapid cooling is necessary to prevent brittleness.

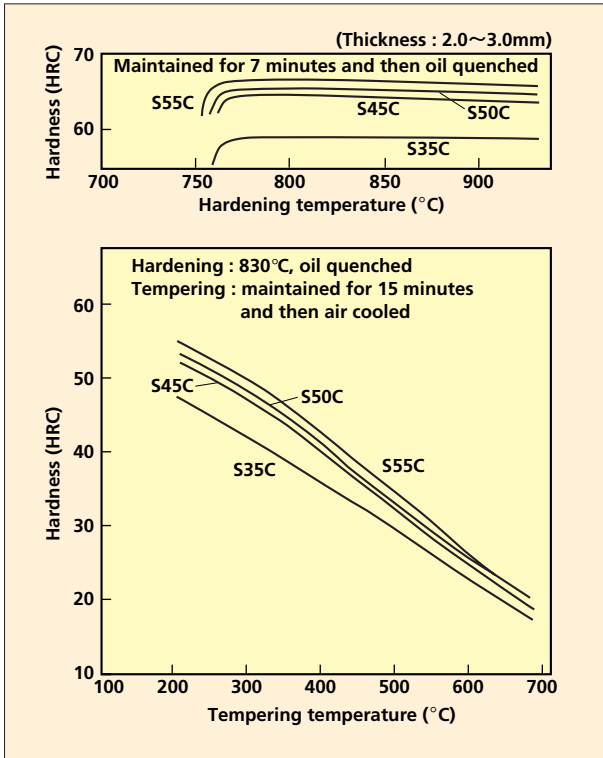


Kure Works' continuous casting facilities

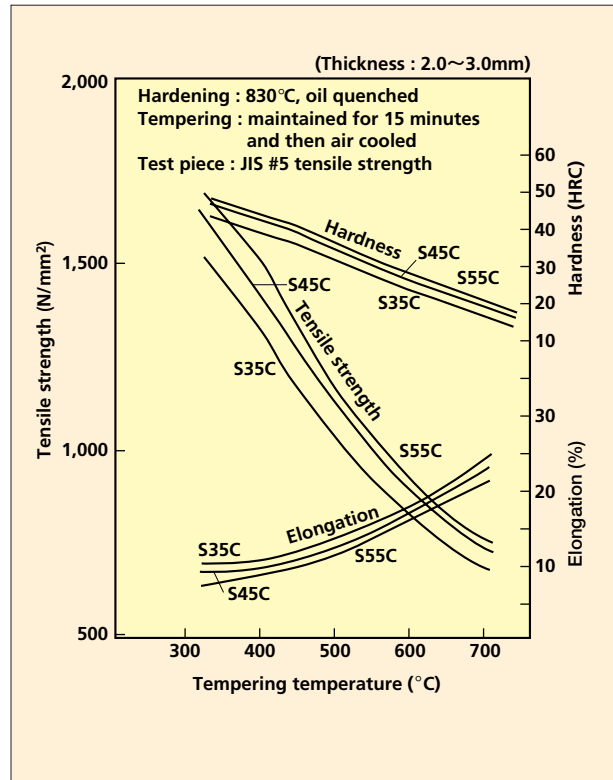


Kure Works' converter

Hardened and tempered hardnesses of S55C, S50C, S45C and S35C

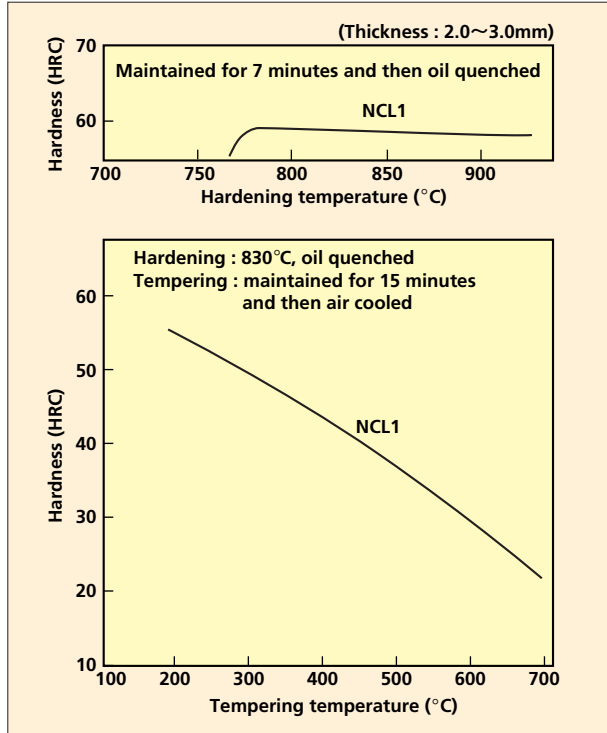


Tempering properties of S55C, S50C, S45C

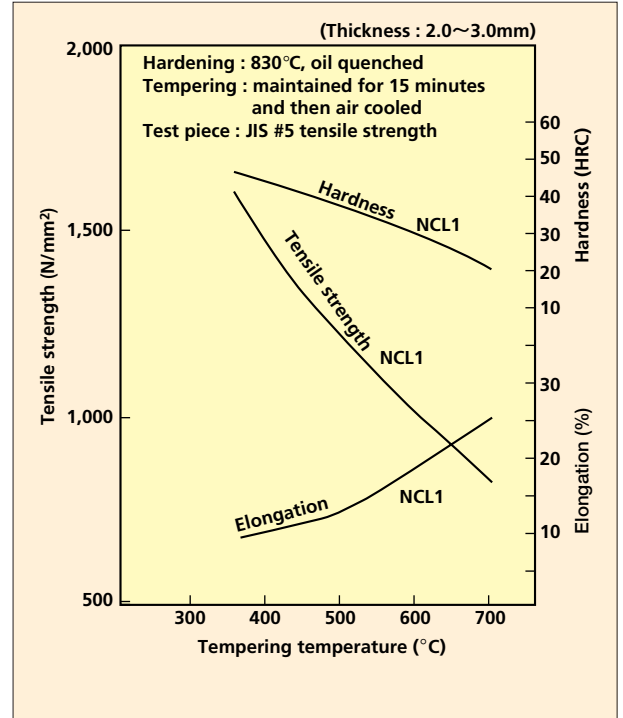


Quality Characteristics

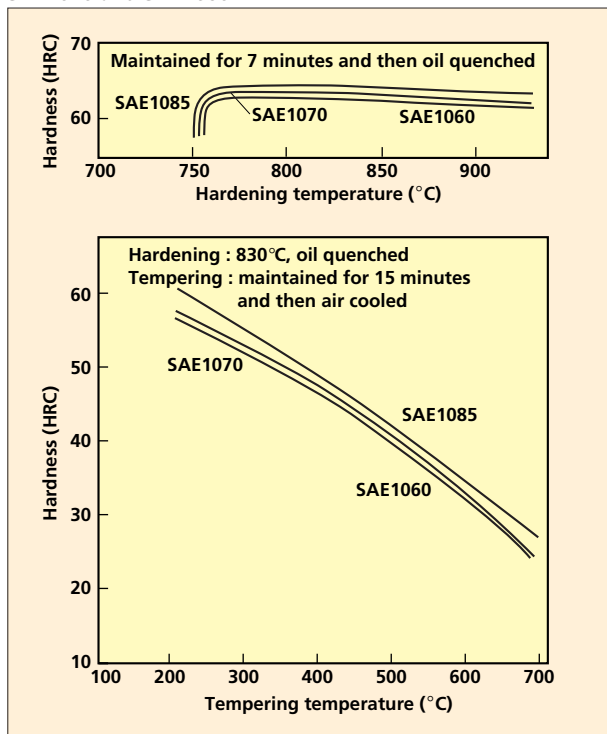
Hardened and tempered hardnesses of NCL1



Tempering properties of NCL1



Hardened and tempered hardnesses of SAE1085, SAE1070 and SAE1060

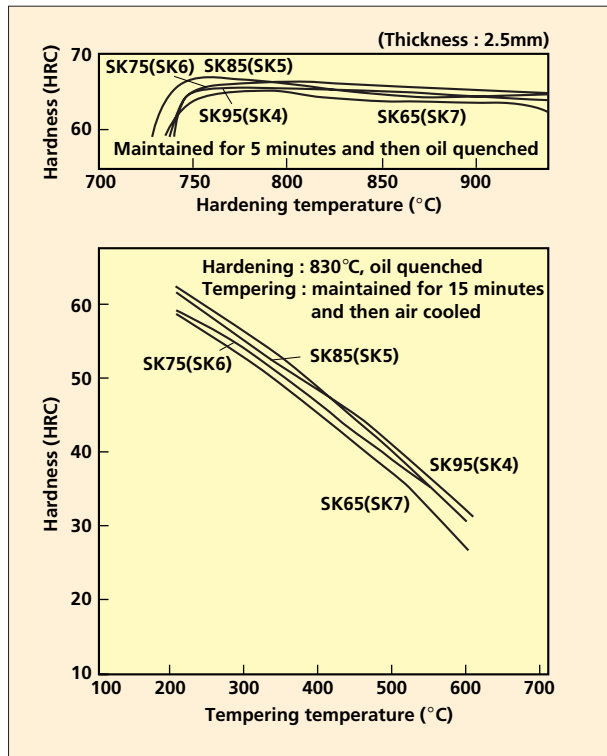


2. Carbon Tool Steel

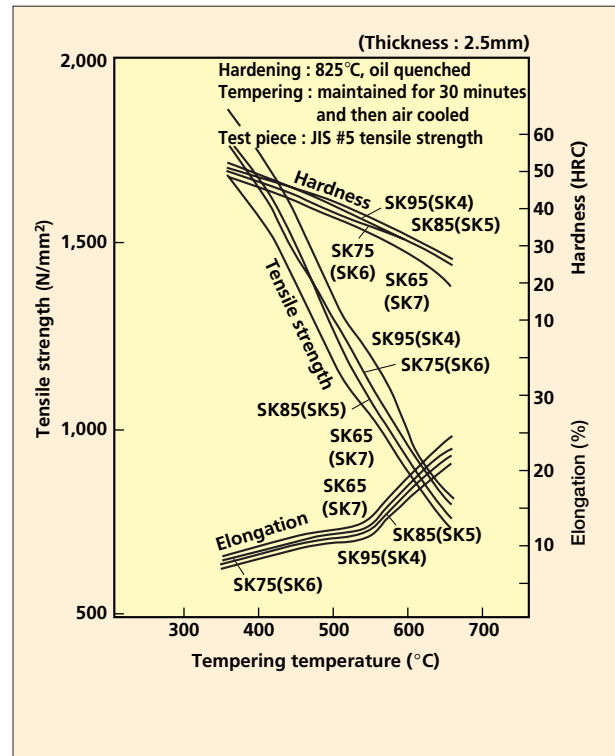
In addition to their applications for various tools, SK85(SK5) ~ SK65(SK7) are widely used for machine structural parts, which require even greater strength than S-C steel.

Strength and anti-abrasion characteristics are required of carbon tool steel, and most types are used after being subjected to hardening and tempering. Types with higher carbon content are used for application requiring anti-abrasion characteristics, and those with lower carbon content are used where toughness is required.

Hardened and tempered hardnesses of SK95(SK4)~SK65(SK7)



Tempering properties of SK95(SK4)~SK65(SK7)



Quality Characteristics

3. Alloy Tool Steel

Nickel, chromium, tungsten, vanadium, molybdenum, etc., are added to carbon tool steel to improve anti-abrasion characteristics and toughness. This alloy tool steel is almost exclusively used for cutting tools because of its excellent properties.

A number of steels with improved properties are produced by Nisshin Steel according to the company's own standards in addition to the types specified by the Japan Industrial Standards.

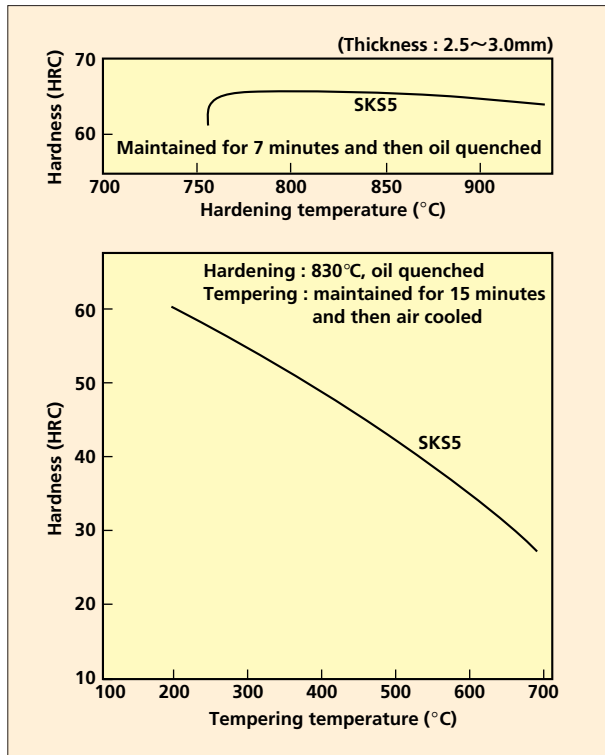
SKS5, SKS51 and NK36, which contain 0.75%~0.85% carbon with nickel and chromium added for improving the toughness and hardening properties. They are recommended for circular saws, which require greater toughness.

Band saws require even greater toughness and SKS51, with a higher nickel content, is recommended.

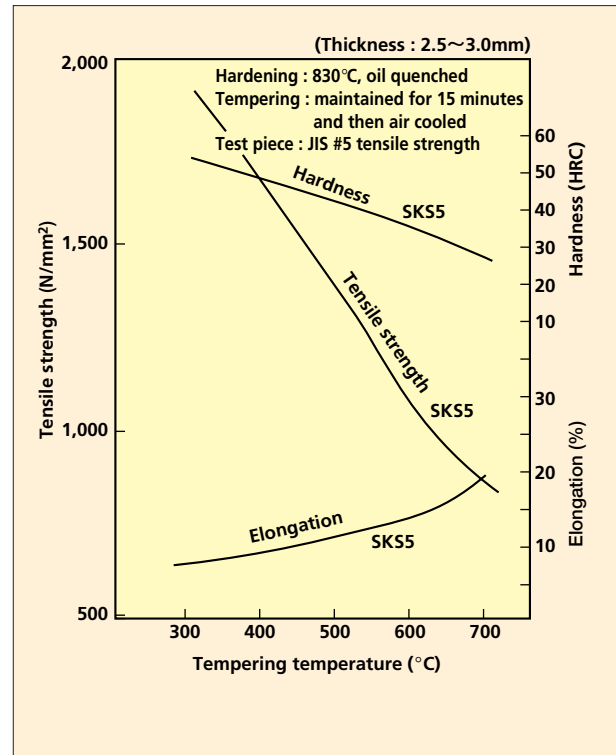
SKS7, which contains 1.00%~1.20% carbon with tungsten and chromium added, is recommended for hacksaw blades, which require greater hardness and anti-abrasion characteristics.

NKS39 and NKS56, according to Nisshin Standards, are used for high-class cutlery. Nickel is added to SK2 to produce NKS39, and chromium is added to SK2 to produce NKS56, imparting excellent toughness and hardening properties.

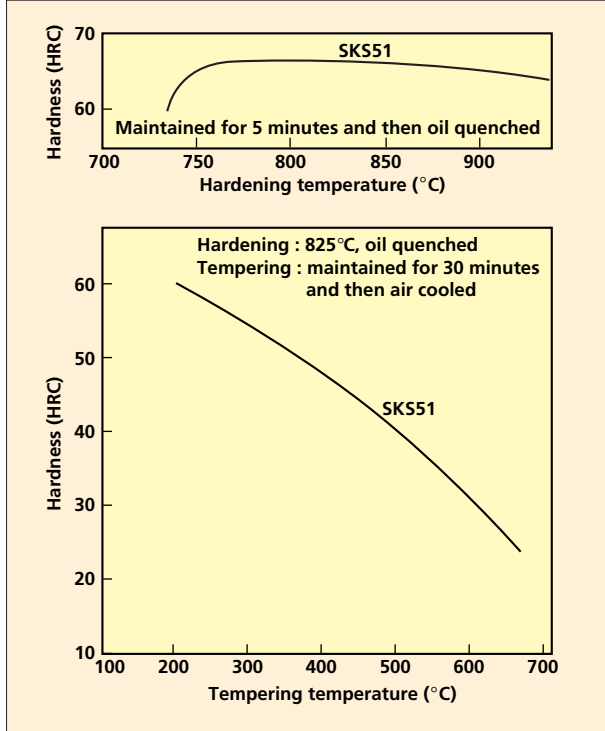
Hardened and tempered hardnesses of SKS5



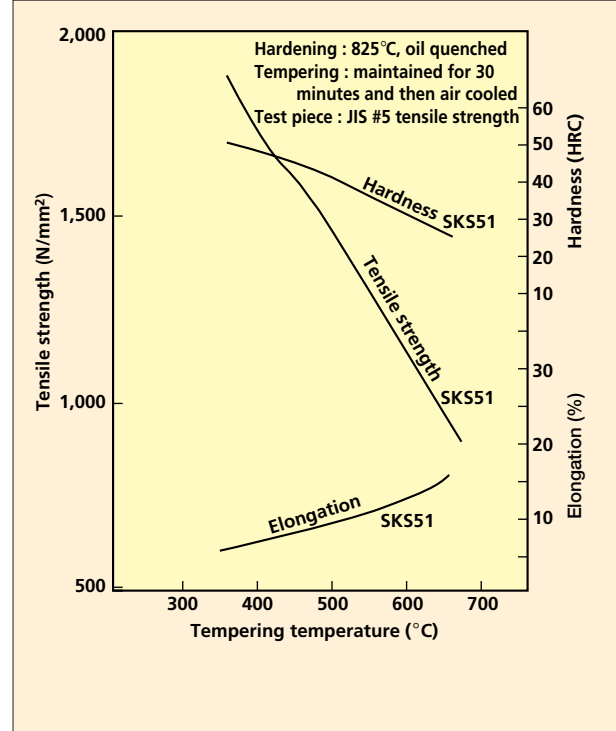
Tempering properties of SKS5



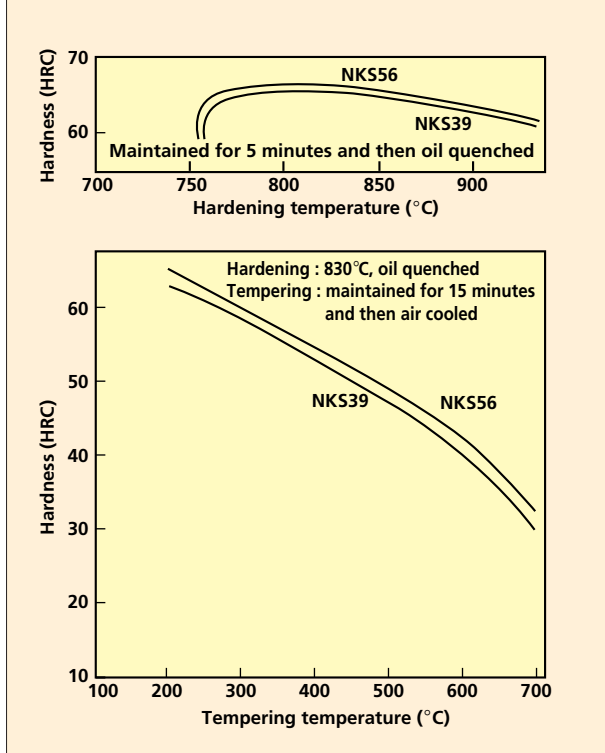
Hardened and tempered hardnesses of SKS51



Tempering properties of SKS51



Hardened and tempered hardnesses of NKS56 and NKS39



Quality Characteristics

4. Alloy Steel for Structural Use

This type of steel, mainly used in machine parts, is produced by adding nickel, chromium, molybdenum, and manganese to carbon steel with a maximum 0.50% carbon content to improve its hardenability and tempering properties. It is usually subjected to hardening and tempering before use and has excellent mechanical properties. Nisshin Steel produces this type of steel in accordance with the Japan Industrial Standards, SAE Standards, and its own Nisshin standards.

●Chromium Steel

With its 0.90%~1.20% chromium and 0.60%~0.85% manganese content, this steel gains excellent hardness and mechanical properties through hardening and tempering. Because of its tendency to tempering brittleness, rapid cooling is recommended for tempering above 550°C.

●Chromium Molybdenum Steel

This steel has 0.15%~0.30% molybdenum added to chromium steel to improve hardness, to mitigate brittleness, and to increase resistance to tempering, thereby improving toughness.

●Nickel Chromium Steel

This steel contains less than 3.5% nickel and 1.0% chromium. Nickel, which greatly improves hardness by rapid cooling, is recommended for tempering above 550°C because of greater tempering brittleness.

●Nickel Chromium Molybdenum Steel

A maximum of 0.70% molybdenum is added to nickel chromium to improve hardness and to moderate tempering brittleness.

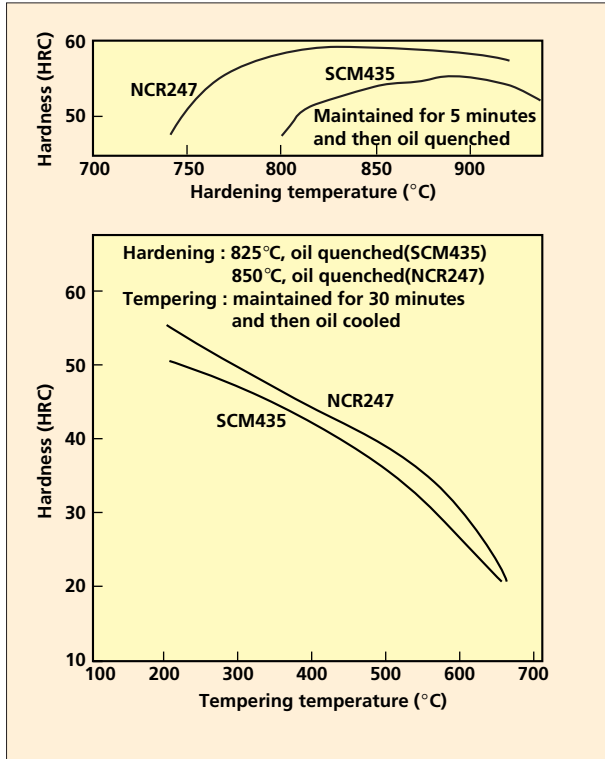
●Case Hardening Steel

All types of steel with maximum of 0.25% carbon content are called case hardening steel and are put to use after carburizing up to 1.0% of the carbon content in the surface layer. The surface layer becomes extremely hard and its abrasion resistance is increased, while the core is very tough and is highly resistant to shock because of the lower carbon content.

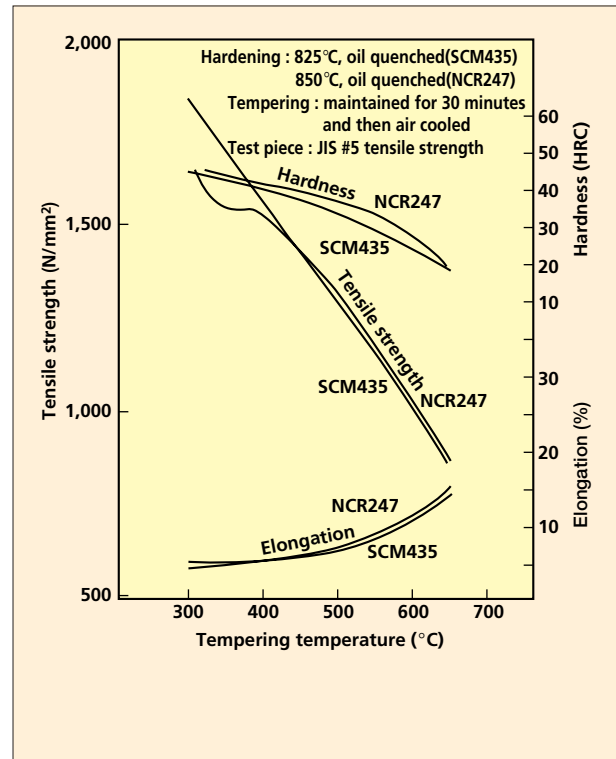
●Manganese Steel

To increase hardenability and improve anti-abrasion characteristics and toughness, 1.20%~1.65% of manganese is added to medium-carbon steel.

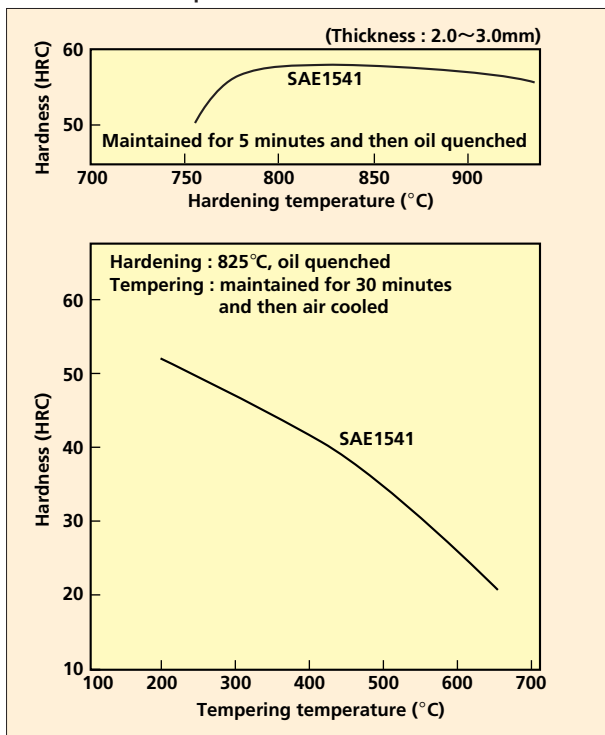
Hardened and tempered hardnesses of SCM435 and NCR247



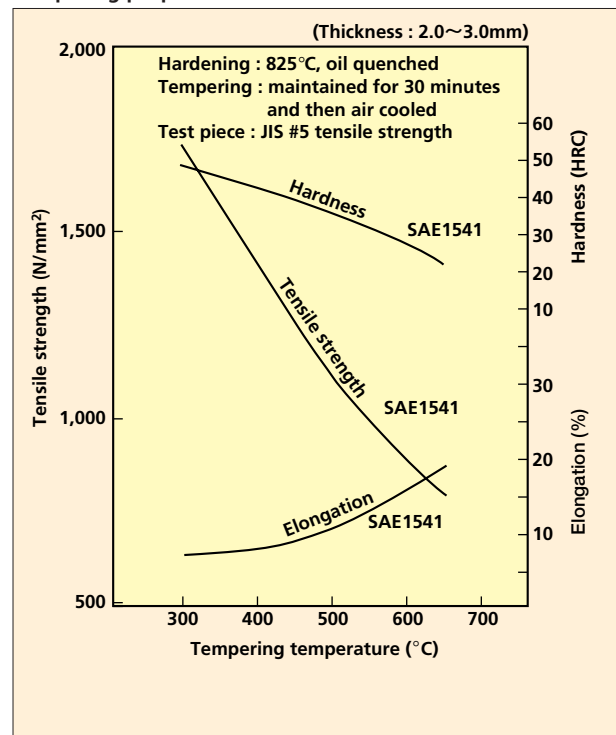
Tempering properties of SCM435 and NCR247



Hardened and tempered hardnesses of SAE1541

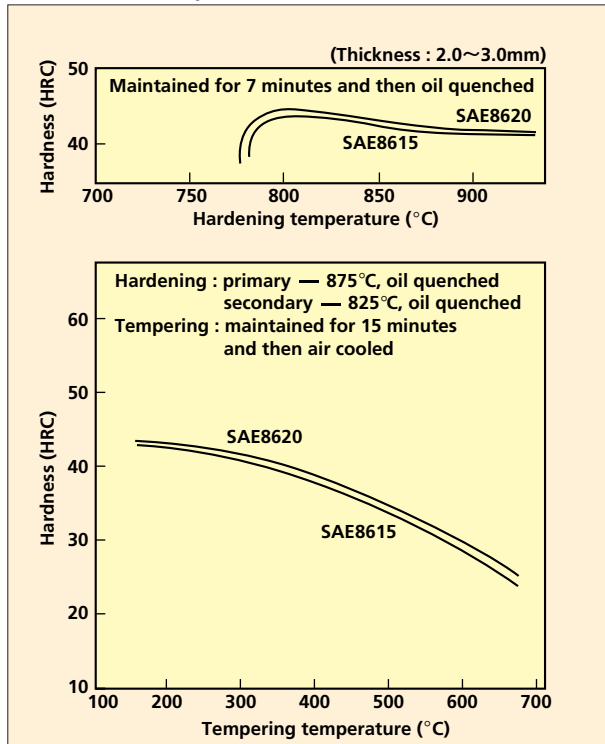


Tempering properties of SAE1541

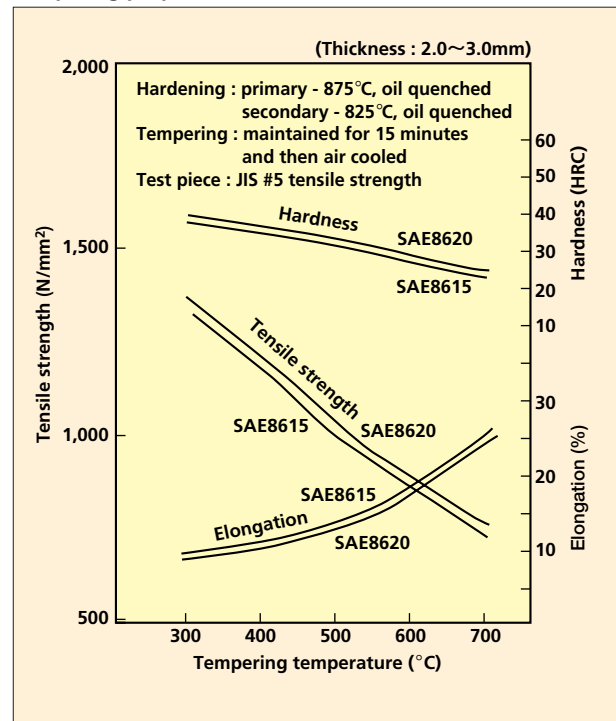


Quality Characteristics

Hardened and tempered hardnesses of SAE8615 and 8620



Tempering properties of SAE8615 and 8620



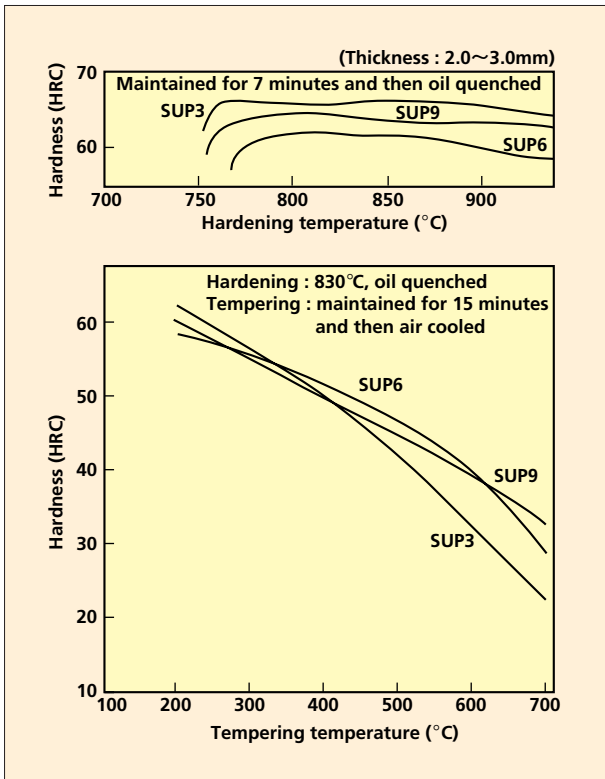
5.Spring Steel

SUP3 is a carbon steel that has a substantially similar chemical composition to SK5. This is mainly intended for rolling stock. SUP6 and SUP7 are silicon manganese steels that are especially suitable for automobile parts because of their high elasticity due to their silicon content, and their improved strength and hardness due to the presence of manganese.

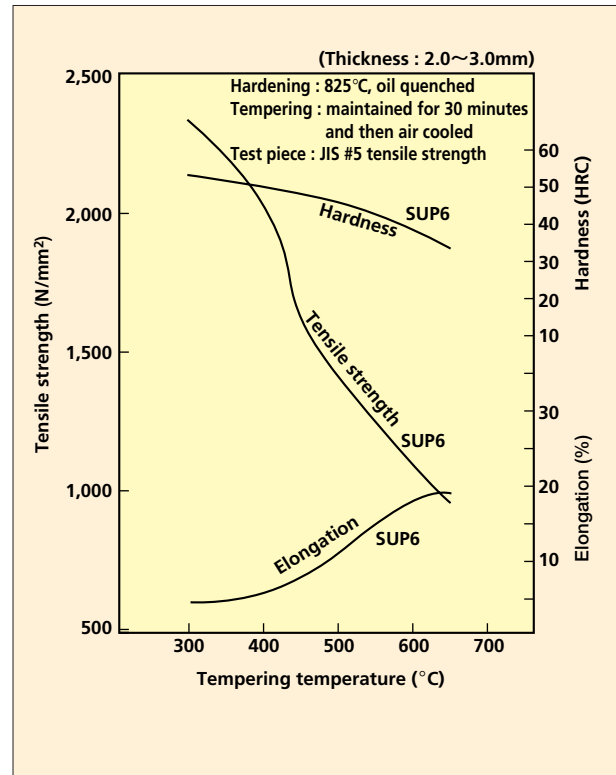
SUP9 is manganese chromium steel. The addition of about 0.8% chromium improves its yield point and tensile strength as well as its resistance to tempering. It may be used in temperature up to 300°C.

0.2% vanadium is added to SUP9 to obtain SUP10—a steel that has increased toughness and that is suitable for use in high-quality springs and diaphragms. Manganese and chromium added to SUP6 and SUP9 impart higher resistance to abrasion, and these types may be used in agricultural and construction machinery parts and in springs.

Hardened and tempered hardnesses of SUP3, SUP6, and SUP9



Tempering properties of SUP6

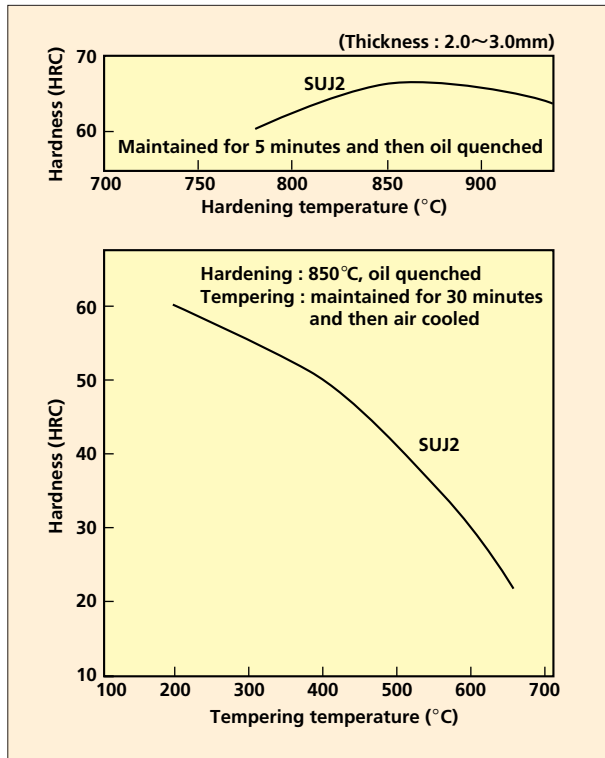


Quality Characteristics

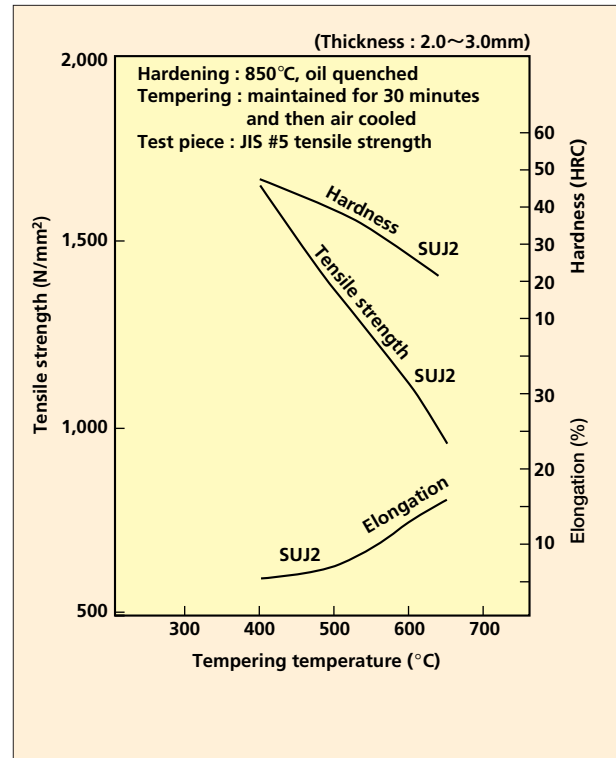
6.High-Carbon Chromium Bearing Steels

1.30%~1.60% chromium is added to high-carbon steel, an equivalent of SK3, to obtain SUJ2. This has excellent hardenability, anti-abrasion, and anti-fatigue properties and is used in bearing parts.

Hardened and tempered hardnesses of SUJ2



Tempering properties of SUJ2





Appendix

1. Hardness Conversion Numbers for steel

Rockwell C Hardness Number	Vickers Hardness Number	Brinell Hardness Number			Rockwell Hardness Number			Rockwell Superficial Hardness Number			Shore Hardness	Tensile Strength, N/mm ² Approx. Value	Rockwell C Hardness Number
		10-mm Standard Ball 3,000-kgf Load	10-mm Hultgren Ball 3,000-kgf Load	10-mm Carbide Ball 3,000-kgf Load	A Scale 60-kgf Load, Diamond Penetrator	B Scale 100-kgf Load Brale, 1/16 in Ball	D Scale 100-kgf Load, Diamond Penetrator	15 N Scale, 15-kgf Load, Superficial Diamond Penetrator	30 N Scale, 30-kgf Load, Superficial Diamond Penetrator	45 N Scale, 145-kgf Load, Superficial Diamond Penetrator			
68	940	—	—	—	85.6	—	76.9	93.2	84.4	75.4	97	—	68
67	900	—	—	—	85.0	—	76.1	92.9	83.6	74.2	95	—	67
66	865	—	—	—	84.5	—	75.4	92.5	82.8	73.3	92	—	66
65	832	—	—	739	83.9	—	74.5	92.2	81.9	72.0	91	—	65
64	800	—	—	722	83.4	—	73.8	91.8	81.1	71.0	88	—	64
63	772	—	—	705	82.8	—	73.0	91.4	80.1	69.9	87	—	63
62	746	—	—	688	82.3	—	72.2	91.1	79.3	68.8	85	—	62
61	720	—	—	670	81.8	—	71.5	90.7	78.4	67.7	83	—	61
60	697	—	613	654	81.2	—	70.7	90.2	77.5	66.6	81	—	60
59	674	—	599	634	80.7	—	69.9	89.8	76.6	65.5	80	—	59
58	653	—	587	615	80.1	—	69.2	89.3	75.7	64.3	78	—	58
57	633	—	575	595	79.6	—	68.5	88.9	74.8	63.2	76	—	57
56	613	—	561	577	79.0	—	67.7	88.3	73.9	62.0	75	—	56
55	595	—	546	560	78.5	—	66.9	87.9	73.0	60.9	74	2,079	55
54	577	—	534	543	78.0	—	66.1	87.4	72.0	59.8	72	2,010	54
53	560	—	519	525	77.4	—	65.4	86.9	71.2	58.6	71	1,952	53
52	544	500	508	512	76.8	—	64.6	86.4	70.2	57.4	69	1,883	52
51	528	487	494	496	76.3	—	63.8	85.9	69.4	56.1	68	1,824	51
50	513	475	481	481	75.9	—	63.1	85.5	68.5	55.0	67	1,755	50
49	498	464	469	469	75.2	—	62.1	85.0	67.6	53.8	66	1,687	49
48	484	451	455	455	74.7	—	61.4	84.5	66.7	52.5	64	1,638	48
47	471	442	443	443	74.1	—	60.8	83.9	65.8	51.4	63	1,579	47
46	458	432	432	432	73.6	—	60.0	83.5	64.8	50.3	62	1,530	46
45	446	421	421	421	73.1	—	59.2	83.0	64.0	49.0	60	1,481	45
44	434	409	409	409	72.5	—	58.5	82.5	63.1	47.8	58	1,432	44
43	423	400	400	400	72.0	—	57.7	82.0	62.2	46.7	57	1,383	43
42	412	390	390	390	71.5	—	56.9	81.5	61.3	45.5	56	1,334	42
41	402	381	381	381	70.9	—	56.2	80.9	60.4	44.3	55	1,294	41
40	392	371	371	371	70.4	—	55.4	80.4	59.5	43.1	54	1,245	40
39	382	362	362	362	69.9	—	54.6	79.9	58.6	41.9	52	1,216	39
38	372	353	353	353	69.4	—	53.8	79.4	57.7	40.8	51	1,177	38
37	363	344	344	344	68.9	—	53.1	78.8	56.8	39.6	50	1,157	37
36	354	336	336	336	68.4	(109.0)	52.3	78.3	55.9	38.4	49	1,118	36
35	345	327	327	327	67.9	(108.5)	51.5	77.7	55.0	37.2	48	1,079	35
34	336	319	319	319	67.4	(108.0)	50.8	77.2	54.2	36.1	47	1,059	34
33	327	311	311	311	66.8	(107.5)	50.0	76.6	53.3	34.9	46	1,030	33
32	318	301	301	301	66.3	(107.0)	49.2	76.1	52.1	33.7	44	1,000	32
31	310	294	294	294	65.8	(106.0)	48.4	75.6	51.3	32.5	43	981	31
30	302	286	286	286	65.3	(105.5)	47.7	75.0	50.4	31.3	42	951	30
29	294	279	279	279	64.7	(104.5)	47.0	74.5	49.5	30.1	41	932	29
28	286	271	271	271	64.3	(104.0)	46.1	73.9	48.6	28.9	41	912	28
27	279	264	264	264	63.8	(103.0)	45.2	73.3	47.7	27.8	40	883	27
26	272	258	258	258	63.3	(102.5)	44.6	72.8	46.8	26.7	38	863	26
25	266	253	253	253	62.8	(101.5)	43.8	72.2	45.9	25.5	38	843	25
24	260	247	247	247	62.4	(101.0)	43.1	71.6	45.0	24.3	37	824	24
23	254	243	243	243	62.0	100.0	42.1	71.0	44.0	23.1	36	804	23
22	248	237	237	237	61.5	99.0	41.6	70.5	43.2	22.0	35	785	22
21	243	231	231	231	61.0	98.5	40.9	69.9	42.3	20.7	35	775	21
20	238	226	226	226	60.5	97.8	40.1	69.4	41.5	19.6	34	755	20
(18)	230	219	219	219	—	96.7	—	—	—	—	33	735	(18)
(16)	222	212	212	212	—	95.5	—	—	—	—	32	706	(16)
(14)	213	203	203	203	—	93.9	—	—	—	—	31	677	(14)
(12)	204	194	194	194	—	92.3	—	—	—	—	29	647	(12)
(10)	196	187	187	187	—	90.7	—	—	—	—	28	618	(10)
(8)	188	179	179	179	—	89.5	—	—	—	—	27	598	(8)
(6)	180	171	171	171	—	87.1	—	—	—	—	26	579	(6)
(4)	173	165	165	165	—	85.5	—	—	—	—	25	549	(4)
(2)	166	158	158	158	—	83.5	—	—	—	—	24	530	(2)
(0)	160	152	152	152	—	81.7	—	—	—	—	24	520	(0)

- Notes : 1. Bold figures are based on Table 2, ASTEM, E140 (ASM-ASTM).
 2. Approximate values are based on revised conversion table JIS Z 8413.
 3. Figures in parentheses are rarely used.

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