HTS

# STAINLESS STEELS FOR DEMANDING APPLICATIONS AVAILABLE FROM STOCK

SINOXX

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# About SINOXX Steels

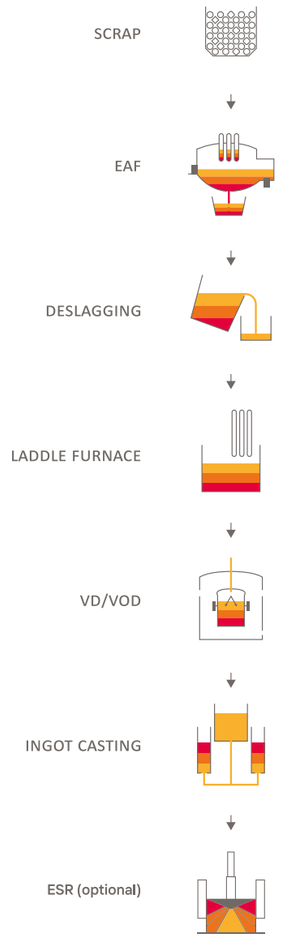
## SINOXX steels

SINOXX is a product group designed for excellent corrosion resistance. The brand comprises steels which contain more than 10.5 % chromium in solid solution, and nickel, molybdenum, titanium or niobium can be added to increase corrosion resistance.

Some SINOXX steels are very stable in humid atmospheres and at the same time resistant to acidic and alkaline environments. Others maintain excellent corrosion resistance even at temperatures above 550 °C.

## Available formats

## Production method






## About the steel mill

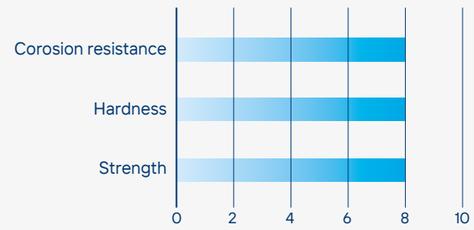
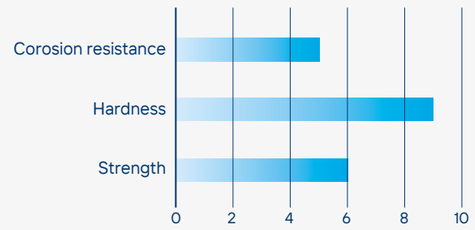
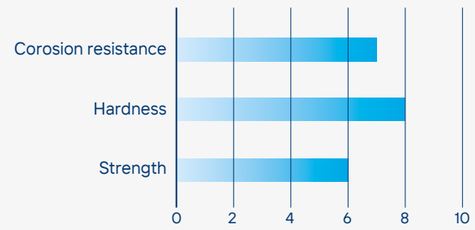
SINOXX steels are produced by SIJ Metal Ravne, the second largest Slovenian steel manufacturer, that produces steel in an electric arc furnace, casting it into ingots and rolling or forging it into quality long steel products. The steel mill produces martensitic, ferritic, austenitic and precipitation hardening steels. Besides stainless, SIJ Metal Ravne is also a widely recognized producer of tool, high speed and special structural steels. For the most challenging conditions, remelted steels are also available.

sij | metal ravne

### Quality System Management

- EN/AS 9100
- ISO 9001
- ISO 14001
- OHSAS 18001
- ISO/IEC 17025

# Grades overview

| | SINOXX 4542 | SINOXX 4125 | SINOXX 4112 |
|---|---|---|---|
| **Designation by standards** | AISI: 17-4PH, EN: 1.4542 | AISI: 440C, EN: 1.4125 | EN: 1.4112, UNS: S44003 |
| **Description** | • Martensitic precipitation/age-hardening stainless steel.<br>• Excellent corrosion resistance.<br>• High strength and hardness. | • High carbon martensitic stainless steel.<br>• Moderate corrosion resistance.<br>• Obtains and keeps excellent hardness (HRC 60), and wear resistance. | • Martensitic chromium steel with molybdenum and vanadium.<br>• High corrosion resistance.<br>• Obtains and keeps excellent hardness (HRC 58), and wear resistance. |
| **Corrosion resistance** | • Fresh and salty water<br>• Industrial & marine atmosphere<br>• Oxidizing chemicals | • Fresh water<br>• Steam<br>• Petroleum products<br>• Alcohol<br>*not recommended for temperatures above 400 °C* | • Fresh water<br>• Steam<br>• Petroleum products<br>• Alcohol |
| **Applications** | Oil field valve parts, chemical process equipment, aircraft fittings, fasteners, pump shafts, nuclear reactor components, gears, paper mill equipment, missile fittings and jet engine parts. | Ball bearings and races, gage blocks, molds and dies, cutlery, valve components, knives, measuring instruments. | Ball bearings and races, gage blocks, molds and dies, cutlery, valve components, knives and measuring instruments. |
| **Machinability** | • Can be machined in the annealed condition; H1150M yields best results.<br>• Post machining solution treatment of parts is required prior to final hardening. | • Best machined in the annealed condition.<br>• Carbide or ceramic tooling is recommended. | • Best machined in the annealed condition.<br>• Carbide or ceramic tooling is recommended. |
| **Weldability** | • Can be satisfactorily welded by the shielded fusion and resistance welding processes.<br>• Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. | • Not commonly welded due to its tendency to air harden.<br>• If welding is required, preheat and post weld treatment is required. | • Not commonly welded due to its tendency to air harden.<br>• If welding is required, preheat and post weld treatment is required. |
| |  |  |  |

SINOXX

# Available dimensions from stock

## Peeled Rounds

| Diameter (mm) | SINOXX 4542 | SINOXX 4125 | SINOXX 4112 |
|---|---|---|---|
| 16 | ● | ● | ● |
| 17 | ● | | |
| 18 | ● | | ● |
| 20 | ● | ● | ● |
| 21 | | ● | |
| 22 | ● | | ● |
| 23 | | ● | |
| 24 | | | ● |
| 25 | | ● | ● |
| 25,4 | ● | | |
| 26 | | | ● |
| 28 | | | ● |
| 30 | ● | ● | ● |
| 32 | | ● | ● |
| 35 | ● | ● | ● |
| 36 | ● | ● | |
| 37 | | | ● |
| 38 | | | ● |
| 40 | ● | ● | ● |
| 42 | | | ● |
| 45 | ● | | ● |
| 46 | | ● | |
| 50 | | | ● |
| 50,8 | ● | | |
| 51 | | ● | |
| 54 | | ● | |
| 55 | | ● | ● |
| 60 | ● | ● | ● |
| 63,5 | ● | | |
| 65 | ● | ● | ● |
| 70 | ● | ● | ● |
| 75 | | ● | ● |
| 80 | ● | ● | ● |
| 85 | ● | | ● |
| 90 | ● | ● | ● |
| 95 | | | ● |
| 100 | | ● | ● |
| 101,6 | ● | | |

| Diameter (mm) | SINOXX 4542 | SINOXX 4125 | SINOXX 4112 |
|---|---|---|---|
| 105 | | | ● |
| 106 | | ● | |
| 110 | | ● | |
| 114,3 | ● | | |
| 120 | | ● | ● |
| 125 | | | ● |
| 127 | ● | | |
| 130 | | ● | ● |
| 140 | | ● | ● |
| 150 | ● | | ● |
| 160 | | ● | ● |
| 165 | ● | | |
| 170 | | | ● |
| 180 | ● | ● | |
| 190 | ● | | ● |
| 200 | | ● | ● |
| 210 | | | ● |
| 220 | ● | | ● |
| 225 | | ● | |
| 230 | | | ● |
| 232 | ● | | |
| 240 | | | ● |
| 245 | | | ● |
| 250 | ● | | ● |
| 252 | | ● | |
| 255 | | | ● |
| 260 | | | ● |
| 280 | ● | | ● |
| 290 | | | ● |
| 300 | | | ● |
| 302 | | ● | |
| 310 | | | ● |
| 325 | | | ● |
| 350 | ● | | ● |
| 352 | | ● | |
| 375 | | | ● |
| 380 | ● | | |



## Rolled flats (width 505 mm)

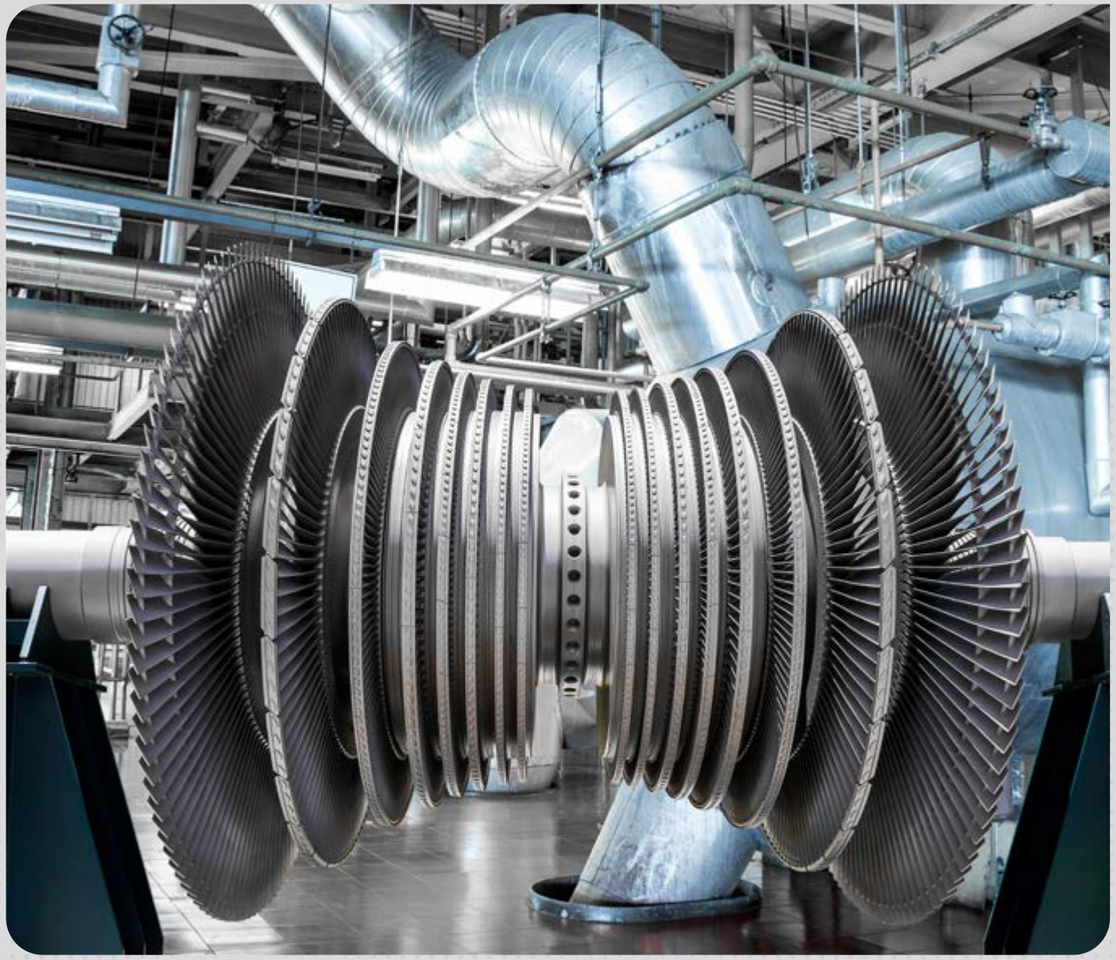
| Thickness (mm) | SINOXX 4542 | SINOXX 4125 | SINOXX 4112 |
|---|---|---|---|
| 25 | ● | | ● |
| 30 | ● | | ● |
| 40 | ● | | ● |
| 50 | ● | | ● |
| 60 | ● | | ● |
| 70 | ● | | ● |
| 80 | ● | | ● |
| 90 | ● | | ● |

## Forged blocks (width 560 mm)

| Thickness (mm) | SINOXX 4542 | SINOXX 4125 | SINOXX 4112 |
|---|---|---|---|
| 100 | ● | | ● |
| 150 | ● | | ● |
| 200 | ● | | ● |

# SINOXX 4542

SINOXX 4542 is a martensitic precipitation/age-hardening stainless steel known for its high strength and hardness, coupled with excellent corrosion resistance. It exhibits favorable fabricability and can undergo age hardening through either single or double-step processes. It demonstrates a robust combination of strength and corrosion resistance in environments including fresh and salt water, industrial and marine atmospheres, and exposure to oxidizing chemicals.







## 01

## Designations by standards

| Brand Name | Ravne | Mat. No. | DIN | EN | AISI/SAE |
|---|---|---|---|---|---|
| SINOXX 4542 | PK346 | 1.4542 | - | X5CrNiCuNb17-4-4 | 17-4PH |

## Chemical composition (in weight %)

| Element | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | Nb |
|---|---|---|---|---|---|---|---|---|---|---|
| min | - | - | - | - | - | 15.00 | - | 3.00 | 3.00 | 5xC |
| max | 0.07 | 1.0 | 1.0 | 0.040 | 0.030 | 17.50 | 0.50 | 5.00 | 5.00 | 0.4500 |

## Applications

It can be used for a variety of applications including oil field valve parts, chemical process equipment, aircraft fittings, fasteners, pump shafts, nuclear reactor components, gears, paper mill equipment, missile fittings and jet engine parts.

- **High temperature applications** – it is suited up to 350 °C, just for short time it can be used maximum 50 °C bellow the precipitation hardening temperature
- **Applications with condition H900 (PH at 482 °C)** – this heat treatment provides high tensile strength and high hardness for applications where wear resistance is needed with good corrosion properties. It is not suited for subzero applications.
- **Applications with condition H1150 (PH at 621 °C)** – this heat treatment provides very high impact strength so the steel can be used in up to -80 °C environments.
- **Applications with condition H1150D (double PH at 621 °C)** – can be used up to -196 °C, with good corrosion resistance.

## 02

## Physical properties (average values) at ambient temperature

### Modulus of elasticity

| Modulus of elasticity [$10^3$ x N/mm$^2$]: |
|---|
| 196V |

### Electric resistivity

| ELECTRIC RESISTIVITY (Ohm.mm$^2$/m) |
|---|
| 0.80 |

### Thermal conductivity

| THERMAL CONDUCTIVITY (W/(m.K)) |
|---|
| 20 °C |
| 15.3, 23.0 at 500 °C |

### Specific heat capacity

| SPECIFIC HEAT CAPACITY (J/(g. K)) |
|---|
| 20 °C |
| 0.46, 0.65 at 500 °C |

### Density

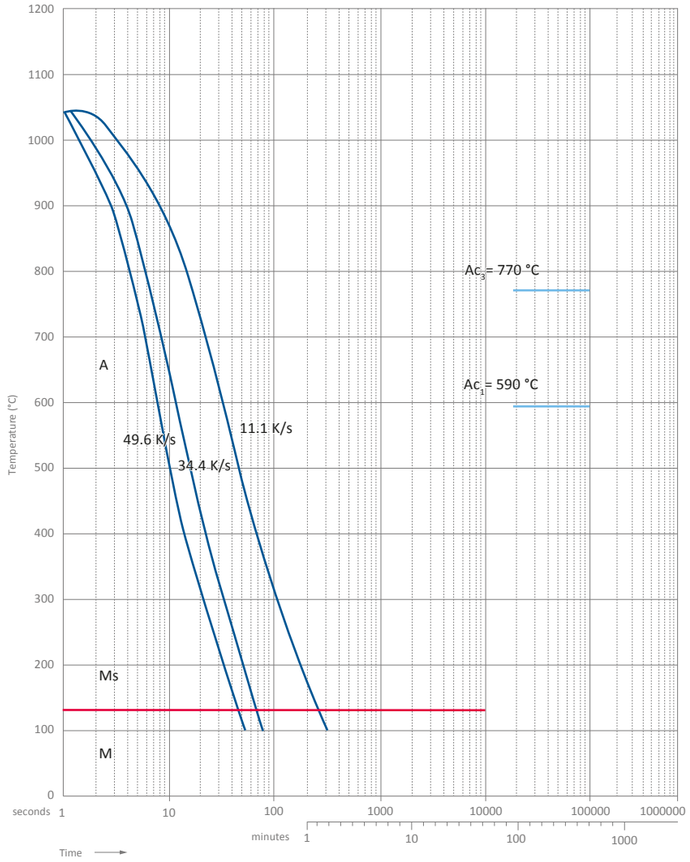
| DENSITY [g/cm$^3$] T: 20 °C |
|---|
| 7.79 |

### Transformation points

| Ac (begin): 590 °C, Ac (finish): 770 °C, Ms: 130 °C, Mf: 30 °C |
|---|

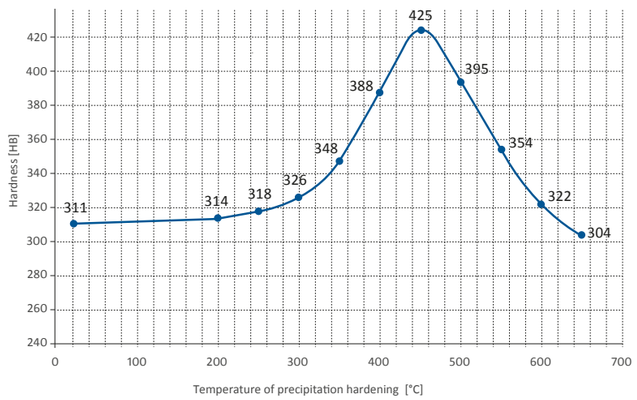
# 03

## Continuous cooling curves - CCT diagram




# 04

## Precipitation hardening diagram






# 05

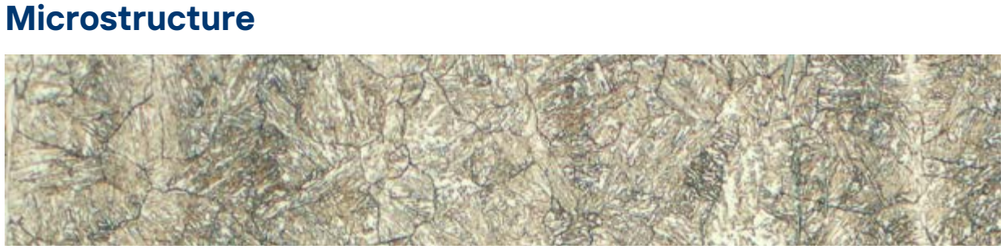
## Temperature range (°C)

| | |
|---|---|
| • **Hot forming** | 1150 °C to 900 °C, than air cooling |
| • **Solution annealing** | 1030 °C to 1050 °C, than cooling in oil or air |
| • **Precipitation hardening** | H900 (482 °C) – 482 °C / 1h / air<br>H925 (496 °C) – 496 °C / 4h / air<br>H1025 (552 °C) – 552 °C / 4h / air<br>H1075 (579 °C) – 579 °C / 4h / air<br>H1100 (593 °C) – 593 °C / 4h / air<br>H1150 (621 °C) – 621 °C / 4h / air<br>H1150D (2 × 621 °C) – 621 °C / 4h / air<br>H1150M (760 °C/2h + 620 °C/4h) |

Microstructure after solution annealing: Martensite + ferrite + austenite

Microstructure after precipitation hardening: Martensite + ferrite + austenite + intermetallic phases

## Microstructure



# 06

## Machinability

Long, gummy chips characterize this steel's machinability. It can be machined in the annealed condition, however condition H1150M will yield best results. Post machining solution treatment of parts will be required prior to final hardening.

## Weldability

SINOXX 4542 can be satisfactorily welded by the shielded fusion and resistance welding processes. Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. When a filler metal is required, AWS E/ER630 welding consumables should be considered to provide welds with properties matching those of the base metal.

When designing the weld joint, care should be exercised to avoid stress concentrators, such as sharp corners, threads, and partial-penetration welds. When high weld strength is not needed, a standard austenitic stainless filler, such as E/ER308L, should be considered.

# SINOXX 4125

This is a high carbon martensitic stainless with moderate corrosion resistance, good strength and the ability to obtain and keep excellent hardness (HRC 60), and wear resistance.

## 01

### Designations by standards

| Brand Name | Ravne | Mat. No. | DIN | EN | AISI/SAE |
|---|---|---|---|---|---|
| SINOXX 4125 | PK348 | 1.4125 | - | X105CrMo17 | 440C |

### Chemical composition (in weight %)

| C | Si | Mn | Cr | Mo | Ni | V | W | Others |
|---|---|---|---|---|---|---|---|---|
| 1.08 | max 1.0 | max 1.0 | 17.0 | 0.60 | - | - | - | - |

### Applications

Ball bearings and races, gage blocks, molds and dies, cutlery, valve components, knives and measuring instruments and other products with highest hardness and wear resistance.



## 02

### Physical properties (average values) at ambient temperature

#### Modulus of Elasticity

| Modulus of elasticity [$10^3$ x N/mm$^2$]: |
|---|
| 200 |

#### Density

| Density [g/cm$^3$]: |
|---|
| 7.67 |

#### Thermal conductivity

| Thermal conductivity [W/m.K]: |
|---|
| 24.2 |

#### Electric resistivity

| Electric resistivity [Ohm mm$^2$/m]: |
|---|
| 0.60 |

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

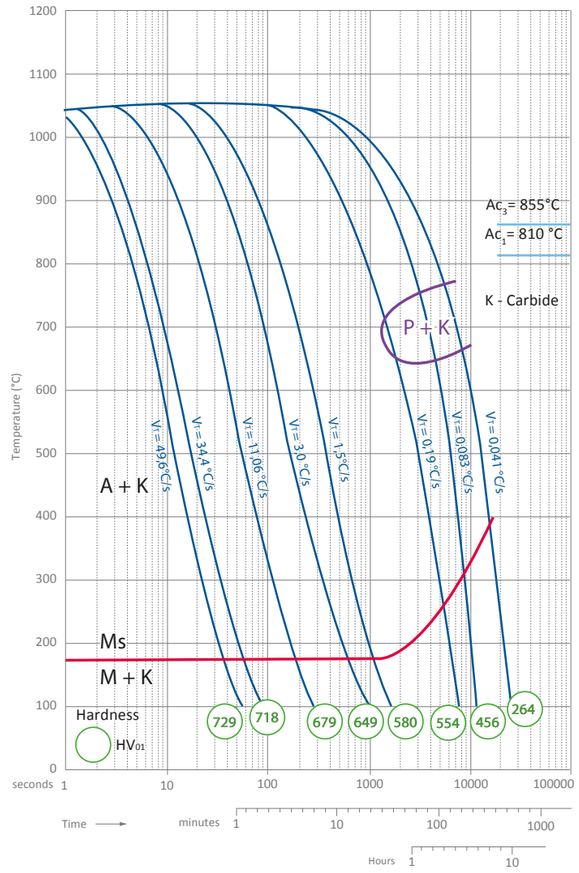
| 20-100 °C | 20-200 °C | 20-300 °C | 20-400 °C | 20-500 °C | 20-600 °C | 20-700 °C |
|---|---|---|---|---|---|---|
| 9.8 | 10.8 | 11.4 | 11.7 | 12.0 | 12.2 | 12.4 |

#### Specific heat capacity

| Specific heat capacity[J/g.K]: |
|---|
| 0.46 |

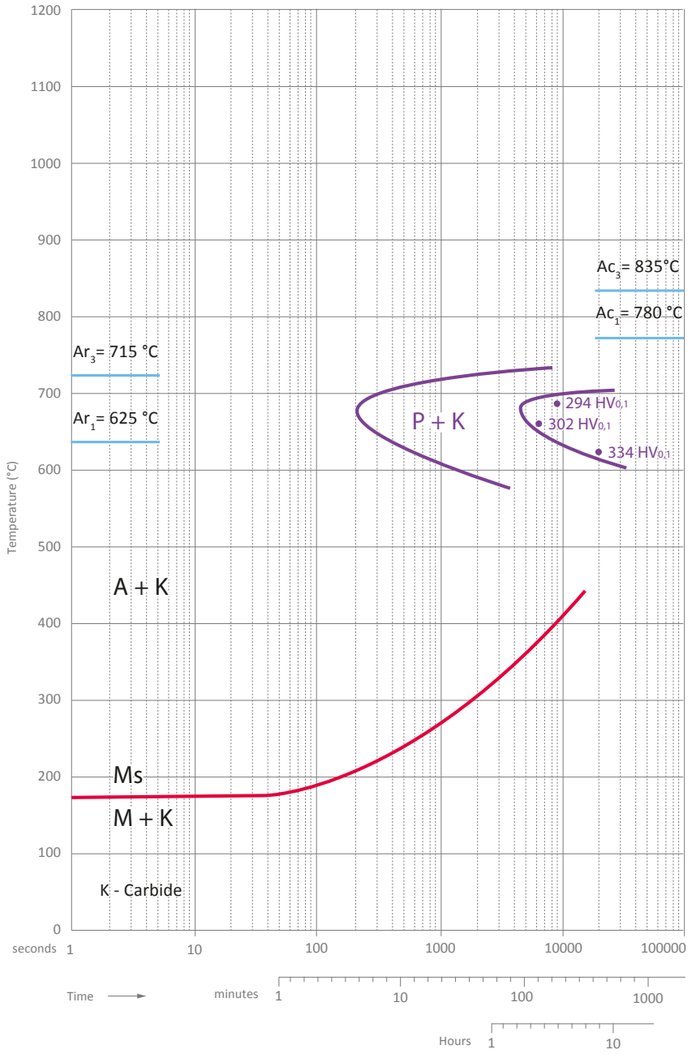
## 03

### Continuous cooling transformation (CCT) diagram



# 04

## Time-temperature transformation (TTT) diagram




## Soft annealing

Heat to 820-860 °C, cool slowly in furnace. This will produce a maximum Brinell hardness of 269.

## Hardening

Harden from a temperature of 1000-1050 °C followed by oil or quenching. Hardness after quenching is min. 58 HRC.

## Tempering

Tempering temperature: See point 05.

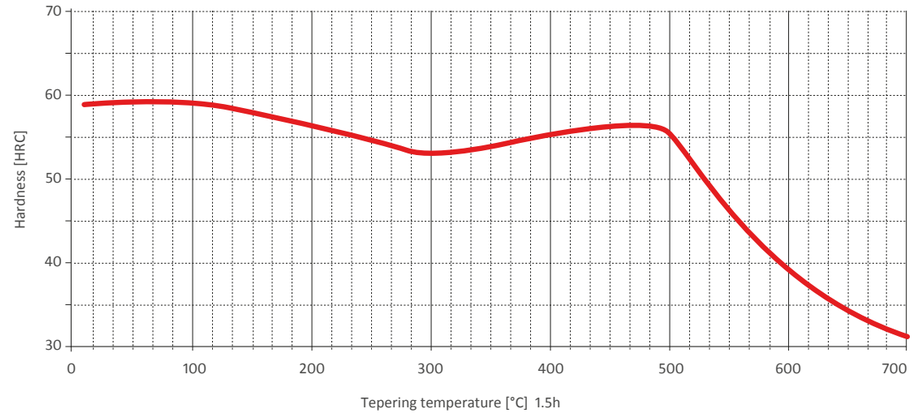


# 05

## Tempering temperature (°C) vs. hardness (HRC)

| 100 °C | 200 °C | 300 °C | 400 °C | 500 °C | 600 °C | 700 °C |
|---|---|---|---|---|---|---|
| 59 | 57 | 54 | 55 | 55 | 39 | 31 |

## Tempering diagram




# 06

## Forging

Pre-heat to 760 °C, then bring slowly up to 1038-1204 °C before proceeding. Do not work this material below 927 °C. Cool material slowly after working and once at room temperature, anneal fully.

## Machinability

Best machined in the annealed condition. Tough, stringy chips can be best handled by the use of chip breakers. Carbide or ceramic tooling is recommended.

## Corrosion resistance

Resistant to a wide variety of media including fresh water, steam, petroleum products and alcohol. Not recommended to be used in annealed condition as it may get rusty. Correct passivation process is recommended to improve the corrosion resistance in quenched and tempered form. HT recommendation to obtain best corrosion resistance. In this case as per the recommendation that is obtained thru low temperature tempering with mirror finished surface. Not recommended to be used in elevated temperature application i.e above 400 °C. Corrosion resistance is reduced when used in elevated temperature condition.

## Welding

Not commonly welded due to its tendency to air harden. If it must be welded, preheat to 260 °C and post weld treat at 732- 760 °C for 6 hours followed by a slow furnace cooling to avoid cracking. Use similar filler metal.

## Cold working

Only slightly cold workable by common procedures.

# SINOXX 4112

This is a highly corrosion-resistant stainless steel, classified as martensitic chromium steel, with the addition of molybdenum and vanadium. It offers a combination of high hardness, wear resistance, and excellent corrosion resistance. The material also exhibits good strength and the capability to achieve and maintain exceptional hardness (up to HRC 58) along with superior wear resistance.





## 01

## Designations by standards

| Brand Name | Ravne | Mat. No. | DIN | EN | UNS |
|---|---|---|---|---|---|
| SINOXX 4112 | OCR6 | 1.41 | X90CrMoV18 | - | S44003 |

## Chemical composition (in weight %)

| C | Si | Mn | Cr | Mo | Ni | V | W | Others |
|---|---|---|---|---|---|---|---|---|
| 0.90 | max 1.0 | max 1.0 | 18.0 | 1.10 | - | 0.10 | - | - |

## Applications

Ball bearings and races, gage blocks, moulds and dies, cutlery, valve components, knives and measuring instruments.

## 02

## Physical properties (average values) at ambient temperature

### Modulus of Elasticity

| Modulus of elasticity [$10^3$ x N/mm$^2$]: |
|---|
| 190-210 |

### Density

| Density [g/cm$^3$]: |
|---|
| 7.68 |

### Thermal conductivity [W/m.K]

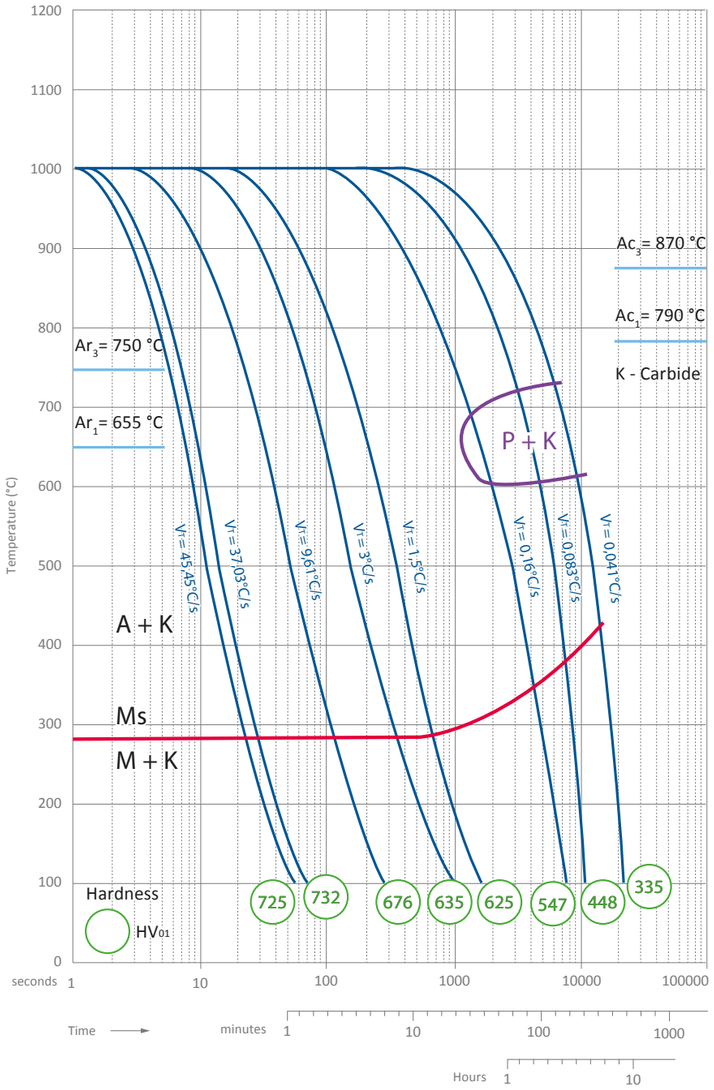
| 200 °C | 400 °C | 500 °C | 600 °C | 700 °C |
|---|---|---|---|---|
| 24.8 | 31.5 | 26.8 | 24.1 | 22.5 |

### Coefficient of linear thermal expansion $10^{-6}$ °C$^{-1}$

| 20-100 °C | 20-200 °C | 20-300 °C | 20-400 °C | 20-500 °C | 20-600 °C | 20-700 °C | 20-800 °C |
|---|---|---|---|---|---|---|---|
| 9.8 | 10.5 | 10.9 | 11.2 | 11.3 | 11.3 | 11.5 | 11.8 |

# 03

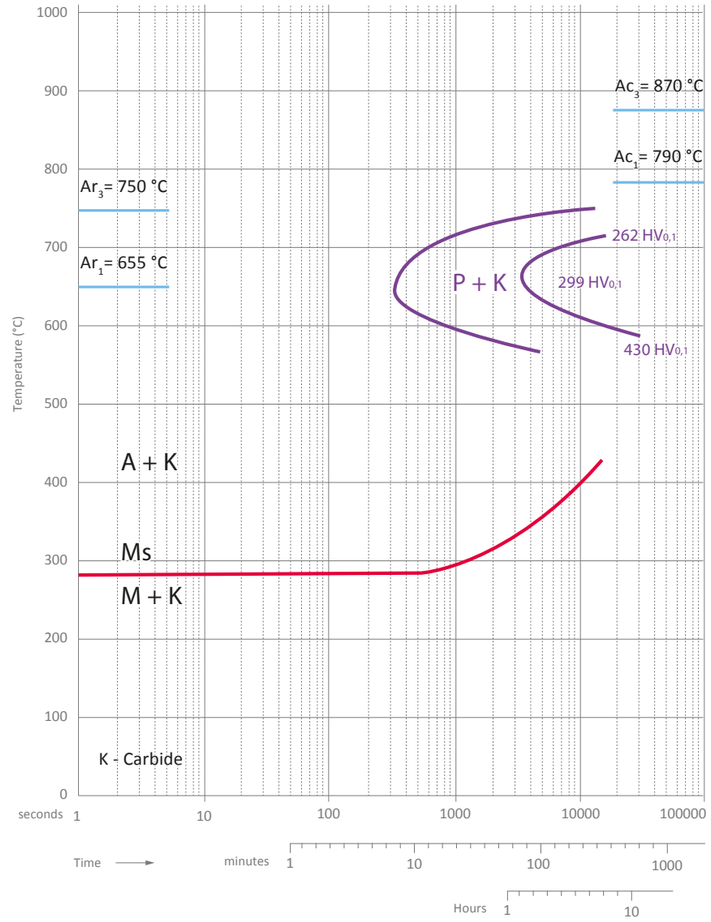
## Continuous cooling transformation (CCT) diagram






# 04

## Time-temperature transformation (TTT) diagram




## Soft annealing

Heat to 810-860 °C, cool slowly in furnace. This will produce a maximum Brinell hardness of 265.

## Stress relieving

Stress relieving to remove machining stresses should be carried out by heating to 650 °C, holding for one hour at heat, followed by air cooling. This operation is performed to reduce distortion during heat treatment.

## Hardening

Harden from a temperature of 1000-1050 °C followed by oil quenching. Hardness after quenching is 56 HRC.

## Tempering

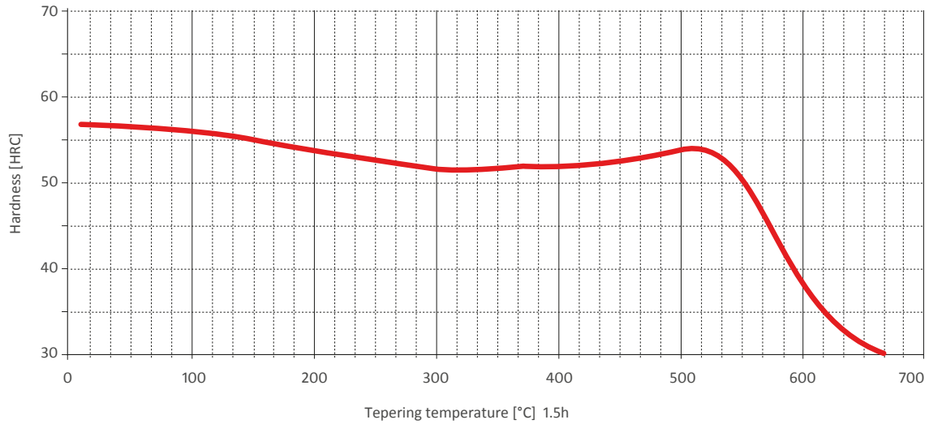
Tempering temperature: up to 150 °C.

# 05

## Tempering temperature (°C) vs. hardness (HRC) diagram

| 100 °C | 200 °C | 300 °C | 400 °C | 500 °C | 550 °C | 600 °C | 650 °C | 700 °C |
|---|---|---|---|---|---|---|---|---|
| 56 | 54 | 52 | 53 | 54 | 51 | 40 | 33 | 29 |

## Tempering Diagram




# 06

## Forging

Pre-heat to 760 °C, then bring slowly up to 1038-1204 °C before proceeding. Do not work this material below 927 °C. Cool material slowly after working and once at room temperature, anneal fully.

## Machinability

Best machined in the annealed condition. Tough, stringy chips can be best handled by the use of chip breakers. Carbide or ceramic tooling is recommended.

## Corrosion resistance

Resistant to a wide variety of media including fresh water, steam, petroleum products and alcohol.

## Welding

Not commonly welded due to its tendency to air harden. If it must be welded, preheat to 260 °C and post weld treat at 732- 760o °C for 6 hours followed by a slow furnace cooling to avoid cracking.

## Cold working

Only slightly cold workable by common procedures.



HTS SINOXX

**HTS Technology Group**
Litostrojska cesta 60, SI-1000 Ljubljana, Slovenia
Phone: +386 1 5000 114
E-mail: sales@htsgroup.com

## HTS SALES AND TECHNICAL SUPPORT NETWORK

### SLOVENIA
**HTS IC d.o.o.**
Litostrojska ulica 60
SI-1000 Ljubljana
Slovenia
Phone: +386 1 5 000 114
E-mail: sales@htsgroup.com

### GERMANY
**HTS MWT GmbH**
Max-von-Eyth-Straße 7
DE-86899 Landsberg/Lech
Germany
Phone: +49 81 91 94 77 214
E-mail: office.mwt@htsgroup.com

### AUSTRIA
**HTS IC GmbH**
Heinrich Bablik-Straße 17
AT-1100 Wien
Austria
Phone: +43 1 60030 2911
E-mail: office.austria@htsgroup.com

### FRANCE
**HTS Technology France**
Lyon Plaza Part Dieu 93 rue de la Villette
FR-69003 Lyon
France
Phone: +33 787 15 83 74
E-mail: jonathan.labarre@htsgroup.com

### CZECH REPUBLIC
**HTS IC s.r.o.**
Viktora Huga 377/4
CZ-15000 Praha 5
Czech republic
Phone: +420 720 532 147
E-mail: office.cz@hts-ic.com

### SPAIN
**ALROTEC TECNOLOGY, SL**
Pol. Ind. de Constantí. Avgda.
de Les Puntes Nav 5
E-43120 Constanti
Spain
Phone: +34 977 525 561
E-mail: alrotec@alro-tec.com

### ITALY
**Sidertoce S.p.A.**
Via XX Settembre, 198
28883 Gravellona Toce (VB)
Italy
Phone: +39 0323 865208
E-mail: info@sidertoce.com

### USA
**HTS International Corporation**
123 Center Park Dr. Ste 233
Knoxville, 37922
USA
Phone: +1 865 410 8880
E-mail: info@htsintl.com