

STAVAX® SUPREME

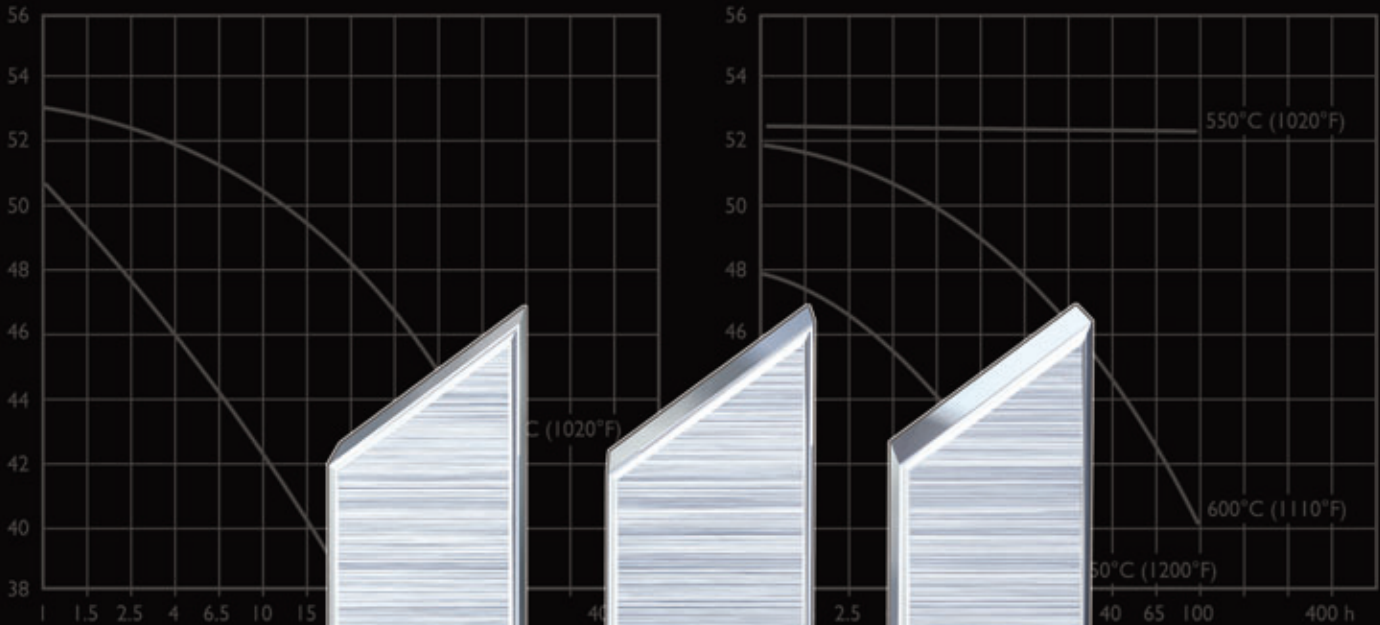
Stainless tool steel

COLD WORK

PLASTIC MOULDING

HOT WORK

HIGH PERFORMANCE STEEL



Typical analysis %	C 2,05	Mn 0,8	Cr 12,5	W 0,2
Standard specification	AISI D6, (S1)	DIN EN 1.2796 (W.Nr. 1.2796)		
Delivery condition	Soft annealed	to approx. 200 HB		
Colour code	Red	our co		

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m ³ lbs/m ³	7 770 0,281	7 700 0,277	7 650 0,275
Modulus of elasticity N/mm ² psi	194 000 28,1 × 10 ⁶	188 000 27,3 × 10 ⁶	173 000 25,1 × 10 ⁶
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	to 100°C 11,7 × 10 ⁻⁶ to 212°F 6,5 × 10 ⁻⁶	to 200°C 12 × 10 ⁻⁶ to 400°F 6,7 × 10 ⁻⁶	to 400°C 13,0 × 10 ⁻⁶ to 750°F 7,3 × 10 ⁻⁶
Thermal conductivity W/m °C Btu in (ft ² h°F)	-	27 187	32 221
Specific heat K/kg °C Btu/lbs °F	455 0,109	525 0,126	608 0,145

General

Demands placed on plastic mould tooling are increasing. Such conditions require mould steels that possess a unique combination of toughness, corrosion resistance and the ability to reach uniform hardness levels throughout large cross sections. Stavax Supreme has proven to be the right choice for these applications. Stavax Supreme is a new premium grade stainless tool steel with the following properties:

- good corrosion resistance
- excellent through-hardening properties
- good ductility and toughness
- good wear resistance
- excellent polishability

The combination of these properties provides a steel with outstanding production performance. The practical benefits of **good corrosion resistance** in a plastic mould can be summarized as follows:

- **Lower mould maintenance costs.**

The surface of cavity impressions retain their original finish over an extended service life. Moulds stored or operated in humid conditions require no special protection.

- **Lower production costs.**

Since water-cooling channels are less like to be affected by corrosion (unlike conventional mould steels), heat transfer characteristics, and therefore cooling efficiency, are constant throughout the mould life, ensuring consistent cycle times.

These benefits, coupled with the high wear resistance of Stavax Supreme, offer the moulder low-maintenance, long-life moulds for the greatest overall tooling economy.

Note! Stavax Supreme is produced using the Electro-Slag-Remelting (ESR) technique. The result is a mould steel with a very low inclusion level providing for excellent polishability characteristics.

Composition	Cr-Ni-Mo-V alloyed
Standard specification	AISI 420 modified
Delivery condition	Annealed to approx. 250 HB.
Colour code	Orange/black with white line across

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty of fitness for a particular purpose.

Applications

Although Stavax Supreme is recommended for all types of moulds, its special properties make it particularly suitable for moulds with the following demands:

- Corrosion/staining resistance, i.e. for moulding of corrosive materials, e.g. PVC, acetates, and for moulds subjected to humid working/storage conditions
- High surface finish, i.e. for the production of optical parts, such as camera and sunglasses lenses, and for medical components, e.g. syringes, analysis vials etc.
- Toughness/ductility, i.e. for complex moulds
- Outstanding through-hardening characteristics i.e. high-hardenability, important for larger moulds

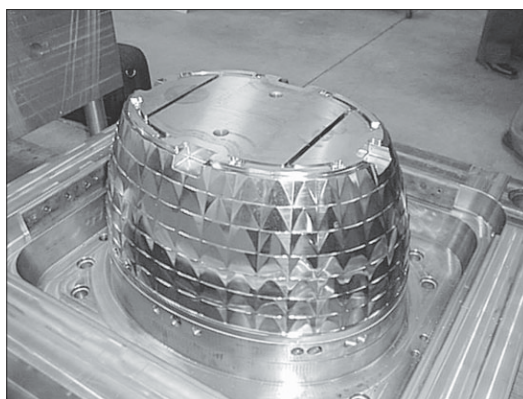
Properties

PHYSICAL DATA

Hardened and tempered to 50 HRC. Data at room and elevated temperatures.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density, kg/m ³ lbs/in ³	7 740 0,280	–	–
Modulus of elasticity MPa psi	210 000 30,5 x 10 ⁶	200 000 29 x 10 ⁶	180 000 26,1 x 10 ⁶
Coefficient of thermal expansion /°C from 20°C /°F from 68°F	–	11,1 x 10 ⁻⁶ 6,1 x 10 ⁻⁶	11,7 x 10 ⁻⁶ 6,7 x 10 ⁻⁶
Thermal conductivity* W/m °C Btu in/(ft ² h °F)	–	20 139	24 166
Specific heat J/kg °C Btu/lb, °F	460 0,110	–	–

* Thermal conductivity is very difficult to measure. The scatter can be as high as ±15%



Mould for production of street-light cover

TENSILE STRENGTH AT ROOM TEMPERATURE

The tensile strength values are to be considered as only approximate. The test samples have been hardened in air from 1020°C (1870°F) and tempered twice to the given hardness.

All specimens have been taken from a bar with the dimension 407 x 203 mm (16 x 8 inches).

Hardness	50 HRC	45 HRC
Tensile strength R _m MPa psi	1 780 2,58 x 10 ⁵	1 500 2,18 x 10 ⁵
Yield point R _{p0,2} MPa psi	1 290 1,87 x 10 ⁵	1 200 1,74 x 10 ⁵

IMPACT TOUGHNESS

Stavax Supreme has much higher toughness/ ductility compared to other stainless tool steels of W.-Nr. 1.2083/AISI 420 type.

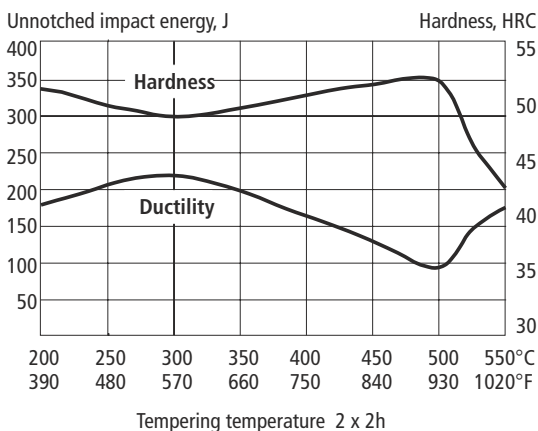
For maximum toughness and ductility use low temperature tempering and for maximum abrasive wear resistance use high temperature tempering.

Approximate room temperature impact strength as measured by samples removed from the center of a forged block, tested in the short transverse direction is shown below.

Original bar dimension: 508 x 306 mm (20 x 12")
Specimen size: 7 x 10 x 55 mm (0,27 x 0,4 x 2,2")
unnotched.

Hardened at 1020°C (1870°F) for 30 minutes.
Quenched in air. Tempered 2 x 2h.

The influence of tempering temperature on the room temperature unnotched impact toughness



CORROSION RESISTANCE

A tool made from Stavax Supreme has a very good corrosion resistance and will resist corrosive environments better than other stainless tool steels of the W.-Nr. 1.2083/AISI 420 type.

Stavax Supreme shows the best corrosion resistance when tempered at a low temperature and polished to a mirror finish.

In the graph below values from potentiodynamic polarization curves have been evaluated to show the difference in general corrosion resistance between Stavax Supreme and W.-Nr.1.2083/AISI 420

measured at low- and high temperature tempering.

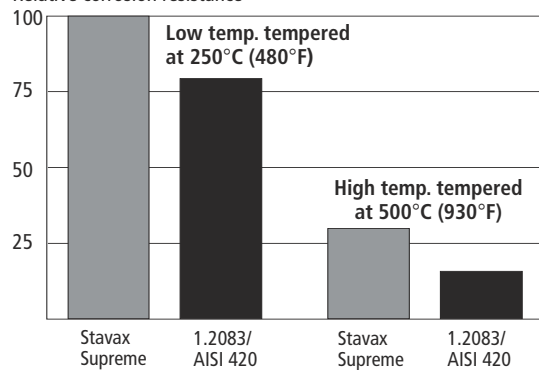
Specimen size: 20 x 15 x 3 mm (0,8 x 0,6 x 0,1")

Hardened at 1020°C (1870°F) for 30 minutes.

Quenched in air. Tempered 2 x 2h.

The influence of mould steel and tempering temperature on corrosion resistance.

Relative corrosion resistance



Heat Treatment

SOFT ANNEALING

Protect the steel and heat through to 740°C (1365°F). Then cool in the furnace at 15°C (30°F) per hour to 550°C (1020°F), then freely in air.

STRESS-RELIEVING

After rough machining the tool should be heated through to 650°C (1200°C), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

HARDENING

Preheating temperature: 600–850°C (1110–1560°F)

Normally a minimum of two preheating steps.

Austenitizing temperature: 1000–1025°C (1830–1880°F) but usually 1020°C (1870°F). For very large moulds 1000°C (1830°F) is recommended.

Temperature		Holding time* minutes	Hardness before tempering
°C	°F		
1020	1870	30	55±2 HRC
1000	1830	30	54±2 HRC

* Holding time = time at hardening temperature after the tool is fully heated through.

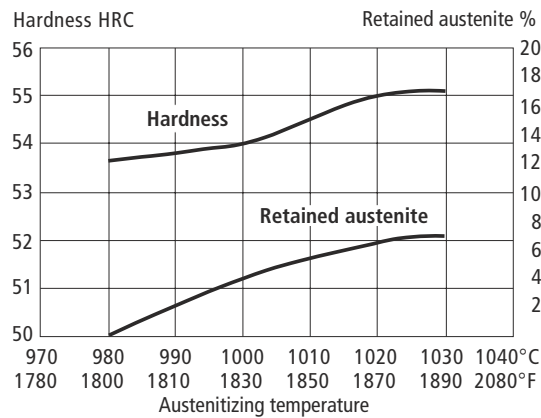
Protect the part against decarburization and oxidation during hardening.

QUENCHING MEDIA AND HARDENABILITY

- Vacuum, cooling in gas with sufficient overpressure
- Warm oil, approx. 80°C (175°F)
- Fluidized bed or salt bath at 250–550°C (480–1020°F) then cool in air blast
- High speed gas/circulating atmosphere

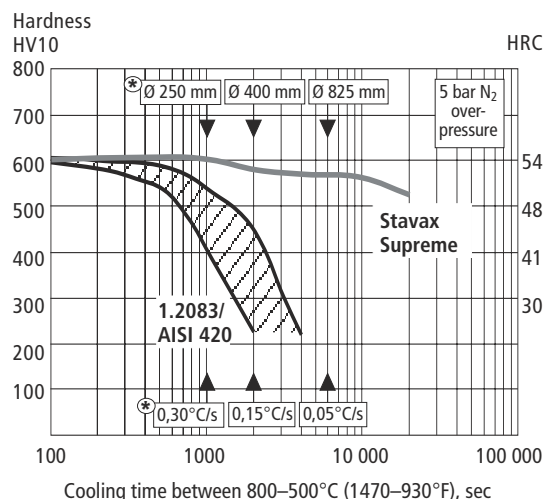
In order to obtain optimum properties, the cooling rate should be as fast as possible while maintaining an acceptable level of distortion. When heating in a vacuum furnace, min. 4–5 bar overpressure is recommended. *Note:* Temper the tool as soon as its temperature reaches 50–70°C (120–160°F).

Hardness and retained austenite as a function of the austenitizing temperature



When hardening larger dimensions of W.-Nr. 1.2083 /AISI 420 type of material, the relatively poor hardenability will provide a low hardness and an undesirable microstructure over the cross section. In some parts of the mould the corrosion resistance and the toughness will be lowered. Stavax Supreme has a much better hardenability than the W.-Nr. 1.2083/AISI 420 type of material so the high hardness will be retained even in the center of large dimensions. The very good hardenability will also have a decisive effect on other properties such as toughness and corrosion resistance.

Hardness as a function of cooling rate during hardening



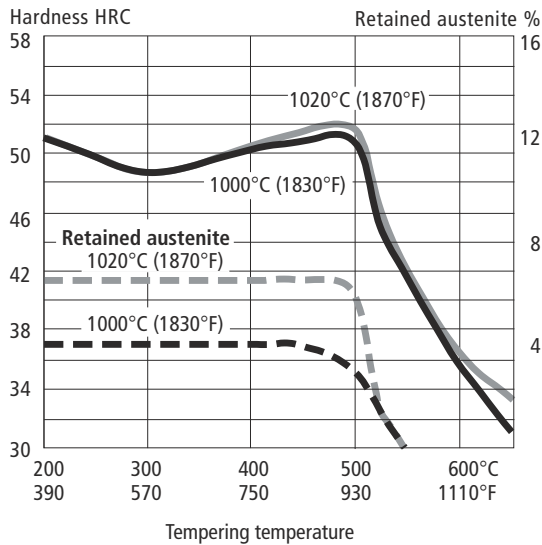
⊛ Cooling rate in the centre of three dimensions is indicated

TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper minimum twice with intermediate cooling to room temperature. Lowest tempering temperature 250°C (480°F). Holding time at temperature minimum 2 hours.

Tempering graph

The tempering curves are approximate.



Note : Tempering at 250–300°C (480–570°F) results in the best combination of toughness, hardness and corrosion resistance. However, for very large moulds and/or a complicated design it is recommended to use a high tempering temperature to reduce the residual stresses to a minimum.

DIMENSIONAL CHANGES

The dimensional changes during hardening and tempering vary depending on temperatures, type of equipment and cooling media used during heat treatment.

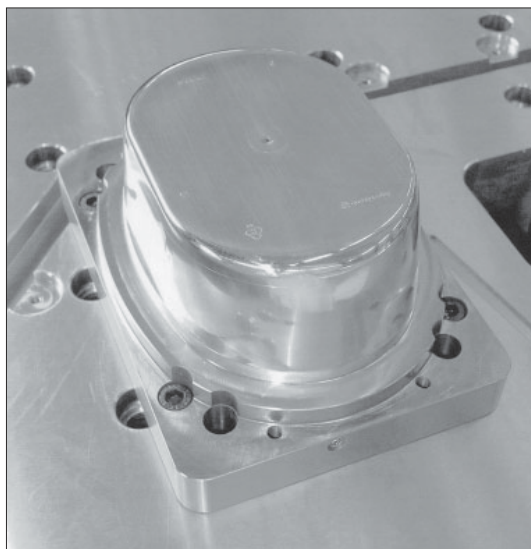
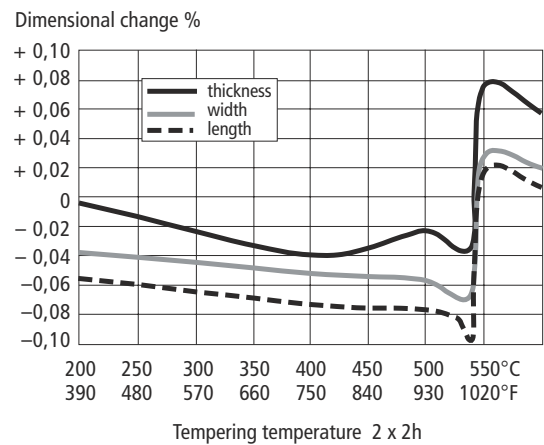
The size and geometry of the tool will also affect distortion and dimensional change. Therefore the tool should always be manufactured with enough machining allowance to compensate for dimensional changes. Use 0,15% as a guideline for Stavax Supreme provided that a stress relief is performed between rough and semifinished machining as recommended.

Dimensional changes were measured for a sample of Stavax Supreme with a size of 100 x 100 x 100 mm (3,9 x 3,9 x 3,9") heat treated under the following conditions:

Austenitizing: 1020°C (1870°F)/30 min., cooling in vacuum furnace with gas at 1,1°C/s (1,8°F/s) between 800°C (1470°F) and 500°C (930°F).

Tempering: 2 x 2 h at various temperatures.

Dimensional changes during hardening and tempering in length, width and thickness direction



Mould for production of big ice cream container

Machining recommendations

The cutting data below are to be considered as guidelines and may require adjustments based on equipment, selection of cutting tools, etc. More information can be found in the Uddeholm publication "Cutting data recommendation".

Condition: Delivered hardness approx. 250 HB

TURNING

Cutting data parameter	Turning with carbide		Turning with high speed steel Fine turning
	Rough turning	Fine turning	
Cutting speed (v_c) m/min f.p.m.	160–210 525–690	210–260 690–850	18–23 59–75
Feed (f) mm/r i.p.r.	0,2–0,4 0,008–0,016	0,05–0,2 0,002–0,008	0,05–0,3 0,002–0,01
Depth of cut (a_p) mm inch	2–4 0,08–0,16	0,5–2 0,02–0,08	0,5–3 0,02–0,1
Carbide designation ISO	P20–P30 Coated carbide	P10 Coated carbide or cermet	–

DRILLING

High speed steel twist drills

Drill diameter		Cutting speed (v_c)		Feed (f)	
mm	inch	m/min	f.p.m.	mm/r	i.p.r.
–5	–3/16	14–16*	46–52*	0,05–0,15	0,002–0,006
5–10	3/16–3/8	14–16*	46–52*	0,15–0,20	0,006–0,008
10–15	3/8–5/8	14–16*	46–52*	0,20–0,25	0,008–0,010
15–20	5/8–3/4	14–16*	46–52*	0,25–0,30	0,010–0,014

* For coated HSS drill $v_c = 22–24$ m/min. (72–79 f.p.m.)

Carbide drill

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide ¹⁾
Cutting speed, (v_c) m/min f.p.m.	21–230 689–755	80–100 262–328	70–80 230–262
Feed, (f) mm/r i.p.r.	0,03–0,10 ²⁾ 0,0012–0,004	0,10–0,25 ²⁾ 0,004–0,01	0,15–0,25 ²⁾ 0,006–0,01

¹⁾ Drills with internal cooling channels and brazed tip

²⁾ Depending on drill diameter

MILLING

Face and square shoulder face milling

Cutting data parameter	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min f.p.m.	160–240 525–787	240–280 787–919
Feed (f_z) mm/tooth in/tooth	0,2–0,4 0,008–0,016	0,1–0,2 0,004–0,008
Depth of cut (a_p) mm inch	2–4 0,08–0,16	0,5–2 0,02–0,08
Carbide designation ISO	P20–P40 Coated carbide	P10–P20 Coated carbide or cermet

End milling

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) m/min f.p.m.	120–150 390–500	160–220 525–722	25–30 ¹⁾ 82–100
Feed (f_z) mm/tooth in/tooth	0,01–0,20 ²⁾ 0,0004–0,008	0,06–0,20 ²⁾ 0,002–0,008	0,01–0,3 ²⁾ 0,0004–0,01
Carbide designation ISO	–	P20–P30	–

¹⁾ For coated HSS end mill $v_c = 45–50$ m/min. (150–165 f.p.m.)

²⁾ Depending on radial depth of cut and cutter diameter

GRINDING

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm publication "Grinding of tool steel"

Type of grinding	Wheel recommendation	
	Delivery condition	Hardened condition
Face grinding straight wheel	A 46 HV	A 46 HV
Face grinding segments	A 36 GV	A 36 GV
Cylindrical grinding	A 60 LV	A 60 KV
Internal grinding	A 46 JV	A 60 IV
Profile grinding	A 100 LV	A 120 KV

Welding

Good results when welding tool steel can be achieved if proper techniques are used. Precautions such as preheating, heat treatment, post weld heat treatment, joint preparation, selection of consumables, etc. are required.

For best result after polishing and photo-etching use consumables with a matching chemical composition to the mould steel.

Welding method	TIG
Working temperature	200–250°C (390–480°F)
Welding consumables	STAVAX TIG-WELD
Hardness after welding	54–56 HRC
Heat treatment after welding:	
Hardened condition	Temper at 10–20°C (50–70°F) below the original tempering temperature.
Delivery condition	Heat treat to 700°C (1290°F) for 5 hours. Then cool freely in air.

Further information is given in the Uddeholm brochure "Welding of Tool Steel" or nearest Uddeholm sales office.

Further information

Please contact your local Uddeholm office for further information on the selection, heat treatment and application of Uddeholm tool steels, including the publication "Steel for moulds".

Photo-etching

Stavax Supreme has a very low inclusion content and a homogeneous microstructure. The high cleanliness level provides for good photo-etching/texturing characteristics.

The special photo-etching process that might be necessary because of Stavax Supreme's good corrosion resistance is familiar to all the leading photo-etching companies.

Further information is given in the Uddeholm booklet "Photo-etching of tool steel".

Polishing

Stavax Supreme has a very good polishability in the hardened and tempered condition.

A slightly different technique, in comparison with other Uddeholm mould steels, should be used. The main principle is to use smaller steps at the fine-grinding/polishing stages and not to start polishing on too rough of a surface. It is also important to stop the polishing operation **immediately after** the last scratch from the former grit size has been removed.

More detailed information on polishing techniques is given in the brochure "Polishing of tool steel".