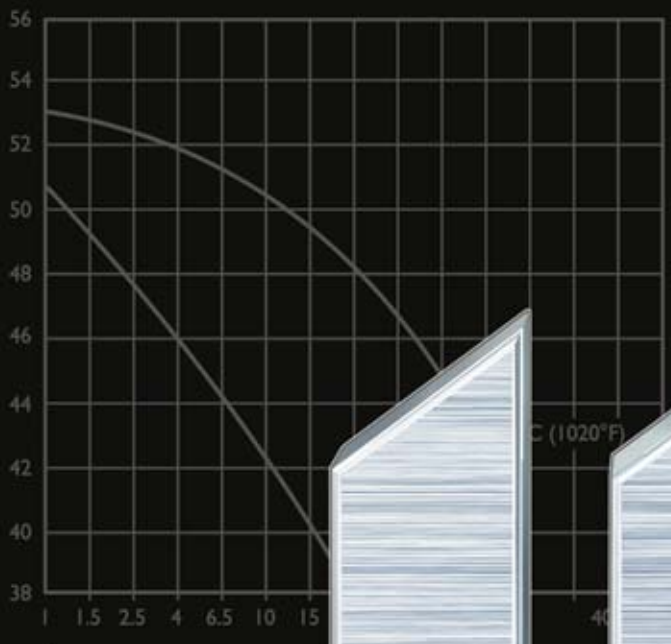
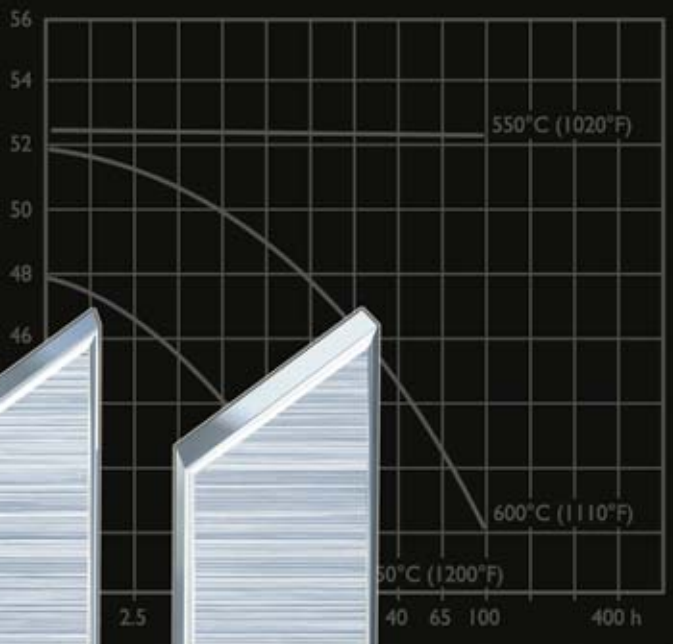
CORRAX

A stainless precipitation hardening steel

COLD WORK | PLASTIC MOULDING | HOT WORK | HIGH PERFORMANCE STEEL





Typical analysis %	C 2,05			Mn 0,8	Cr 4,5	W 0,2
Standard specifikation	AISI D6, (				03) (W.Nr. 1.2796)	
Delivery condition	Soft anne				o approx. 200 HB	
Colour code	Red					

Temperature	20°C (68°F)		
Density kg/m³	7 770		
Density lbs/m³	0,281		
Modulus of elasticity N/mm²	194 000	188 000	178
Modulus of elasticity psi	28,1 x 10⁶	27,3 x 10⁶	25,8 x 10⁶
Coefficient of thermal expansion per °C from 20°C	to 100°C 11,7 x 10⁶	to 200°C 12 x 10⁶	to 400°C 13,0 x 10⁶
Coefficient of thermal expansion per °F from 68°F	to 212°F 6,5 x 10⁶	to 400°F 6,7 x 10⁶	to 750°F 7,3 x 10⁶
Thermal conductivity W/m °C	-	27	32
Thermal conductivity Btu in (ft²h°F	-	187	221
Specific heat K/kg °C	455	525	608
Specific heat Btu/lbs °F	0,109	0,126	0,145

		200°C (390°F)	400°C (750°F)
	70	7 650	7 650
	0,277	0,276	0,275
N/mm²	194 000	189 000	173 000
psi	28,1 x 10⁶	27,4 x 10⁶	25,1 x 10⁶
Coefficient of thermal expansion per °C from 20°C	to 100°C 12,3 x 10⁶	to 200°C 14 x 10⁶	to 400°C 15,1 x 10⁶
Coefficient of thermal expansion per °F from 68°F	to 212°F 6,1 x 10⁶	to 400°F 6,7 x 10⁶	to 750°F 7,3 x 10⁶
Thermal conductivity W/m °C	20,5	21,5	23,0
Thermal conductivity Btu in (ft²h°F	142	149	159
Specific heat K/kg °C	460	-	-
Specific heat Btu/lbs °F	0,110	-	-

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 for fitness for a particular purpose.

General

Compared with conventional corrosion resistant tool steel, Corrax has the following advantages:

- Flexible hardness, 34–50 HRC, achieved by an ageing treatment in the temperature range 425–600°C (790–1110°F).
- Extremely good dimensional stability during the ageing
- High uniformity of properties also for large dimensions
- Very good weldability, no preheating necessary
- No hard "white" layer after EDM
- Corrosion resistance superior to that of AISI 420 and W.-Nr. 1.2083

Typical analysis %	C 0,03	Si 0,3	Mn 0,3	Cr 12,0	Ni 9,2	Mo 1,4	Al 1,6
Delivery condition	Solution treated to ~34 HRC						
Colour code	Black/grey						

Applications

- Injection moulds for
  – corrosive plastics
  – rubber
  – medical and food industry
- Extrusion dies
- Plastic processing
  – screws
- Engineering parts.

Properties

PHYSICAL DATA

Aged to ~46 HRC.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m^3 lbs/in^3	 7 700 0,28	 – –	 – –
Modulus of elasticity N/mm^2 psi	 200 000 29 x 10^6	 190 000 28 x 10^6	 170 000 25 x 10^6
Coefficient of thermal expansion per°C from 20°C per°F from 68°F	 – –	 11,7 x 10^{-6} 6,5 x 10^{-6}	 12,3 x 10^{-6} 6,8 x 10^{-6}
Thermal conductivity W/m °C Btu in/ft^2 h °F	 – –	 18 125	 21 146

MECHANICAL DATA

Tensile strength at room temperature.

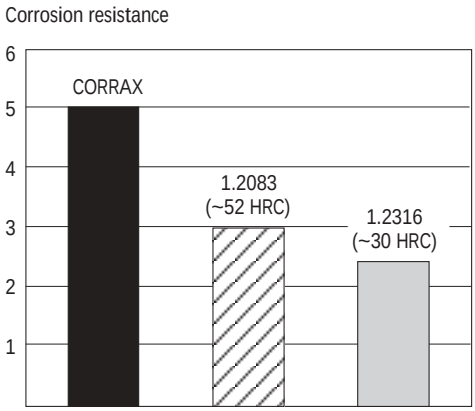
	Solution treated ~34 HRC	Aged to ~40 HRC	Aged to ~46 HRC	Aged to ~50 HRC
Yield strength $R_{p0,2}$ N/mm^2 psi	 700 100 000	 1 000 150 000	 1 400 200 000	 1 600 230 000
Tensile strength R_m N/mm^2 psi	 1 100 160 000	 1 200 170 000	 1 500 220 000	 1 700 250 000

Compressive strength at room temperature.

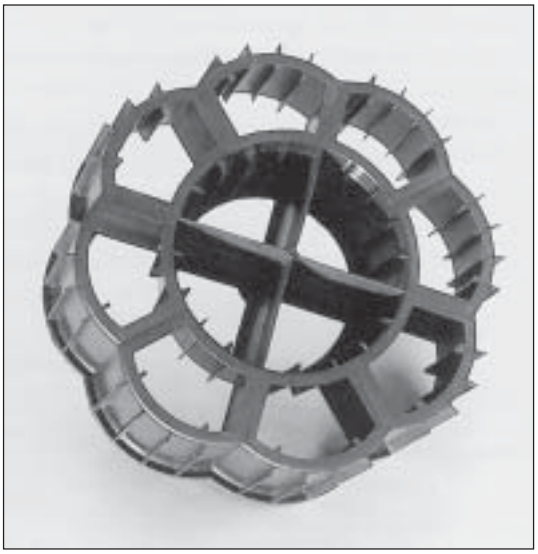
	Solution treated ~34 HRC	Aged to ~40 HRC	Aged to ~46 HRC	Aged to ~50 HRC
$R_{c0,2}$ N/mm^2 psi	 900 130 000	 1 300 190 000	 1 600 230 000	 1800 260 000

CORROSION RESISTANCE

Corrax has a very good corrosion resistance, better than the corrosion resistant standard grades used for plastic moulding. The corrosion resistance is the same in all heat treated conditions (except after nitriding).



Corrax will withstand attacks from most corrosive plastics and diluted acids.
A mold made of Corrax will also have good resistance to humid working and storage conditions. Corrax also shows better resistance to stress corrosion cracking than standard hardenable corrosion resistant steel grades.



Corrax is a very suitable mould steel for plastic parts with complicated design.

Heat treatment

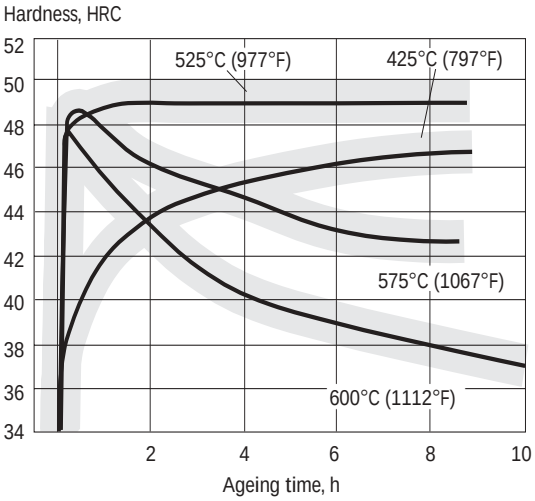
Corrax is delivered in solution treated condition and can be used in the as-delivered condition. When, however, the steel is to be heat treated to a higher hardness, the following instructions may be helpful.

STRESS RELIEVING

Stress relieving can not be performed as for other steel grades since an increase in temperature results in a higher hardness because of ageing effect.

AGEING

Corrax can be used in as-delivered condition. Higher hardness is obtained by ageing. Suitable ageing parameters can be obtained from the figure below. Ageing time means the time at the ageing temperature after the tool is fully heated through.



When the ageing time is reached, cool the tool in air to room temperature. Ageing at high temperature gives a better toughness compared with ageing to the same hardness at a lower temperature.

Ageing recommendation

Ageing temperature/time	Hardness
525°C/2 h (977°F/2 h)*	~50 HRC
575°C/2 h (1067°F/2 h)	~46 HRC
600°C/4 h (1112°F/4 h)	~40 HRC

** Ageing to 50 HRC is only recommended when toughness is not important*

If Corrax is used at temperatures higher than 200°C (390°F) the solution treated condition (delivery condition) is not recommended because ageing can occur during use.

SOLUTION TREATMENT

It is possible to solution treat Corrax, if aged, in order to get back to the delivery condition. Solution treatment should be done at 850°C (1560°F), holding time 30 minutes. Cool in air.

DIMENSIONAL CHANGE

Ageing results in a small and uniform decrease in volume. The following shrinkage can be expected during ageing.

Ageing	Dimensional change %		
	Longi-tudinal direction	Trans-versal direction	Short trans-versal direction
525°C/2 h (977°F/2 h) ~50 HRC	–0,07	–0,07	–0,07
575°C/2 h (1067°F/3 h) ~46 HRC	–0,09	–0,09	–0,09
600°C/4h (1112°F/4h) ~40 HRC	–0,14	–0,14	–0,14

Cutting data recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendations".

Delivery condition: solution treated to ≈ 34 HRC

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel Fine turning
	Rough turning	Fine turning	
Cutting speed (v_c) m/min f.p.m.	110–160 360–525	160–210 525–690	13–18 43–59
Feed (f) mm/r i.p.r.	0,2–0,4 0,008–0,016	0,05–0,2 0,002–0,008	0,05–0,2 0,002–0,008
Depth of cut (a_p) mm inch	2–4 0,08–0,16	0,5–2 0,02–0,08	0,5–3 0,02–0,12
Carbide designation ISO	P20–P40 coated carbide	P10 Coated carbide or cermet	–

MILLING

Face- and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min f.p.m	70–90 230–295	90–110 295–360
Feed (f_z) mm/tooth inch/tooth	0,2–0,4 0,008–0,016	0,1–0,2 0,004–0,008
Depth of cut (a_p) mm inch	2–5 0,08–0,20	–2 –0,08
Carbide designation ISO	P20–P40 Coated carbide	P10–P20 Coated carbide or cermet

End milling

Cutting data parameters	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) m/min f.p.m.	60–100 200–328	70–110 230–360	20–25[1] 66–82[1]
Feed (f_z) mm/tooth inch/tooth	0,006–0,20[2] 0,0002–0,008[2]	0,06–0,20[2] 0,002–0,008[2]	0,01–0,35[2] 00004,–0,014[2]
Carbide designation ISO	K10, P40	P20–P30	–

[1] *For coated HSS end mill v_c = 35–45 m/min. (115–148 f.p.m.)*
[2] *Depending on radial depth of cut and cutter diameter.*

DRILLING

High speed steel twist drill

Drill diameter		Cutting speed (v_c)		Feed (f)	
mm	inch	m/min	f.p.m.	mm/r	i.p.r.
– 5	–3/16	13–15*	43–49*	0,05–0,10	0,002–0,004
5–10	3/16–3/8	13–15*	43–49*	0,10–0,20	0,004–0,008
10–15	3/8–5/8	13–15*	43–49*	0,20–0,25	0,008–0,010
15–20	5/8–3/4	13–15*	43–49*	0,25–0,30	0,010–0,012

[1] *The same cutting speed when using coated HSS drill v_c 13–15 m/min. (43–49 f.p.m.).*

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide[1]
Cutting speed (v_c) m/min f.p.m.	180–200 590–656	100–130 328–427	50–70 164–230
Feed (f) mm/r i.p.r.	0,05–0,15[2] 0,002–0,006[2]	0,10–0,25[2] 0,004–0,01[2]	0,15–0,25[2] 0,006–0,01[2]

[1] *Drill with internal cooling channels and brazed carbide tip.*
[2] *Depending on drill diameter.*

GRINDING

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

Wheel recommendation

Type of grinding	Delivery condition and aged condition
Face grinding straight wheel	A 46 GV
Face grinding segments	A 36 FV
Cylindrical grinding	A 60 JV
Internal grinding	A 60 IV
Profile grinding	A 120 JV

When good surface finish is required a SiC-wheel could be an alternative.

EDM

Corrax can be EDM'd in the same way as ordinary tool steels. The "white layer" will, however, not be as hard and is therefore more easily removed.

Welding

Preheating is not necessary.

When welding on Corrax in delivery condition, intermittant welding is recommended.

In order to obtain an even hardness, it is necessary to carry out a heat treatment after welding. The temperature and time are determined by the required hardness and the filler material. Corrax TIG-Weld is recommended to be used as filler mateiral.

For further information, please contact your local Uddeholm office.

Photo-etching

Corrax has a very good corrosion resistance and a special process is thus required for chemical photo-etching.

Fine patterns with shallow depths <0,04 mm (0,002 inch) are readily achievable.

Property comparison chart

Uddeholm steel grade	Hardness HRC	Wear resistance	Corrosion resistance
CORRAX	34		
CORRAX	50		
STAVAX SUPREME	52		
STAVAX ESR	52		
ELMAX	58		
RAMAX 2	37		
IMPAX SUPREME	32		

Further information

Please, contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steels.