HARDOX®
TechSupport

Information from SSAB Oxelösund. **#40**

HARDOX 550 in the Workshop

HARDOX 550 combines a very high abrasion resistance with workshop friendliness.

It can be fabricated with conventional workshop methods, by following the recommendations of this document.

The recommendations cover *welding, cutting, drilling/milling and bending.*

Welding HARDOX 550

General
HARDOX 550 can be welded with all conventional methods and to all other weldable steels. Cold cracking can most easily be avoided by choosing stainless austenitic consumables and/or by preheating the plate prior to welding.
Note that soft zones will occur in areas heated to a temperature >200°C (400 F), thus softening may arise when welding small components.
If welding is to be performed on oxygen fuel or plasma cut edges, the joint preparation is recommended to be machined to bright metal.

Preheating
The preheat temperature is determined by the HARDOX 550 plate thickness. Preheating is most important when tack welding and welding of the root pass. Tack welds should be at least 50 mm (2″) long to reduce the stresses in the weld joint.

Consumables
Use stainless austenitic consumables or soft ferritic consumables having basic flux. Weld metal strength R_e < 500 N / mm² (72 ksi) hydrogen content ≤ 5 ml / 100 g.

Recommended preheat and minimum interpass temperature [°C, (F)]

Austenitic consumables	Room temp		50°C (120 F)						
Ferritic consumables	125 (260)	150 (300)	175 (350)		200 (400)				
Plate thickness [mm] *	≤ 10	15	20	25	30	35	40	45	50
Plate thickness [in] *	≤ 3/8″	5/8″	3/4″	1″	1 1/4″		1 1/2″	1 3/4″	2″

*) Single plate thickness
HD ≤ 5ml/100 g weld deposit, Heat input 1.7 kJ/mm

Consumables suitable for welding HARDOX 550

	Electrodes	**Wires**	
Manufacturer	**Austenitic**	**Austenitic (solid wire)**	**Ferritic (solid wire / flux-cored wire)**
ESAB	OK 67.45	OK Autrod 16.95	OK Autrod 12.51 / OK Tubrod 15.00
LINCOLN	Jungo 307	LNM 307	LNM/LNT Ni 1 / Outershield T55-H
OERLIKON	Citochromax N	Interfil 18 8 6	Carbofil 1 / Fluxofil 40
SAF	Safinox R 307	Nertalic 51	Nertalic 70S / Safdual 31
Thyssen	Thermanit X	Thermanit X	UNION K52 / Thyssen TG 50b

Cutting HARDOX 550

Table 1.

Preheat recommendations for oxygen fuel cutting of HARDOX 550

Thickness [mm (in)]	Temperatur [°C (F)]
< 20 mm (<3/4″)	No preaheating
20 - 30 mm (3/4″ - 1 1/4″)	100 °C (200)
30.1 - 50 mm (1 1/4″-2″)	150 °C (300)

Table 2.

Maximum recommended cutting speed for Oxygen fuel cutting of HARDOX 550, if no preheating is employed. Slow cutting / Submerged cutting

Thickness [mm (in)]	Max cutting speed [mm/min (in/min)]
≤ 20 (3/4″)	no restriction
25 (1″)	270 (11)
30 (1 1/4″)	230 (9)
35	190
40 (1 1/2″)	160 (6)
45 * (1 3/4″)	140 (5.5)
50 * (2″)	130 (5)

*When using cutting speeds < 140 mm/min (5.5 in/min) the tendency for developing a poor cut edge quality becomes evident, therefore attention must be paid when 1) selecting the cutting nozzle and 2) selecting the cutting gas pressure.

1) The nozzle should be selected according to the plate thickness. The use of high efficiency or high speed nozzles has proven to give a better edge quality then standard nozzles.

2) Try to reach a state of best performance by adjusting the cutting gas pressure.

Thermal cutting

General guidelines for cutting

Allow a cold plate to reach room temperature before thermal cutting.

For demanding applications, in 40 – 50 mm (1 1/2″ - 2″) plate thickness, it is recommended to perform ultrasonic inspection of the cut edge, not less than two weeks after cutting.

Preheating for Oxy fuel cutting

The best way to avoid cut edge cracking when oxygen fuel cutting is to use preheating. The preheating can be performed by the use of burner lances, electrical heating mats or by furnace tempering. The recommended preheat temperatures for HARDOX 550 are given in table 1. No restriction on cutting speed is required.

Slow cutting speed when Oxy fuel cutting

An alternative to preheating prior to cutting is to reduce the cutting speed. The heat accumulated in the plate during the cutting process will then act as a kind of preheating. Cutting at a low cutting speed has, however, shown to be less reliable than the use of preheating for preventing cut edge cracking. If preheating is not employed, the maximum permissible cutting speed is given in table 2. The lower the cutting speed used, the less the risk for cut edge cracking.

Slow cooling when Oxy fuel cutting

Regardless of whether preheating or slow cutting speeds are employed, a slow cooling rate of the cut part will reduce the risk for cut edge cracking. Slow cooling rate can be achieved if the parts are stacked together while still warm and covered with an insulating blanket. Allow the parts to cool slowly down to room temperature.

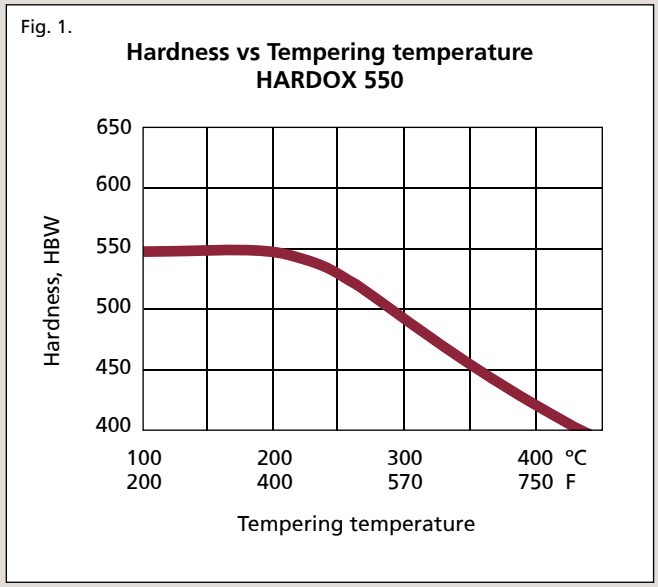
Submerged cutting

Cutting of small components with Oxy fuel cutting

To gain full benefit from the plate hardness it is important to consider the hardness reduction due to tempering by preheating and the heat generated from the cutting. In figure 1 the reduction in hardness due to tempering temperature is shown. The smaller the size of the cut part, the greater the probability for softening.

By “small components” we mean when the distance between two individual cuts is less then 200 mm (8″). The best way to prevent softening of small components is to perform cutting submerged in water* or to choose another cutting method where the amount of heat generated is limited, like laser or abrasive water jet cutting.

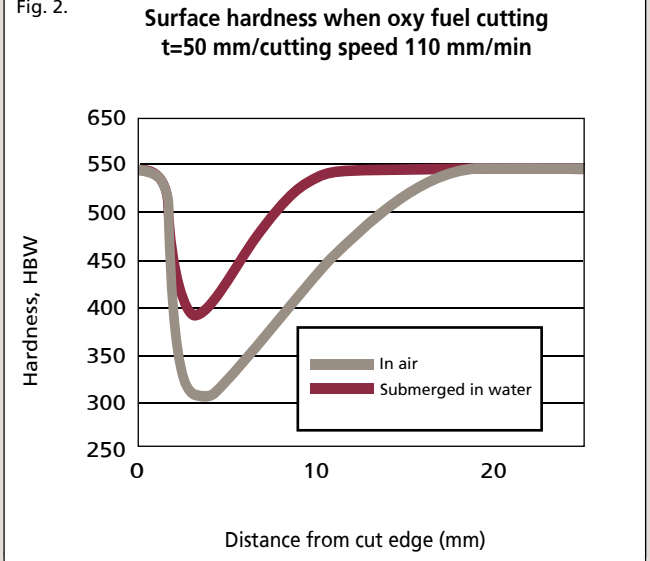
Fig. 1.



Minimize HAZ softening

The width of the softened HAZ is minimized if thermal cutting is performed submerged in water*. Figure 2 displays the extension of the heat affected zone (HAZ) from oxy fuel cutting in air and submerged in water.

Fig. 2.



Abrasive Water Jet cutting

Abrasive water jet cutting (AWJ) is an excellent method for cutting HARDOX 550. The method is highly recommended when cutting thicker gauges. The use of AWJ produces narrow tolerances, no heat affected zone and an excellent cut edge quality.

Plasma Cutting

Plasma cutting can be performed up to a plate thickness of 20 mm (3/4″), in air as well as submerged in water. There is no need for preheating, and there are no restrictions on cutting speed.

Laser Cutting

Laser cutting can be performed up to a plate thickness of 20 mm (3/4″), without restrictions on cutting speed.

* Cutting speeds for submerged oxy-fuel cutting are the same as for slow cutting, table 2.

Machining HARDOX 550

HARDOX 550 can be machined in ordinary stable machines. It is important to avoid vibrations and to use proper tools of the cemented carbide type.

Drilling

Only use cemented carbide type of drills. Provide an abundant supply of coolant.

Recommended data for drilling

Tool	Cutting speed Vc [m/min (in/min)]	Feed rate, f [mm/rev (in/rev)]
Solid cemented carbide	20–30 (800-1200)	0.07–0.11 (0.003-0.004)
Brazed cemented carbide	20–30 (800-1200)	0.07–0.11 (0.003-0.004)
Indexable inserts	35–50 (1400-2000)	0.05–0.11 (0.002-0.004)

Milling

Only milling cutters with cemented carbides inserts are recommended.

Recommendations for face and square shoulder milling

FACE AND SQUARE SHOULDER MILLING Coated cemented carbide inserts of ISO class K20	
Feed [mm/tooth (in/tooth)]	Cutting speed [m/min (in/min)]
0.07 (0.003)	80 (3100)
0.1 (0.004)	75 (3000)
0.2 (0.008)	70 (2800)

Recommendations for end milling

END MILLING Coated cemented carbide inserts of ISO class K20, C2	
Cutting speed [m/min (in/min)]	Feed rate [mm/rev (in/rev)]
80 - 100 (3100-3900)	0.1 - 0.2 (0.004-0.008)

Counterboring and countersinking

Spot facing and countersinking of HARDOX 550 is performed with tools having cemented carbide inserts and a revolving pilot. Apply coolant.

Recommended process parameters

Process	Cutting speed [m/min (in/min)]	Feed Rate [mm/rev (in/rev)]
Counterboring	15–50 (600-2000)	0.10–0.20 (0.004-0.008)
Countersinking	10–35 (400-1400)	0.07–0.14 (0.003-0.006)

Tapping and threading

HARDOX 550 is too strong for tapping tools. If threads are desired they have to be made in a numerically controlled machine with a thread milling tool of the cemented carbide type. The cutting speed should be approximately 30 m/min (1200 in/min).

Bending HARDOX 550

HARDOX 550 can be moderately bent by V-die bending and roller bending. HARDOX 550 may fracture unstable during bending and fragments and pieces may fly off. During bending, the operator and other personnel must therefore not stand in front of the bending machine - they should move aside.

Recommended minimum punch radius and die opening width for V-die bending

Plate thickness [mm (in)]	At right angels [R/t]	Along [R/t]	At right angels W/t	Along W/t	Spring back [°]
t < 8 (5/16")	5	6	12	14	13 - 22
8 ≤ t < 20 (5/16" ≤ t < 3/4")	6	7	14	16	13 - 22
t < 20 (3/4")	8	9	18	20	13 - 22

R = Punch radius
t = plate thickness
W = Die opening width

HARDOX®
WEAR PLATE

HARDOX wear plate only from SSAB Oxelösund
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