HARDOX®
TechSupport

Information from
SSAB Oxelösund.

#16

Cutting of HARDOX wear plate

Oxygen fuel cutting of HARDOX wear plate is as simple as cutting of regular Mild Steel. When cutting of thicker HARDOX plates special attention is needed. For thick and hard plates the risk of developing cut edge cracks increases. By following the recommendations and guidelines given below cut edge cracking and component softening can be prevented.

Cutting methods

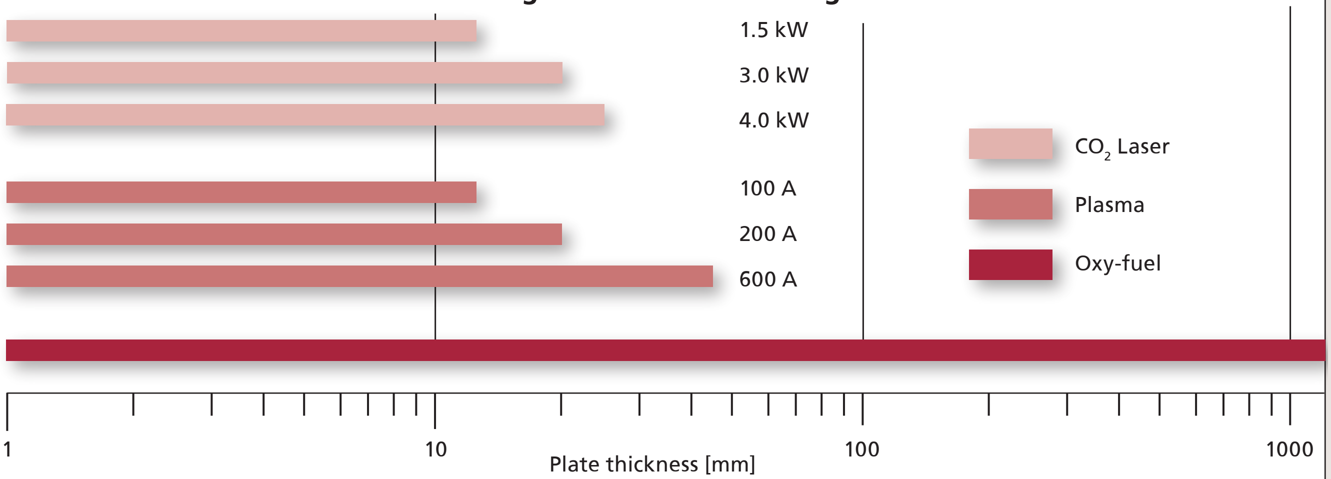
HARDOX wear plate can very well be cut using both cold and thermal cutting methods. The cold methods are abrasive water jet cutting, shearing, sawing or abrasive grinding, while thermal methods are oxy-fuel, plasma and laser cutting.

Abrasive water jet cutting

Table 1 **General features for different cutting methods**

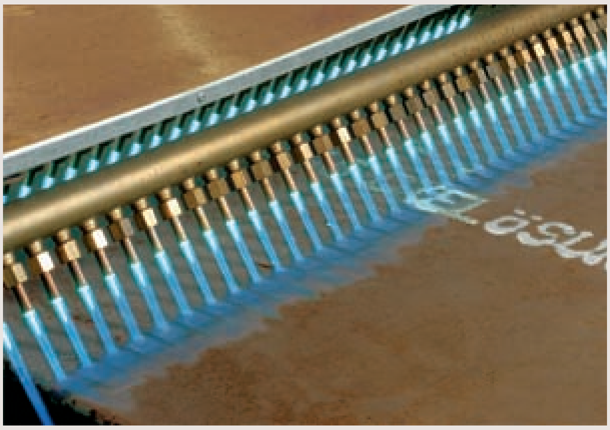
Cutting method	Cutting speed	Kerf	HAZ	Dim. tolerance
Abrasive water-jet cutting	8–150 mm/min	1–3 mm	0 mm	±0,2 mm
Laser cutting	600–2200 mm/min	<1 mm	0,4–3 mm	±0,2 mm
Plasma cutting	1200–6000 mm/min	2–4 mm	2–5 mm	±1,0 mm
Gas cutting	150–700 mm/min	2–5 mm	4–10 mm	±2,0 mm

Diagram 1 **Thickness range for different cutting methods**



Cut edge cracking

Cut edge cracking is a phenomenon that is closely related to hydrogen cracking in welds and occurs when thermal cutting methods are used. If cut edge cracks should occur, they will become visible between 48 hours and up to several weeks after the cutting. So cut edge cracking can be regarded as delayed cracking. The risk of cut edge cracking increases with the steel hardness and plate thickness.



Preheating using the Linde blow pipe system.

Preheating

Preheating prior to cutting is the best way of eliminating the risk of cut edge cracking. Preheating is most commonly applied prior to oxy-fuel cutting. As shown in Table 2, the preheating temperature depends on the steel grade and the plate thickness.

Preheating can be carried out by means of burner lances, electric heating mats or by heating in a furnace. The required temperature should be measured on the opposite side from that at which heating takes place.

N.B. It is important to maintain a low temperature gradient across the plate cross-section in order to avoid local overheating at the contact area of the heat source.

Table 2. Preheating of HARDOX prior to oxy-fuel cutting.

Grade	Plate thickness	Preheating temp.
HARDOX HiTuf	≥90 mm	100°C
HARDOX 400	45–59,9 mm 60 – 80 mm >80 mm	100°C 150°C 175°C
HARDOX 450	40– 49,9 mm 50 – 69,9 mm 70 - 80 mm	100°C 150°C 175°C
HARDOX 500	30–49,9 mm 50 – 59,9 mm 60 – 80 mm	100°C 150°C 175°C
HARDOX 550	20–50 mm	150°C
HARDOX 600	12–29,9 mm 30–50 mm	150°C 175°C

Low cutting speed

Another way of avoiding cut edge cracking is to maintain a low cutting speed. This could be an alternative if preheating cannot be carried out. Cutting at low speed is less reliable than preheating for preventing cut edge cracking. If preheating is not employed, the maximum permissible cutting speed depends on the steel grade and the plate thickness, as shown in Table 3.

A combination of preheating and low cutting speed is recommended for reducing further the susceptibility to cut edge cracking.

Table 3.
Maximum cutting peed, mm/minute, if no preheating is employed in oxy-fuel cutting.

Plate thickness	HARDOX 400	HARDOX 450	HARDOX 500	HARDOX 550	HARDOX 600
≤12 mm	no restrictions	no restrictions	no restrictions	no restrictions	no restrictions
≤15 mm	no restrictions	no restrictions	no restrictions	no restrictions	300 mm/min
≤20 mm	no restrictions	no restrictions	no restrictions	no restrictions	200 mm/min
≤25 mm	no restrictions	no restrictions	300 mm/min	270 mm/min	180 mm/min
≤30 mm	no restrictions	no restrictions	250 mm/min	230 mm/min	150 mm/min
≤35 mm	no restrictions	no restrictions	230 mm/min	190 mm/min	140 mm/min
≤40 mm	no restrictions	230 mm/min	200 mm/min	160 mm/min	130 mm/min
≤45 mm	230 mm/min	200 mm/min	170 mm/min	140 mm/min	120 mm/min
≤50 mm	210 mm/min	180 mm/min	150 mm/min	130 mm/min	110 mm/min
≤60 mm	200 mm/min	170 mm/min	140 mm/min	-	-
≤70 mm	190 mm/min	160 mm/min	135 mm/min	-	-
≤80 mm	180 mm/min	150 mm/min	130 mm/min	-	-
>80 mm	Preheating	-	-	-	-

Slow cooling

Regardless of whether or not preheating of the cut parts is employed, a slow cooling rate will reduce the risk of cut edge cracking. Slow cooling can be achieved if the parts are stacked together while still warm from the cutting process, and are covered with an insulating blanket. Allow the parts to cool slowly down to room temperature.

Post-heating

Heating of the parts immediately after cutting is another method that can be used. This will prolong the time at temperature to allow the hydrogen to escape from the plate and, to some extent, reduce the residual stresses at the cut edge. The soaking temperature should be the same as that given in Table 2, and the soaking time should be at least 5 minutes per mm of plate thickness.

Burner lances, electric heating mats or heat treatment in a furnace can be used for post-heating.

Reducing the risk of softening

The resistance of the steel to softening depends on its chemistry, microstructure and the way in which it has been processed.

The smaller the part that is thermally cut, the greater the risk of the whole component being softened. If the temperature of the steel exceeds 200–250°C, the hardness of the steel will be reduced, according to diagram 2.

Cutting method

When small parts are cut, the heat supplied by the cutting torch and by preheating will be accumulated in the workpiece. The smaller the size of the cut part, the greater the risk of softening. When ***oxy-fuel*** is used for cutting 30 mm or thicker plate, the rule of thumb is that there is risk of loss of hardness of the entire component if the distance between two cuts is less than 200 mm.

The best way of eliminating the risk of softening is to use cold cutting methods, such as ***abrasive water jet cutting***. If thermal cutting must be performed, ***laser or plasma cutting*** is preferable to oxy-fuel cutting.

This is because oxy-fuel cutting supplies more heat and thus raises the temperature of the workpiece.

Submerged cutting

An effective way of limiting and reducing the extent of the soft zone is to water-cool the plate and the cut surfaces during the cutting operation. This can be done either by submerging the plate in water or by spraying water into the cut during cutting. ***Submerged cutting*** can be done both in plasma cutting and in oxy-fuel cutting.

Some advantages offered by ***submerged cutting*** are listed below.

- Narrower heat affected zone
- Prevents loss of hardness of the whole component
- Reduced distortion of the cut part
- Parts are cooled directly after cutting
- No fumes or dust
- Reduced noise level

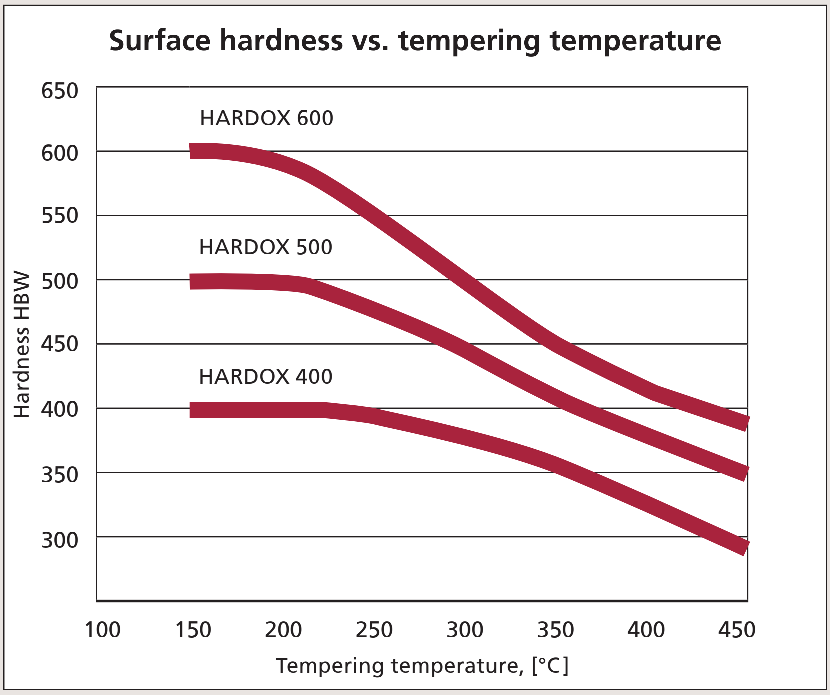
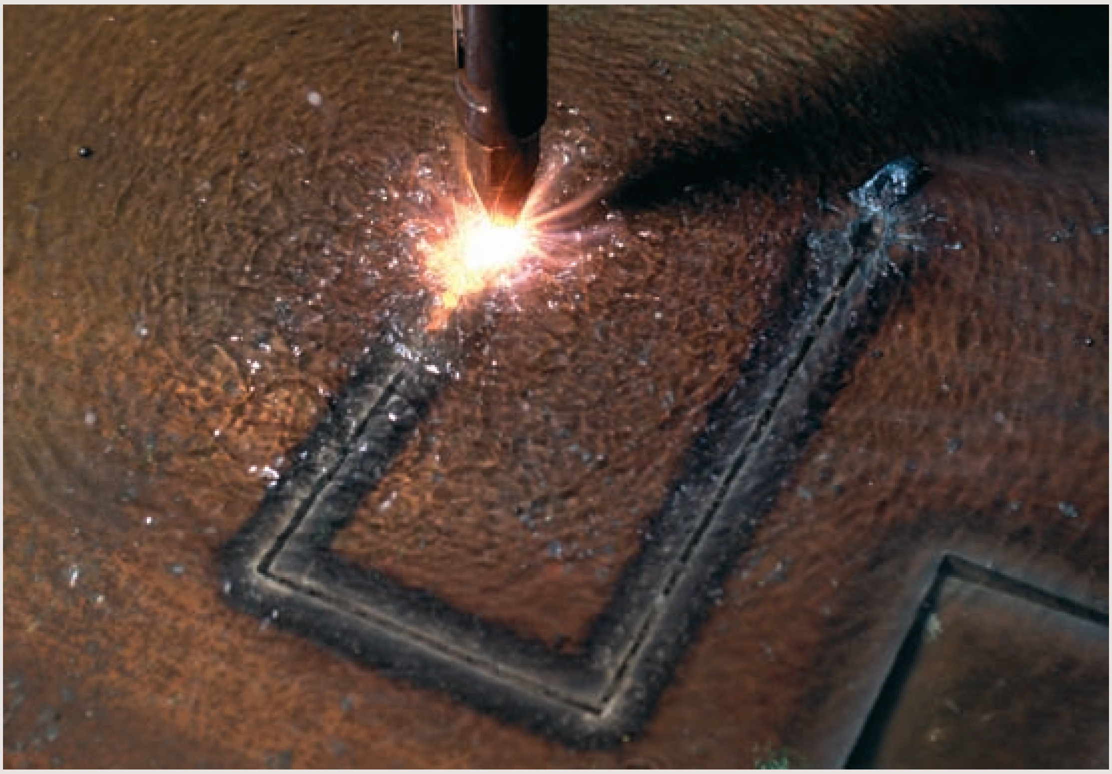


Diagram 2

Submerged cutting.



Avoiding both softening and cut edge cracking when oxy-fuel cutting small parts from thick HARDOX plate

When small parts are cut by oxy-fuel from thick HARDOX plate, there is risk of softening as well as cut edge cracking. This is best avoided by submerged cutting at low cutting speed in accordance with Table 3.

For thermal cutting of HARDOX 600, see special information sheet – TechSupport#23.

HARDOX WEAR PLATE

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