Parameters for Oxy-Acetylene Gas Welding & Cutting

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Steps to be followed:

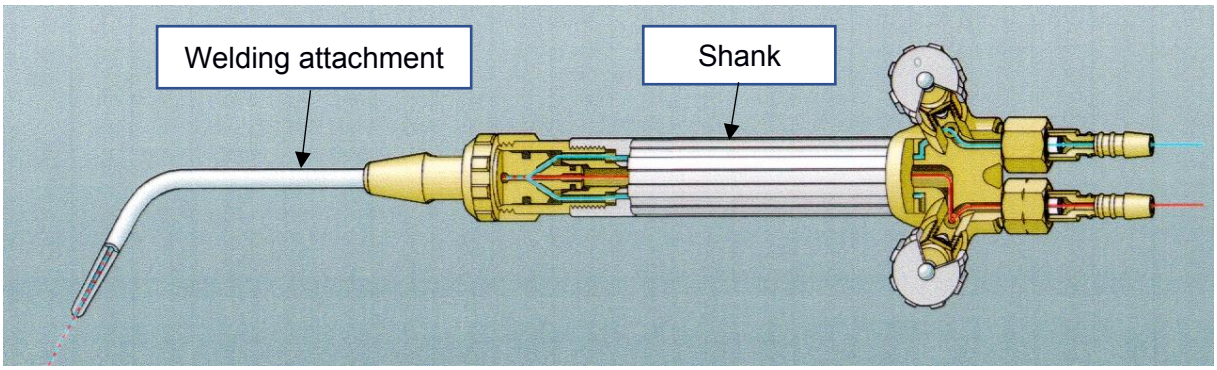
In order to obtain the best possible result doing oxy- acetylene gas welding & cutting there are 4 steps that need to be followed:

1) Selecting the correct welding attachment/ nozzles.
2) Setting the correct working pressures.
3) Adjust to the correct flame setting.
4) Make use of correct welding & cutting technique.

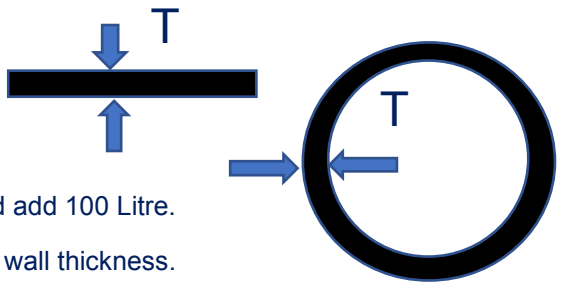
There are a number of different types of oxy-acetylene torches on the market. The most popular and common design in the marine market are the X-21 equal pressure torch. It was originally designed by Engineer Carl Fredrik Jensen in company NAG in 1959. Even today this type of torch design is very much in use and especially popular onboard vessels. The parameters and information given in the following article is based on the X-21 torch design being used. In the attachment **"Injector and equal pressure torches"** you will find more information with regards to different torch designs.

Oxy-Acetylene Gas Welding.

Selecting the correct welding attachment.



Gas welding will in most cases be performed on steel plates and small diameter steel pipes. Plate and wall thickness will normally be up to 7mm. Above this thicknesses electric arc welding using electrodes will be the preferred method. The welding attachment size is given in Litres per hour. If a welding attachment is 230Liter, it indicates that it will consume 230 Litre of oxygen and 230 Litre of acetylene per hour (slightly less acetylene). What welding attachment to choose depend on plate thickness/ wall thickness (if pipe).



The rule of thumb goes like this:

100 Litre per mm thickness.

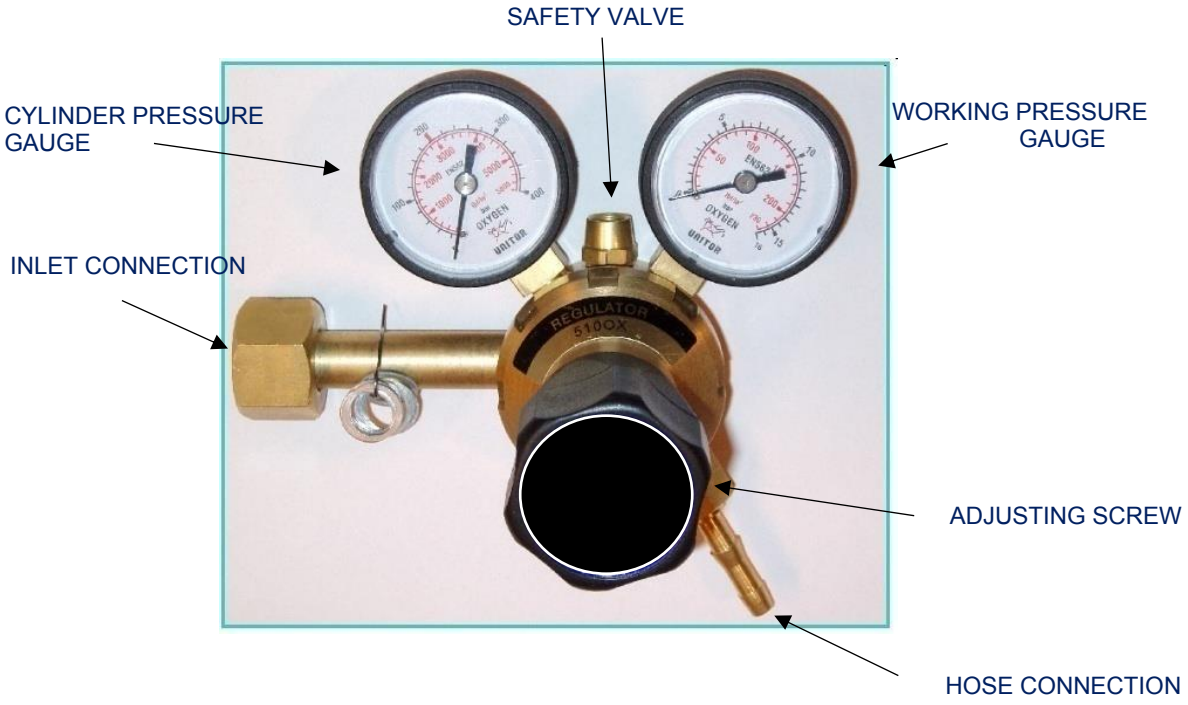
So, for every mm plate or pipe wall thickness we should add 100 Litre.

Selecting your welding attachment depending on plate/ wall thickness.

Material thickness, mm	0,2-0,5	0,5 – 1,0	1,0-2,0	2,0-3,0	2,0-4,0	3,5-5,0	4,0-6,0	5,0-7,0
Size no. AGA	0	1	2	2E	3	3E	4	4E
Welding attachment in litre/hour	40	80	160	230	315	400	500	650

Welding attachment above 650 litre/hour is referred to as heating attachments.

Setting the correct working pressures



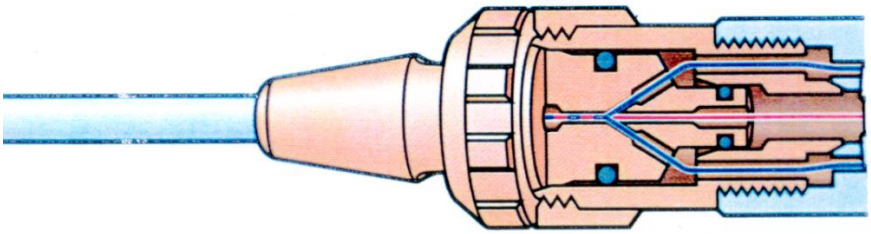
Operating instruction for setting oxygen and acetylene working pressure:

Make sure that the regulator adjusting screw is screwed so far out that it runs freely on its treads. This will close between regulator's high pressure and low-pressure side. Slowly open the cylinder top valve. The cylinder pressure gauge on the regulator will indicate the cylinder pressure in bar. Fully open the needle valves on the shank. Adjust the working pressures to 0,3 bar on the regulators working pressure gauge by means of the regulators adjusting screw. Shut the needle valves on the shank. There will be a slight pressure increase on the regulators working pressure gauges when doing this.

Working pressure and gas consumption.

Material thickness, mm	0,2-0,5	0,5 – 1,0	1,0-2,0	2,0-3,0	2,0-4,0	3,5-5,0	4,0-6,0	5,0-7,0
Size no. AGA	0	1	2	2E	3	3E	4	4E
Welding attachment in litre/hour	40	80	160	230	315	400	500	650
Acetylene pressure in bar	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Oxygen pressure in bar	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Gas consumption Ox Gas consumption Ac In litre per hour	40 39	80 73	160 145	230 209	315 285	400 364	500 460	650 591

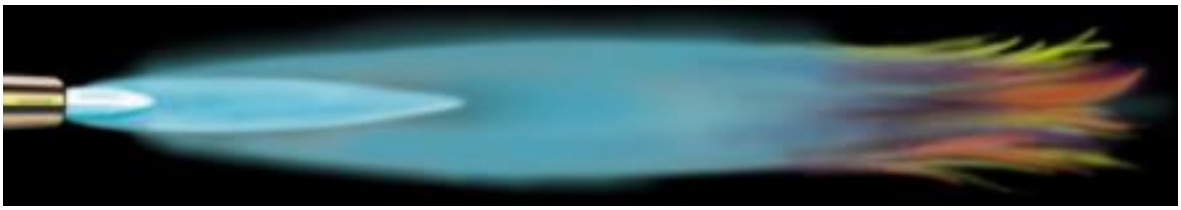
Working pressure might need to be increased if hoses are longer than 10m.



Note that the mixing chamber is part of the welding attachment. When changing from one welding attachment to another it is therefore important to re-adjust the working pressure in order to keep working pressure at 0,3bar.

There are also flexible welding attachments and large size heating attachments single flame and multiflame "rosebuds" available.

Adjust to the correct flame setting



Carburizing flame

The carburizing flame has an excess of acetylene, and is recognized by a secondary flame zone between the inner cone and the flame envelope. This zone is less bright and whiter in colour than the inner cone, but is considerably brighter than the flame envelope. This soft flame (also called a reducing flame) is used for welding of aluminium and aluminium alloys, and for soft soldering.

Neutral flame

Two distinct zones may be seen in the neutral flame. The inner core of the flame has a bright white-bluish light and extends only a short distance from the tip. Around this inner cone is the flame envelope which is darker and less intensely blue. This flame is metallurgically neutral, and is used for welding, heating and cutting of steel. There is also a transparent reducing zone in front of the white inner cone. It is difficult to distinguish but it is the main factor for welding steel without a fluxing agent.

Oxidizing flame

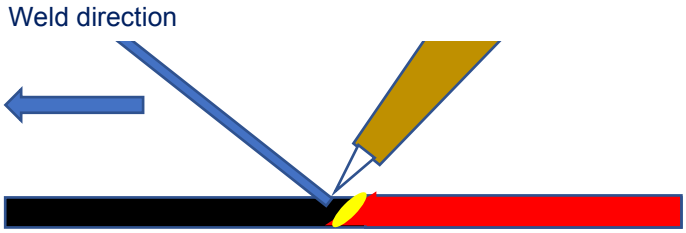
By increasing the oxygen flow slightly beyond the point where the secondary zone disappears one will obtain an oxidizing flame (with excess oxygen). The flame will be shorter and sharper than the neutral flame, with a shorter, more pointed inner cone. This flame is slightly hotter than the neutral flame, and is used for welding cast iron, brass, bronze and zinc alloys, and for some brazing alloys.

The correct welding technique.

We distinguish between two different welding techniques: Leftward welding and Rightward welding.

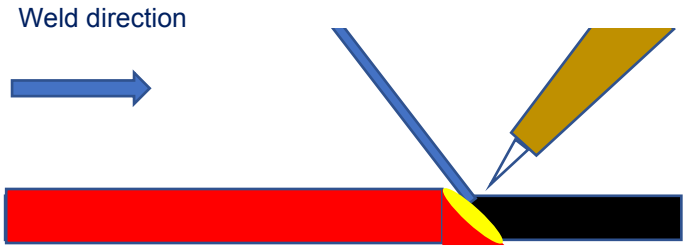
Leftward welding

For material thickness up to 3 mm (1/8 in) use Leftward welding.

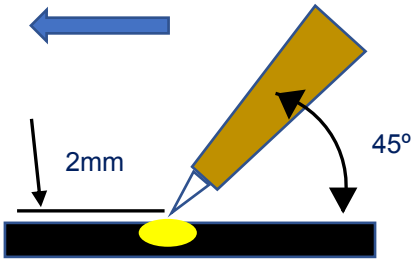


Rightward welding

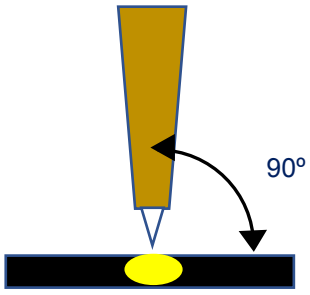
For material thickness above 3 mm (1/8 in) use Rightward welding.



The same welding technique is performed also in vertical up and in overhead position.



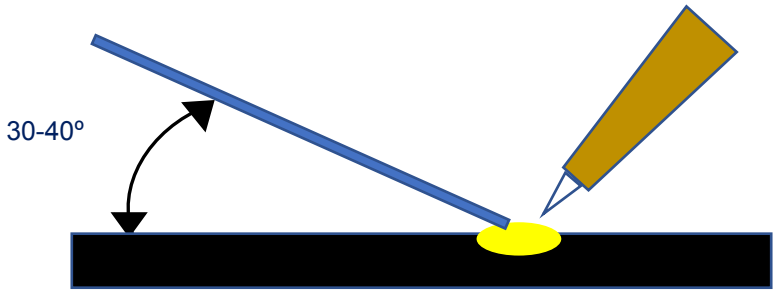
Welding necks direction of travel angle at approximately 45º



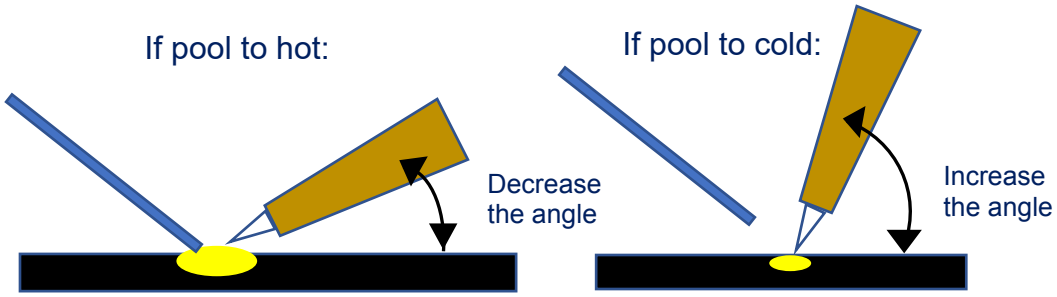
Welding necks side-angle 90º

The hottest spot in an oxy acetylene flame (3100º C) is approximately 2-3mm in front of the white inner cone. It is therefore important that the welding neck is kept so that the hottest spot is on the base materials surface.

The welding consumable in the form of a rod is feed into the welding pool in order to create a weld deposit. The welding rods angle should be approximately 30 to 40º and be manipulated in a way so that its contact point is in the molten pool and does not interfere with the welding attachment or the white inner cone.



In electric arc welding one can regulate the heat to the weld pool by adjusting the welding machines amperage. In gas welding one has to regulate the heat by adjusting the welding attachments angle and also by manipulating the welding rod. It requires therefore more skill to master gas welding compered to electric arc welding.



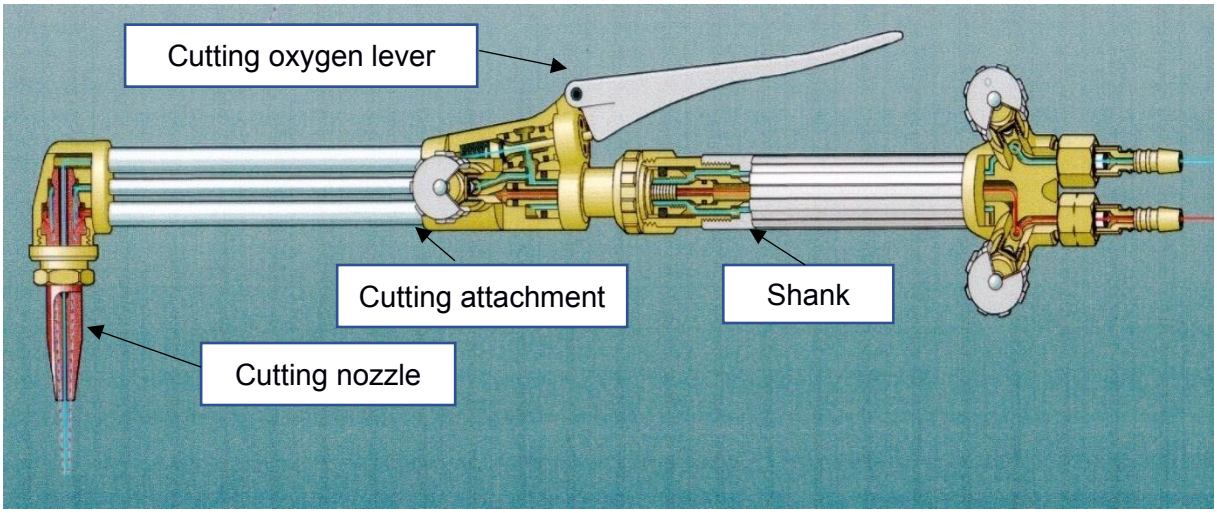
If the welder observe that the molten pool is getting to large, he will decrease the attachment angle in order to reflect the heat away from the pool. He might also increase the adding of the filler rod to the pool in order to “cool it down”. The most common mistake by welders are to withdraw the welding attachment when observing that the pool is getting to hot.

If the welder observe that the pool is getting to small, he will increase the attachment angle in order to have less heat reflected away from the pool. He might also add less filler rod to the pool.

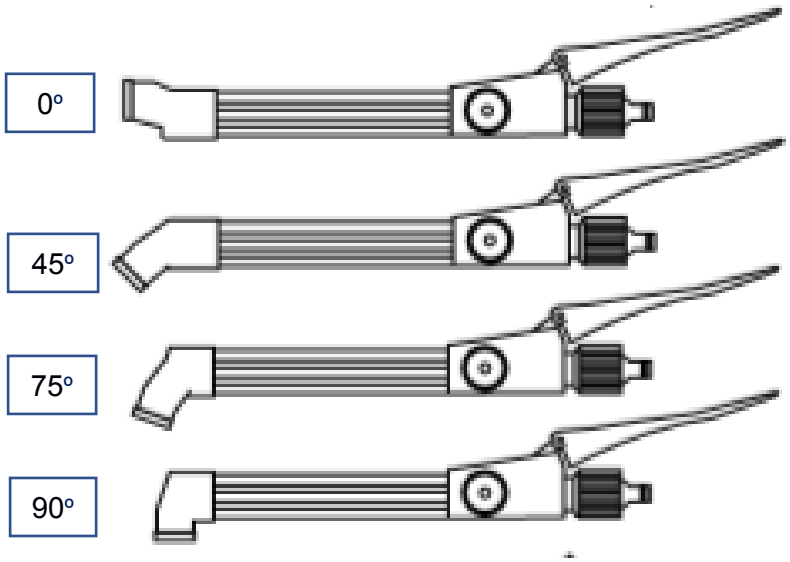
During gas welding the welder have to keep a close eye on the pool size and continually do the necessary adjustments to the welding attachment and the way he uses the welding rod.

Oxy- Acetylene Gas Cutting.

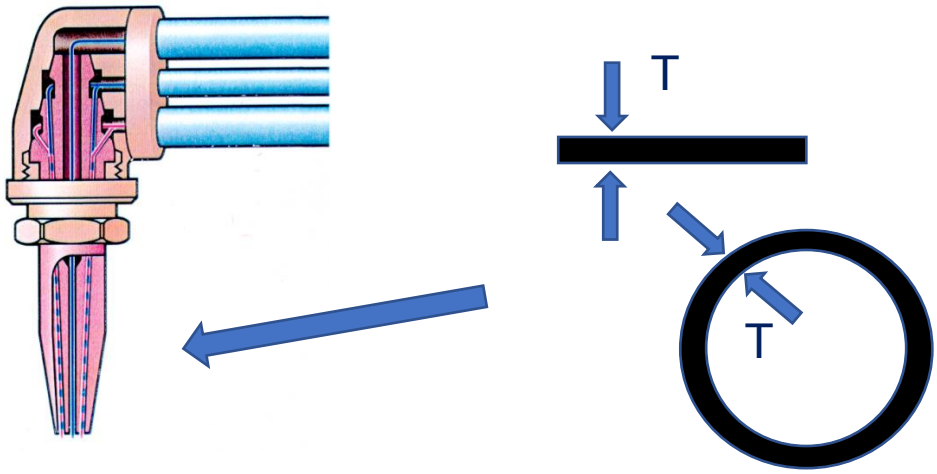
Selecting the correct cutting attachment, cutting nozzle and setting the correct working pressures.



Cutting attachments comes with different head angles. The 0º and 45º are suitable for gouging work. The 75º and 90º most suitable for general cutting.



What cutting nozzle to select depends on the material thickness



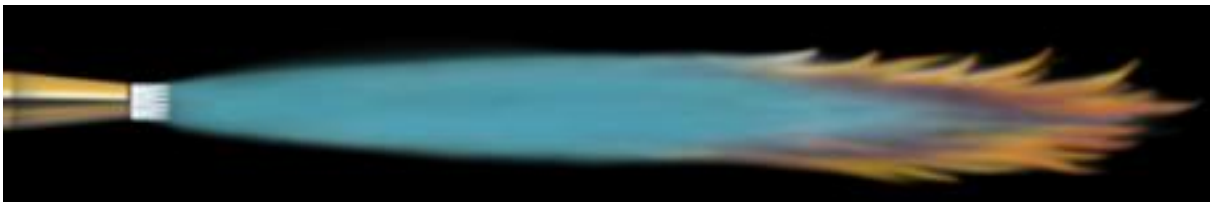
Cutting table

Material thickness, mm	1-3	3-10	10-25	25-50	50-100
Cutting nozzle AGA	HA 311-1	HA 311-2	HA 311-3	HA 311-4	HA 311-5
Distance base material	2	2	3	5	5
Acetylene pressure, bar	0,2	0, 2	0,2	0,2	0,3-0,5
Oxygen pressure, bar	0,5-2,5	1,0- 2,5	1,5-4,0	1,5-4,0	3,0-6,0
Gas consumption L/hour Ox	1300	1600	3600	6800	7800-14100
Gas consumption L/hour Ac	100	300	400	500	700
Cutting speed mm/min	Max.1000	950-430	580-350	500-300	380-180

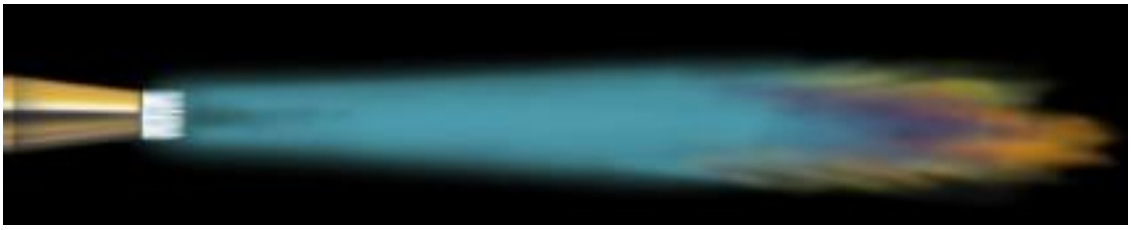
For a metal to be flame cut:

- The metals ignition point must come before its melting point. Steel melts at1535ºC but it ignites point is at 884ºC. If we preheat the steel to its ignition point and then introduce the cutting oxygen, we can ignite the steel (a rapid oxidation process takes place).
- The metals oxides must melt before the metal. Aluminium melts at 658ºC but its oxides melt at 2000ºC. Because of this, aluminium and a number of other metals cannot be cut by oxy acetylene.
- The heat from the combustion of the metal with oxygen must be sufficient to maintain the flame cutting. The thermal conductivity must also be low enough so that the material can be brought to ignition point. Copper and aluminium are good conductors so it will be difficult to reach their ignition point.
- The oxides formed in cutting must be fluid when molten so that not to interrupt the cutting operation. Cast iron have heavy oxides making it difficult to maintain a cut.

Adjust to the correct flame setting.



Carburizing flame



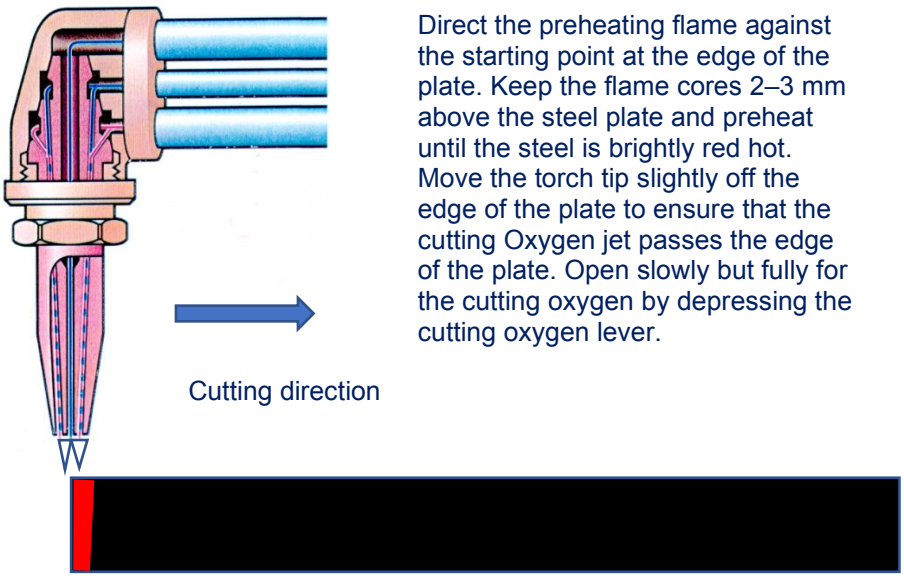
Neutral flame

Neutral flame when cutting oxygen handle is depressed

Oxidising flame

For cutting and gouging regulate to a neutral flame

The correct cutting technique.

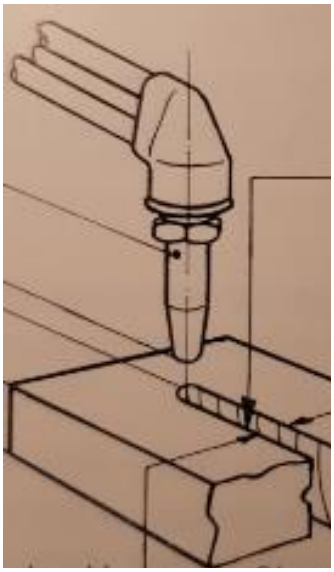


Direct the preheating flame against the starting point at the edge of the plate. Keep the flame cores 2–3 mm above the steel plate and preheat until the steel is brightly red hot. Move the torch tip slightly off the edge of the plate to ensure that the cutting Oxygen jet passes the edge of the plate. Open slowly but fully for the cutting oxygen by depressing the cutting oxygen lever.

Keep the nozzle at the distance from the plate indicated in the cutting table (2 –5 mm) and move the nozzle onto the plate. Guide the torch steadily along the line to be cut. Use a cutting speed within the limits given in the cutting table and ensure that the slag blows through completely resulting in a steady stream of sparks downwards from the bottom of the cut.

Correct cutting nozzle
Depending on base materials thickness

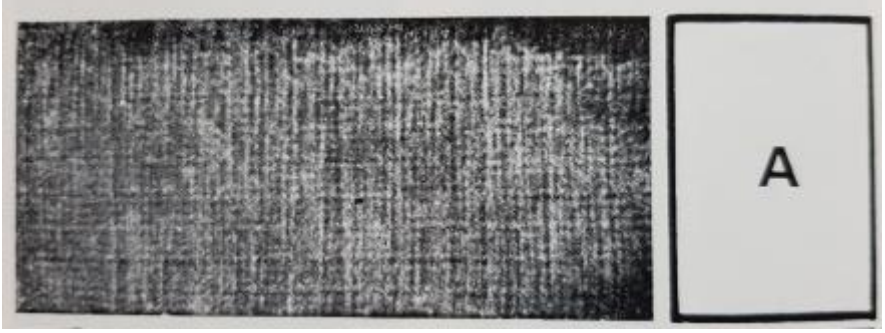
Distance to base material



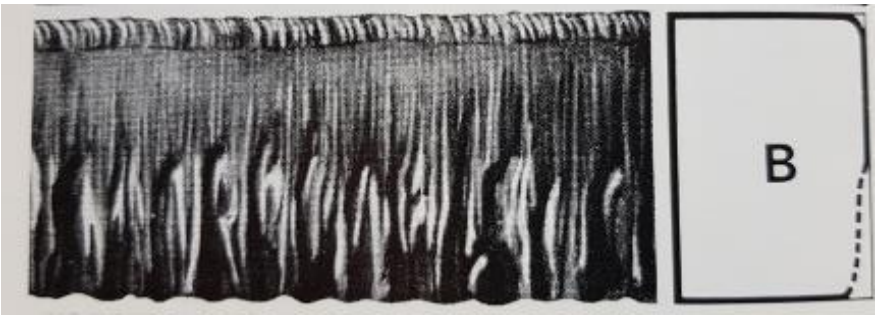
Line to be cut

Cut width

Correct cut and the most common cutting faults.

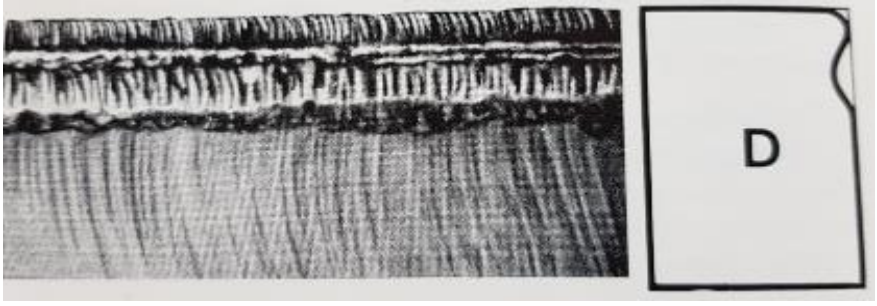


A. Correct cut shall give square corners and a smooth cut surface without pronounced cut gouges.

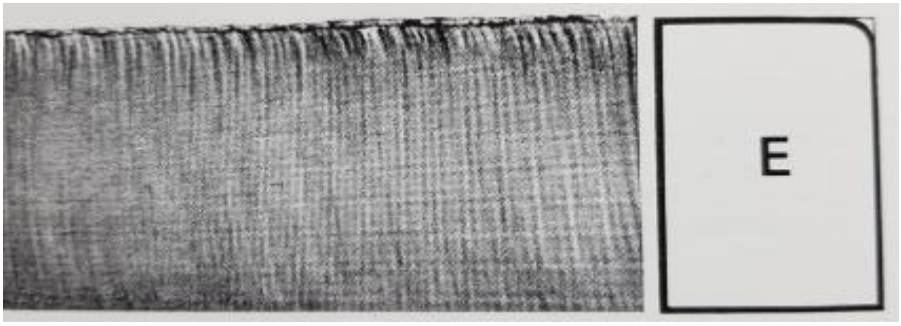


B. Too low cutting speed or too low cutting oxygen pressure will give a rounded top edge and uneven surface with gouges in the lower part of the cut.

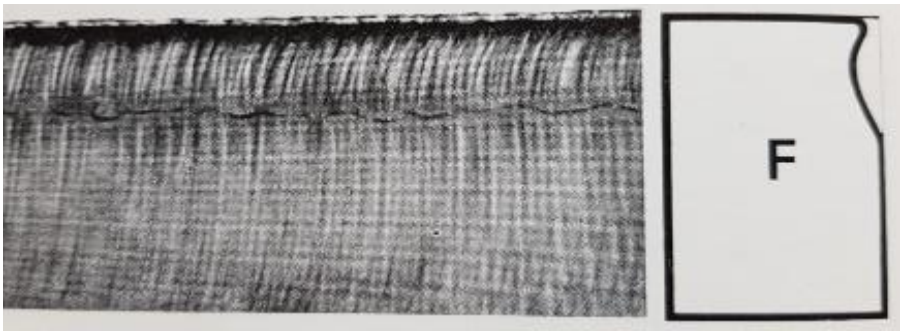
C. Too high cutting speed will give an uneven top edge, pronounced drag lines in the surface and a rounded lower edge.



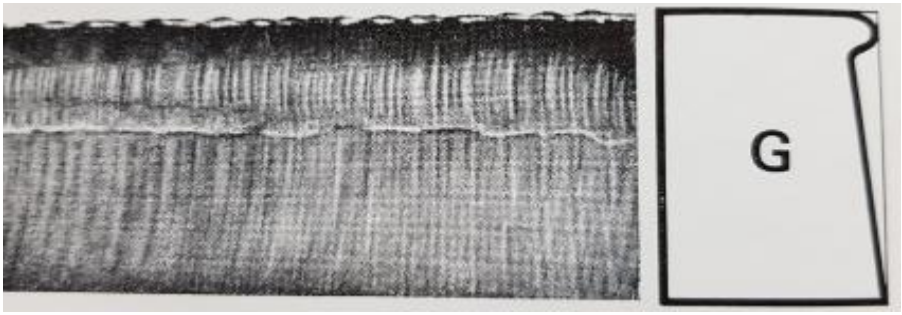
D. Too long distance between nozzle and plate will give a melted and rounded top edge and cutback in upper part of the surface. Lower part will be smooth and bottom edge sharp.



E. Too short distance between nozzle and plate will give melted, rounded top edge, surface and the bottom edge will be acceptable, or in some cases with pronounced drag lines.



F. Too high oxygen cutting pressure or contaminated cutting oxygen hole in the nozzle will give slightly rounded upper edge and pronounced cutback in upper part of the surface.



G. Too strong preheating flame will give a melted and rounded upper edge and pronounced cutback down through the surface, contaminated with slag and melted steel.

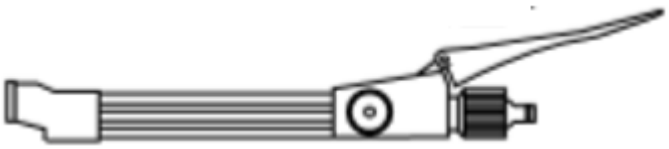
Oxy-Acetylene Gas Gouging.

Selecting the correct attachment, gouging nozzle and setting the correct working pressures.

Gouging will normally be best performed using the 0º and 45º cutting attachment

Gouging nozzle

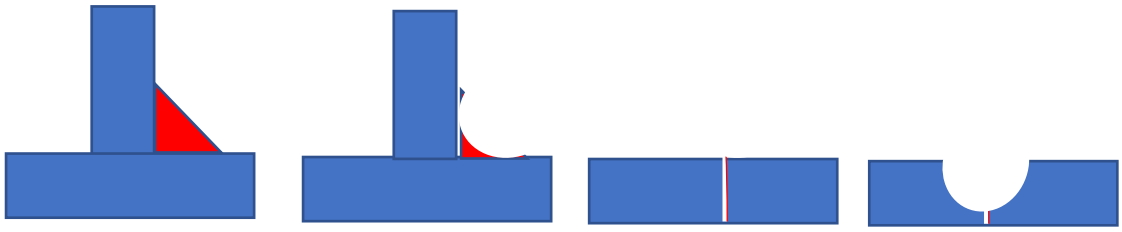
0º cutting attachment



Gouging table

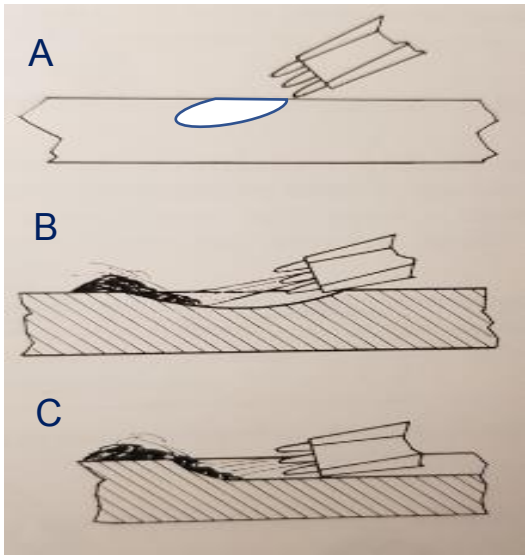
Gouging nozzle AGA	A 351 B-8	A 351 B-10	A 351 B-12
Groove Width mm	6-8	8-111	11-13
Groove Depth mm	3-6	6-11	10-13
Acetylene pressure bar	0,2-0,5	0,2-0,5	0,2-0,5
Oxygen pressure bar	5,0	6,0	7,0
Gas consumption L/hour Ox	5300	10800	19700
Gas consumption L/hour Ac	900	1800	2200
Gouging speed mm/min	600	1000	1200

Gouging is primarily used for removing old welds or for opening cracks before welding.



Old weld …removed by gouging A crack …gouged out

The correct gouging technique.

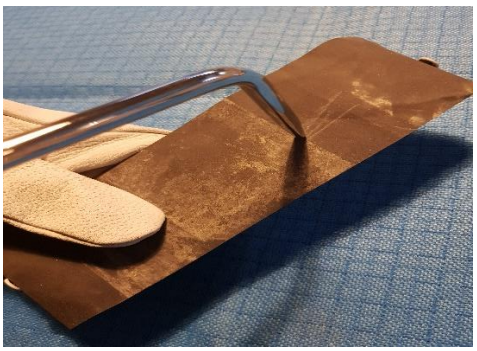


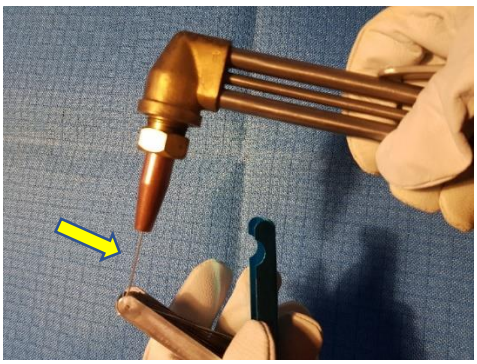
A. The start location is heated to white hot. Nozzle angle to be 30 to 40º to the base materials surface.

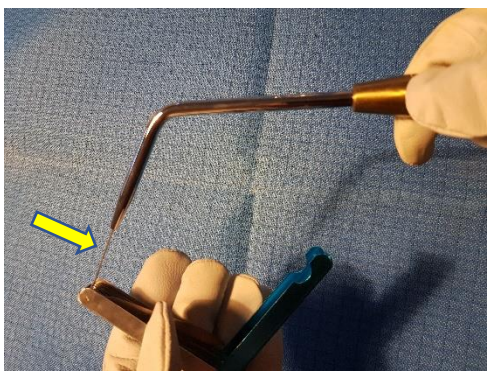
B. Open slowly for cutting oxygen. When the gouging process starts the nozzle angle should be reduced to 5 to 10º.

C. The nozzle should be rested lightly in the groove and moved with an even gouging speed and with an angle of 5 to 10º. Distance between the nozzle orifice to the molten pool should be 6 to 12mm.

Maintenance of equipment.







Grinding welding attachments and cutting nozzles end.

If the end of a welding attachment or cutting nozzle has been damaged, it can be repaired, by grinding the surface against fine emery paper placed on a flat surface.

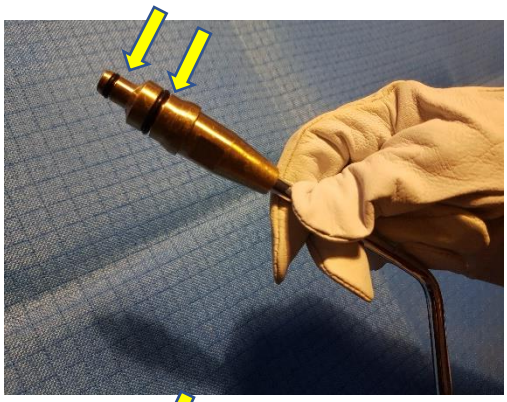
The correct flame and an even flow of cutting oxygen can be obtained only by keeping the edges of the holes sharp and at right angles to the axis of the passages. A nozzle hole with an uneven edge or widened orifice will also increase the risk of backfire.

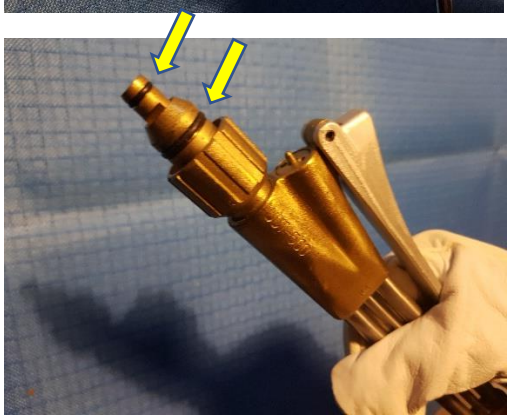
Most welding attachments are so made that the length of the attachment holes can be shortened by grinding off up to 3 times the hole diameter without the flame becoming smaller than that of a new attachment. Thus, a cylindrical part will always be left having a length at least equal to the diameter of the hole. It ought not to be shorter than this, to avoid backfire (popping).

On cutting nozzles up to approximately 4mm of material may be removed.

Clean the holes in welding attachment and cutting nozzles with cleaning needles. These should run freely in the holes. Do not twist them, just stick them straight in and pull them out. Never use steel wire, reamers or spiral drills for cleaning. These can ruin the smooth surfaces of the hole. It is very important that the small holes in the sealing end of the cutting nozzles should not be enlarged in any way.

Welding attachments and cutting nozzles may be carefully cleaned externally by means of a soft brass brush. Do not use a steel brush.





There are two types of O-rings on welding attachments and cutting attachments. O-ring small and O-ring large.

Make sure to inspect the state of the O-rings and change them if not in a good state.

They are normally available in packets of 10 pcs of either size or as kits with 2 small and 2 large.

Also inspect all seals and seating surfaces before assembling the equipment. Check at regular intervals for damage, deformation or wear. Replace them if they are defective.

To facilitate changes of welding attachment or cutting nozzles, the sealing rings and sealing surfaces in the cutting attachment connection head should be lightly smeared with a special lubricant.

Oil or grease must never be used.

Many compressed gases like oxygen are oxidising and can ignite spontaneously, without an ignition source, when in contact with oil and grease. Therefore, lubricants, that are used in oxygen and gas fittings, have to meet demanding requirements. They should be approved by BAM (German Federal Institute for Materials Research and Testing). They are referred to as synthetic and feature extraordinary temperature stability and good sealing properties. The lubricants have oxidation stability, are inert and non-inflammable.

Injector and equal pressure torches.

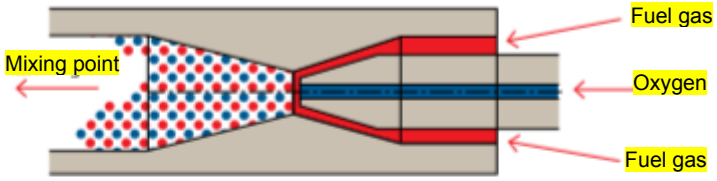
Background:

Two general types of welding torches are used:

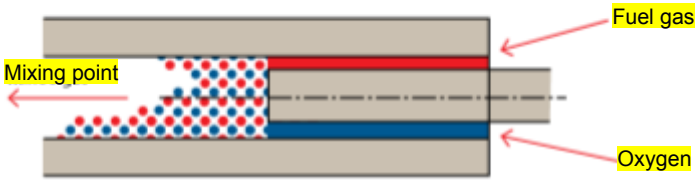
- Injector torches (low pressure torches)
- Equal pressure (balanced-pressure torches)

The injector torch is also known as low-pressure torch. The fuel-gas pressure is 0.07 bar (1 psi - pound per square inch) or less. The oxygen pressure ranges between 0.7 to 2.8 bar (10 to 40 psi), depending on the size of the torch tip. A jet of relatively high-pressure oxygen produces the suction necessary to draw the fuel gas into the mixing head. The welding tips may or may not have separate injectors in the tip.

Injector torch



Equal pressure torch



The expression fuel gas imply acetylene, propylene, propane, natural gas, and modified propane (such as MAPP).

Equal-pressure torches are often called balanced-pressure torches because the fuel gas and the oxygen pressure are kept equal. Operating pressures vary, depending on the type of tip used.

The X-21 is an equal pressure torch.

Most industrial oxy fuel torches are of equal pressure design (Victor, Smith, Purox, Harris, Drew Marine, Unitor etc.). The big advantage of the equal pressure torches is that you have total control of the acetylene/ oxygen ratio. This is important when you want to have a very carburizing or oxidizing flame. Because of the design of the mixing chamber, the equal pressure torches have a significantly higher flow rating. This is important when running large "rosebuds" heating attachments This style mixer works well with acetylene, propylene, propane, natural gas, and modified propane's (such as MAPP). The equal pressure torch is safer than the injector torch, since equal gas pressures are used; you are less likely to get a flashback.

The advantages of the injector torches are:

You do not have to adjust the fuel gas pressures, only the oxygen. You only need a small amount of pressure in the fuel gas. This is important if you are using natural gas. The injector torch will actually suck open the fuel gas regulator diaphragm even when the adjusting screw is backed way out (closed) and the gauges will show zero pressure and yet you have a flame.

The disadvantages of the injector torches are:

Not optimized for acetylene. Cannot run the very large heating attachments and does not run very well when you feed the injector mixer with high fuel gas pressures.

Bottom line is:

If you use acetylene as fuel gas, use an equal pressure torch.
If the job at hand require use of large size heating attachments ("rosebuds") or cutting nozzles, stick to equal pressure torches.