

BASIC Gas Welding



Outcomes

1. Learn the basics of Gas Welding
 1. Hoses
 2. Regulators
 3. Cylinder storage
 4. Turning on the Acetylene and Oxygen Cylinders
 5. Setting the regulators
 6. Cutting (oxy/acetylene and plasma)
 7. Simple bead on flat
 8. Outside Corner Joint
 9. Butt or Tee Joint with Filler Rod

We will cover

- **Safety Equipment**
- **Gas Welding**
 - Cylinders, Valves, hoses, torches, filler rod
- **Oxy/Acetylene cutting**
 - Torch, gas pressures, technique
- **Plasma cutting**

Notice

Protect your own safety.

You are responsible for verifying all information related to safety and protection measures.

You are responsible for damage to equipment and facilities.

(I believe that I am giving you accurate information but, *don't take my word for it. Independently verify for yourself.*)

Welding

Fusion of 2 (or more) pieces of metal by melting and joining.

(Plastic is also welded – but will not be discussed as part of this Workshop.)

Welding

Uses Heat

Created by:

Combustion (gas welding, forge welding)

Electric resistance arc (arc welding)

Friction

Induction

(and, Electron Beam, Laser, Plasma)

Welding

What is a good weld.

A good weld starts with clean well aligned material

Smooth, non porous, as strong as or stronger than the metals being joined.

Full penetration (melted joint is all the way through the material)

Full fusion (materials are melted together, weld is not laying on top of the joined materials)

No 'inclusions' – non-metallic stuff, carbon, slag, or other foreign materials in the weld.

Rusty metal makes lots of sparks and poor welds – rust gets combined in the weld. Rust is not strong.

Safety gear

Protection from heat and radiation.

And, Keep a Fire Extinguisher handy and know where additional extinguishers are located.

Protective Gear

Clothing, cotton (man made fabrics, polyester, rayon, nylon, melt and stick to you)

Gloves (stuff is hot)

Long sleeves

Long pants

Shoes

Goggles / helmet

Head cover or Do Rag

Special welding garments

Fume Extraction

Extract the fumes or provide lots of ventilation.

Fume extractors

Fans

The great outdoors

Welding Space

Flamable objects (wood shavings, rags, fluids) in the welding shop area are subject to having hot metal set them on fire.

Typically your vision may be somewhat blocked by goggles or a hood, you may not be aware of a fire.

Galvanize/Platings

Don't weld Galvanized or Zinc plated metal. The fumes are very dangerous (Zinc Flu).

Cadmium and other platings are dangerous as well

Pot Metal (is a Zinc alloy) There are some special rods (Muggy Weld) that is more like brazing (not getting up to the temperature where Zinc fumes become hazardous)

Protecting Others

Gas welding – flying sparks

Gas cutting – Lots of flying sparks

Let people around you know what is going on. Let folks know you are lighting a torch. Give them a chance to move to a safe area. (Tell them to move if they don't take the hint.)

Inspection

Check the equipment for problems before you start.

General inspection

Torch, valves work, connections tight

Hoses, no cracks, general condition

Gas cylinders, damage, upright, constrained

Regulators, connections tight

Hood or goggles, lenses clean and in good shape,
adjusted for your head

Striker, works

Get Comfortable

- Set up the work at a convenient height
- Make it easy to move along the weld seam
- If possible, be seated
- Have a place to brace your arms/hands

Welding uses lots of small moves and fine motor control

Arrange the hoses so they are not pulling on the torch or uncomfortable.

Place welding on a suitable surface. Fire bricks are good. A welding table (avoid welding to the table).
Concrete is not a good welding surface (H₂O expands).

Make a dry run – move the torch along the weld path to be sure nothing binds up and that you have good access to the joint.

Oxy/Acetylene

EYE PROTECTION

APPLICATION	BASE METAL THICKNESS	LENS SHADE
Oxygen/Acetylene Welding	Up to 1/8"	3-4
Oxygen/Acetylene Welding	1/8" to 1/2"	4-5
Oxygen/Acetylene Welding	1/2" and over	5-6
Oxygen/Acetylene Cutting	Up to 1"	4-5
Oxygen/Acetylene Cutting	1" to 6"	5-6
Oxygen/Acetylene Cutting	6" and over	6-8

Combustion

Uses heat of combustion, typically Acetylene and Oxygen. (Can use other gasses, propane, natural gas, hydrogen)

Oxy/Acetylene Flame is 6,396° F

(Butane lighter ~ 3,000° F)

(Propane torch ~3,200° F)

(MAAP (methylacetylene and propadiene) ~3,700° F)

Cylinders

Keep upright (If laid down allow 30 minutes upright before using)

Cylinder cap when not in use

Oxygen and Acetylene Cylinders

O₂ 2,400 psi

Acetylene 250 psi

Secure tanks with chain.

Regulators

Remove protective cap

Visually Inspect

Look for any contamination on or in the gas outlets of both the bottle and regulator

Gauges should be up at slight angle.

Be sure regulator valve is all the way open

Don't stand in front of regulators when opening valve.

These are all dry connections. (No oil, grease, pipe dope, Teflon tape, etc.)

Regulators

O₂, no oil or grease (instant fire)

Gauge reads tank pressure

Reg reads pressure to hose

Use 8-20 for welding

20-30 for cutting

Use two hands to open valve to avoid shocking gauge

Open a few turns

Acetylene

Open ¼ turn

Use 5 lbs regulator pressure

Never use 15 or more – acetylene explosive

Wait, didn't you just tell me the cylinder is at 250 psi?

Yes, but, the cylinder is full of acetone and acetylene is dissolved in that

That's why only ¼ turn – helps to keep acetone from being drawn out of the bottle.

Gas Pressures

Oxygen & Acetylene Gas Pressures

WELDING

METAL THICKNESS	ROD DIAMETER	TIP (Drill Size)	PRESSURES (PSI)	
			OXYGEN	ACETYLENE
1/16"	1/16-3/32"	56	8 - 20	5
1/8"	3/32-1/8"	53	11 - 25	5
1/4"	5/32-3/16"	48	12 - 23	5

CUTTING

METAL THICKNESS	ORIFICE (Drill Size)		PRESSURE (PSI)	
	PREHEAT	CUTTING	OXYGEN	ACETYLENE
1/8 - 3/8"	70	67	20 - 30	3
3/8 - 3/4"	62	58	30 - 40	5
3/4 - 1"	57	54	40 - 45	5
1 1/2 - 2"	54	51	45 - 50	5

Torch Body

Red is Acetylene

Green is Oxygen

Torch tips

Finger tight only
Bigger tip – bigger fire, more heat

(Victor Torch Sizes)

Metal Thickness --Tip Size

1/4 - 1/2 ----- 5

3/16 - 1/4 ----- 4

1/8 - 3/16 ----- 3

1/16 - 1/8 ----- 2

5/64 - 3/32 ----- 1

3/64 - 5/64 ----- 0 (The zero tip is called an "aught")

1/32 - 3/64 ----- 00 ("double aught")

1/64 - 1/32 ----- 000 ("triple aught")

Striking Torch

Always use a striker (flint on steel)

ONE Gas at a time

Acetylene first

- 1/8 turn of torch valve
- Use Striker
- will be smoky
- rooted, or attached to end of torch
- adjust for about 1 inch of straight flame

O2

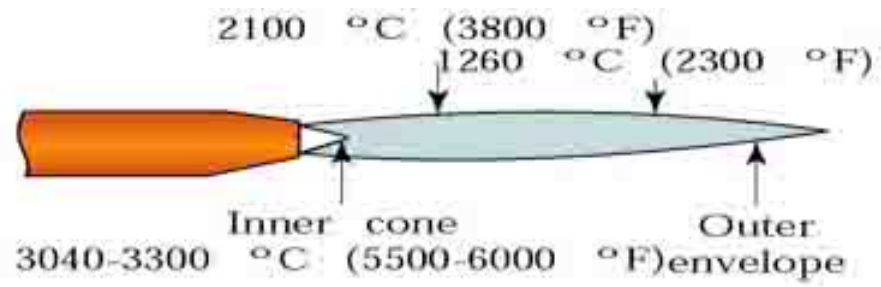
- crack valve slowly
- bring down to neutral flame (blue cone – neutral flame)

- Carburizing/reducing flame, dual cone for some brazing, less oxygen
- Oxidizing flame, more oxygen, hiss or roar, lots of sparks, rarely used

Striking Torch

A high pitch whistle indicates a burn back (gasses are combusting inside the torch – Shut down and restrike

Neutral Flame



Reducing Flame

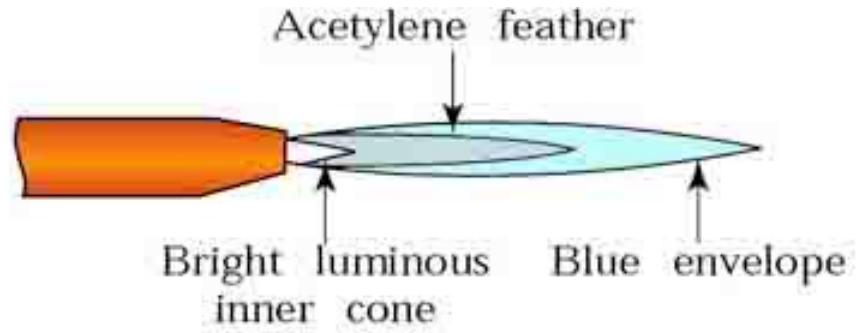


Figure 2: Carburizing Flame

Oxidizing Flame

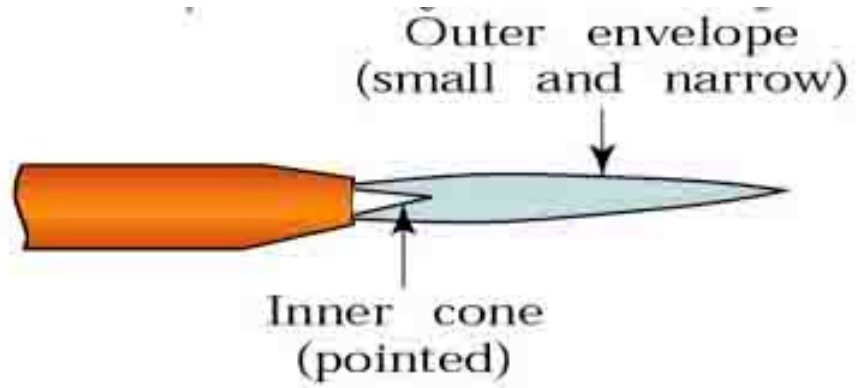


Figure3: Oxidizing Flame

Turning off

Torch
O2 First
Then Acetylene

Close cylinder valves

Bleed pressure from lines *One at a time*
Open regulators (valves counter-clockwise)

Types of Joints

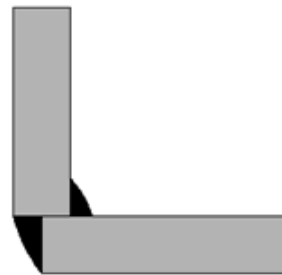
Types of Welding Joints



Butt Joint



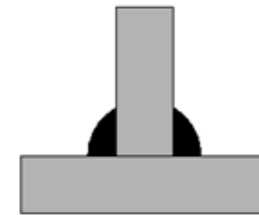
Lap Joint



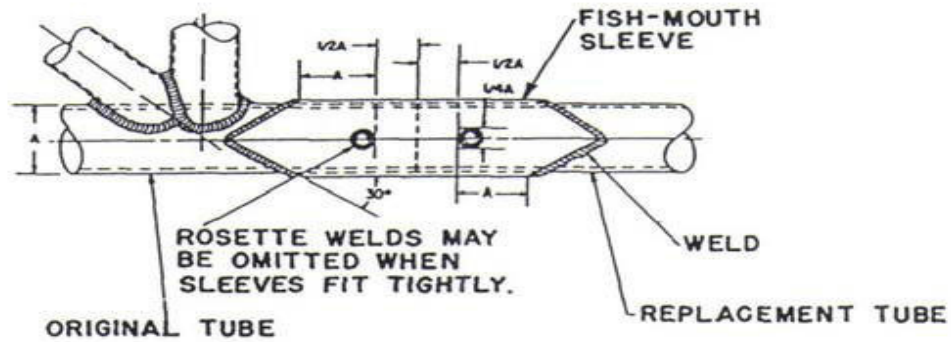
Corner Joint



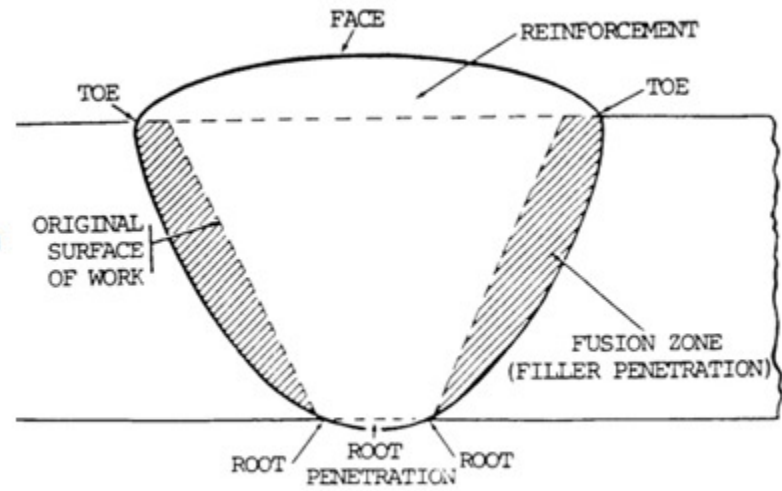
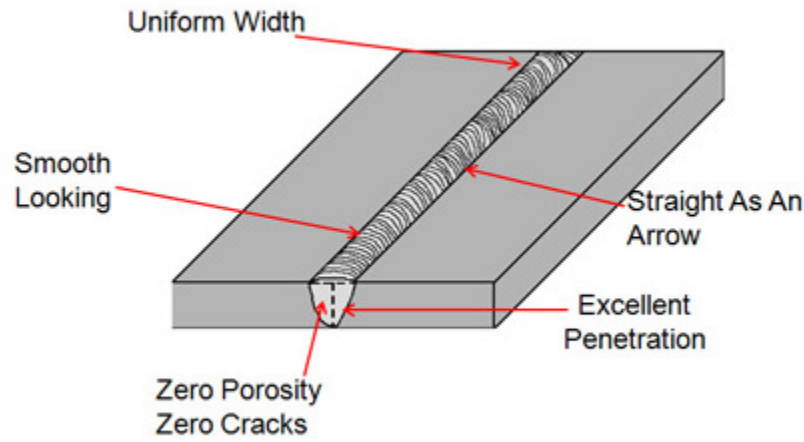
Edge Joint



Tee Joint

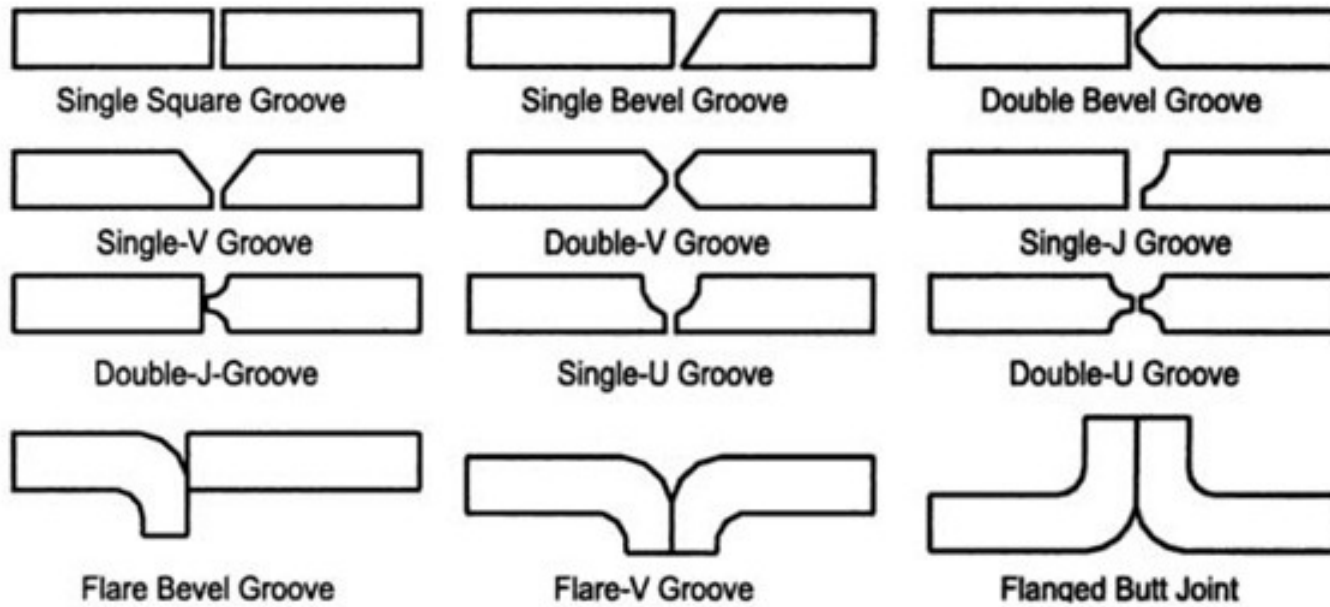


Good Welds



Weld Preparation

Butt Joints - Edge Preparation & Weld Type



Filler Rod

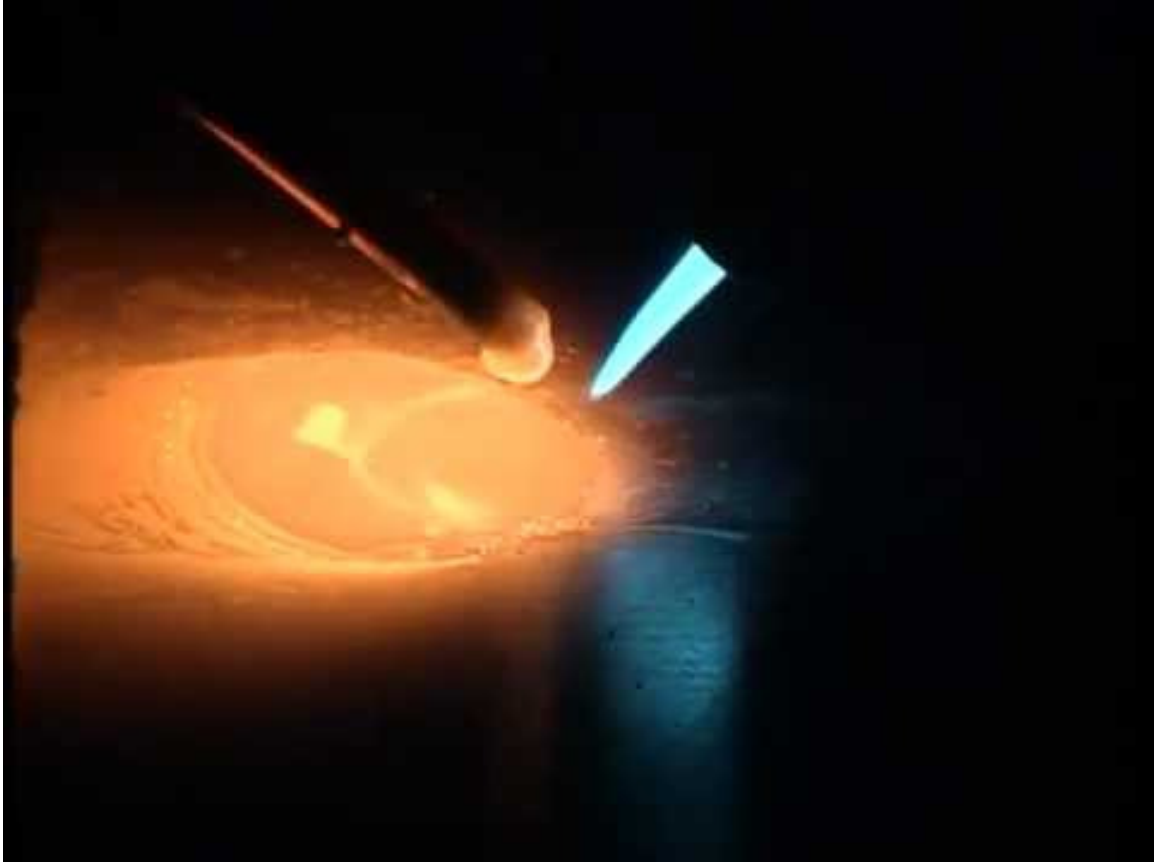
Carbon steel welding rods have a copper coating to prevent rusting and oxide build-up. The AWS classification for these products is pretty straightforward. Most welders use RG-45 or RG-60 rods. Here's what the designation means:

RG - Rod Gas

45 - tensile strength times 10,000 = 45,000 PSI

RG-65 is a less commonly used, low-alloy rod designed for high speed fusion welding of pressure vessels, tanks and piping.

The Puddle



Filler Rod

Dip the filler rod into the front edge of the puddle so a little of the rod melts off into the puddle

Too much filler rod will cool the puddle – it may harden

If the filler rod gets stuck in the puddle, just heat until the puddle reforms and remove the rod from the molten metal.

Move the flame closer to the metal for more heat and a bigger puddle. Move flame away to cool the puddle.

Feeding the Rod

Feeding the Filler Rod

You will need to work out a method for using one hand to feed the filler rod

1. Just hold it
2. Traditional
3. Index
4. Kane

(vid)

Cutting Torch

Used to cut metal (not for thin sheet metal)

Uses an oxygen jet to oxidize (burn off) metal
Heat of the burning metal keeps the cut going

Makes lots of molten metal slag

Red is Acetylene

Green is Oxygen

3rd knob on torch is for O₂ heater flame adjustment.

Lever turns on O₂ jet

Use the heater flame to get a thinner part of the metal hot and then start the cut

(vid)

Rosebud

Used for heating metal

Usually as preheat for welding

Or

To get metal hot in advance of bending, forming, forging.

Plasma Cutting

So much nicer than Oxy/Acetylene

Is an ARC process

Uses 'DRY' air and and electric arc to make a VERY hot plasma stream. **45,000°F**

Has a very thin 'kerf'

Very little slag and easily removed

Typically start cuts at an edge, but can pierce (there's a technique)

Still makes lots of sparks.

Ground is very important –

(vid)

Tacking

Tacking is making small welds around the piece to hold the pieces in position while the welding is done.

You are using lots of heat and metal expands quite a bit when heated.

The 'tack' welds hold everything in alignment and helps prevent warping.

Coupons

As well as cutting metal with both an oxy/acetylene torch and a plasma torch, we will make 3 welding 'coupons' (these are just sample test welds).

Cutting your material

Cut a 5-6 inch (or so) piece from the end of your material using the oxy/acetylene torch

Cut 4 more 5-6 inch (or so) pieces using a plasma torch

Running your first bead

No filler rod

Not joining 2 pieces

Just getting used to seeing the puddle and moving it along the material.

Place your first material piece on a firebrick and run a bead down the middle of the piece from one end to the other.

Practice where and how you will move the torch with the torch off.

Strike the torch and make your first weld.

Running your first bead



Running your first bead

Look for consistent width and height

Try to go in a straight line

Just get used to the equipment

Adjust your welding position as needed

Your first Joint

Use 2 pieces of metal and a couple of magnets to make a piece of angle

2 pieces together, one slightly overlapping the other

'Tack' (melt it together a little at each end – this will hold the pieces together as you weld.)

Weld the joint by just melting the metal and moving the puddle along the joint.

(vid weld 1)

Third Coupon

Your choice

A Butt Joint (easier)

A Tee Joint (a little more challenging)

Position material, tack, and weld.

Use filler rod to add additional material to the weld puddle.

(vid weld 2)

Tips

Puddle too hot

 Metal drips through – holes form

Too cold

 Weld material just laying on top, no fusion.

When welding a thick piece to a thin piece, concentrate the heat more on the thick piece.

To fill a hole, work from the edge in, jump around, don't try to fill the hole all at once from one side.

If you stick the torch into the puddle it will pop.

Listen to the sound of the torch (knobs can get bumped)

Please ask Questions

If you are not sure – Ask

Stewards are here to help you make better welds
(but not to do the welding for you)

There are special techniques and materials for
special circumstances.

There's a lot more to learn.

Biggest problems

Gas welding – not enough / too much heat
Incorrectly adjusted flame

Dirty materials

Cooling the puddle with too much filler rod

Welding your work to the welding table

Bumping the Oxygen or Acetylene valves on the torch.

Picking up *hot* parts

Be Safe

Be Safe.

Be Careful.

Equipment



Victor (a manufacture of gas torches) has kindly loaned us some equipment for this workshop.

They make world class equipment that is really wonderful to use.

If you are considering purchasing a torch, I can highly recommend them.