

BASIC TIG Welding



Outcomes

1. Talk about the basics of TIG Welding
 1. Hoses
 2. Flow Regulators
 3. Cylinder storage
 4. Turning on the Shielding Gas
 5. Setting gas flow
 6. Tungsten electrodes
 7. Machine settings
 8. Simple bead on flat
 9. Outside Corner Joint
 10. Butt Joint with Filler Rod
 11. Same welds on Aluminum

Workshop

This is a *Basic* TIG Welding Workshop.

It is not intended to be a complete learning experience

Welding is a huge body of information that can take a lifetime to master. We are going to talk about some basic welding materials and processes and make some sample coupons for you to take with you. This workshop is meant to only scratch the surface of a complex and highly technical field of study. Competency will require much additional reading and practice.

We will cover

- **Safety Equipment**
- **TIG Welding**
 - Cylinders,
 - Valves,
 - Hoses,
 - Torches,
 - Tungstens
 - Filler rod

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.)

GTAW TIG

Uses a tungsten electrode in a holder that supplies a gas lens (shielding gas).

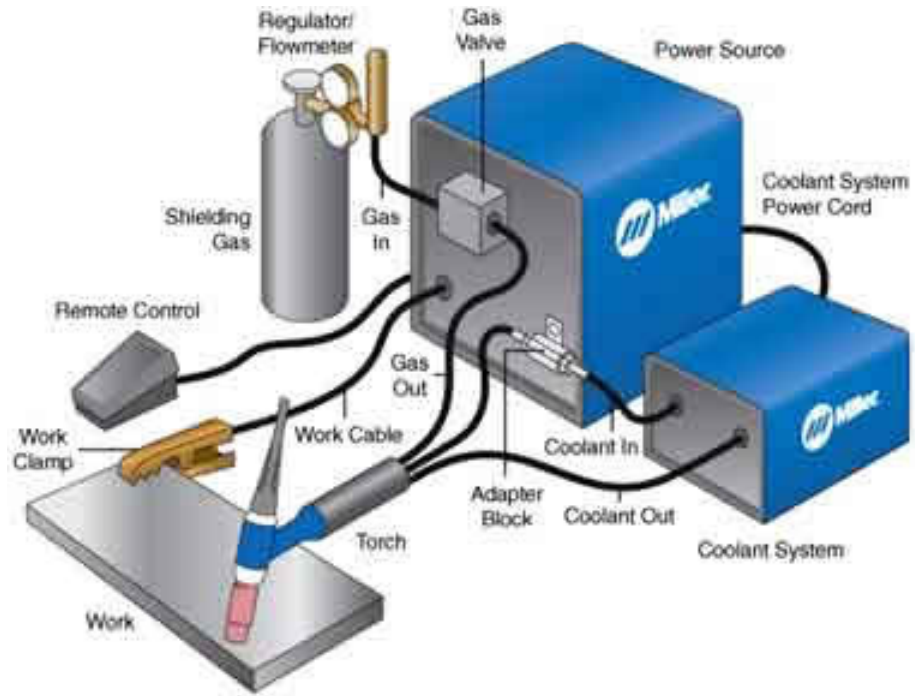
Draws an electric arc

Arc is controllable with a foot pedal

Much like torch welding except using an arc as the heat source.

Usually need a filler rod

GTAW TIG



Welding

What is a good weld.

A good weld starts with clean well aligned material

TIG Welding is especially sensitive to dirty Materials

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.

Welding

TIG welding can produce a Strong, Clean, and Beautiful weld.

TIG can weld low carbon through high carbon (tool) steels.

DC Welding:

TIG can weld exotic materials. Titanium, Chromoly, Cast Iron, Stainless steel, Gold, Silver, Nickel, Inconel, Brass, Bronze, Copper alloys, and many others. (And some combinations of these.)

AC Welding:

Aluminum, Magnesium (but don't weld Magnesium – too dangerous)

TIG welding does not create 'proud' welds like MIG welding.

TIG can also weld Lead and pure Zinc – but don't.

Also be careful with Brass (can contain Zinc or Lead)

Brazing

A TIG torch can be used to Braze

More like soldering.

Uses special fillers that wet to the metals

Can be used to join different metals

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, and you need shielding from UV)

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 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

Magnesium will catch fire and is almost impossible to put out. Don't try to weld it. (Containment chamber needed.)

NOTE: Some aluminum alloys are NOT weldable (7075 and the 70xx series)

UV

Arc welding produces a lot of UV (Ultra-Violet Rays)
Same ones that give you sunburn

Except

It will be the worst sunburn you ever had and it will
happen very quickly (single digit minutes)

Sunburned eyes are no fun at all and can cause
blindness.

For TIG welding, use a welding hood (full face
coverage).

Protecting Others

TIG welding – very bright arc light, flying sparks

Let people around you know what is going on. Let folks know you are striking an arc. Give them a chance to move to a safe area and shield their eyes. Just shielding their eyes if they are close is not enough – UV will sunburn them. (Tell them to move if they don't take the hint.)

Pets. A cat or dog (and probably other pets) will stare at the arc until they go blind. Protect their vision. Move them out of sight of the welding operation.

Eye Protection

Operation	Electrode	Current	Minimum
Shielded metal arc welding = Stick = SMAW	Less than 3	Less than 60	7
	3 - 5	60-160	8
	5 - 8	160-250	10
	More than 8	250-550	11
Gas metal arc welding and flux cored arc welding = GMAW - MIG		Less than 60	7
		60-160	10
		160-250	10
		250-500	10
Gas tungsten arc welding = GTAW = TIG		Less than 50	8
		50-150	8
		150-500	10
Plasma arc cutting	(Light)**	Less than 300	8
	(Medium)**	300-400	9
	(Heavy)**	400-800	10
Torch brazing			3
Torch soldering			2

Protecting Others

Let people around you know what is going on. Let folks know you are striking an arc. 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

Hoses, no cracks, general condition

Gas cylinder, no damage, upright, constrained

Flow Regulators, connections tight

Hood or goggles, lenses clean and in good shape,

adjusted for you and your head

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.

Arc

Oxy/Acetylene Flame is 6,396° F

TIG Arc is about 3 times that or about 21,000 ° F

About the temperature of a Plasma cutter

Cylinders

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

Cylinder cap when not in use

We use pure Argon with our TIG welders

2,200 PSI when full

Secure tanks with chain.

Regulators

TIG uses a Flow Regulator

Flow is measured in CFH, Cubic Feet per Hour

To mount the Regulator:

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



Regulators

No oil, grease, tape, pipe dope, or any other kind of sealer on threads
Dry connection only.

Gauge reads tank pressure
Second Gauge (if fitted) reads Flow in CFH or,
Position of ball in tube shows flow in CFH
Use two hands to open valve to avoid shocking gauge
Open a few turns

Use between 15 and 25 CFH
Less – poor shielding
More – wastes expensive gas

Keep the gas nozzle over the weld for 10 or so seconds 'after' you stop welding. The shielding gas will help protect the weld from oxidization.

Torch Body



TIG Gun (Torch) Consumables

GTAW Steel vs Aluminum

Steel (and many other metals)
DC polarity

Aluminum
AC polarity
Argon shielding gas

Tungsten Electrodes

GTAW – TIG welding The 'T' is for Tungsten

Pure tungsten does not work really well

Doped with rare earth elements to help

Many are radio-active

Thorium is very popular because it welds easy, **but**, it

Emits Alpha particles (helium nucleus)

Generally not a problem outside the body

But, Dust from grinding could be deadly if it gets in your lungs.

**Makersmiths does NOT allow use of
radio-active electrodes !**

Consider Zirconated, Lanthanated, Ceriated alternatives

Tungsten Electrodes

Tungsten Electrode Selection Chart

Tig Mode	Tungsten Type	Colour
AC	Pure	Green
DC or AC/DC	Ceriated 2%	Grey
DC or AC/DC	Lanthanated 1%	Black
DC or AC/DC	Lanthanated 1.5%	Gold
DC or AC/DC	Lanthanated 2%	Blue
DC	Thoriated 1%	Yellow
DC	Thoriated 2%	Red
AC	Zirconiated 1%	White

Tungsten Electrodes

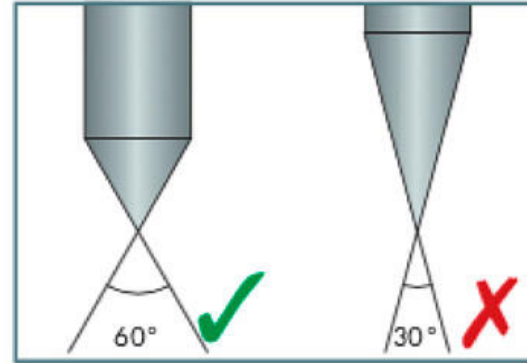
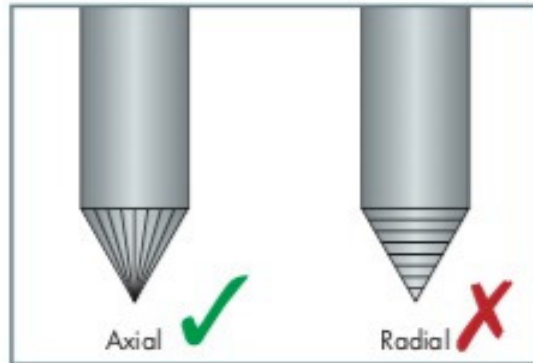
Grind the tip at 22.5 degrees
(This will mean the conical tip length is about 2/3rds the diameter of the electrode.)

A slightly rounded tip will work well on Aluminum. This will happen naturally as you start the weld (the point of the tip will melt a little into a small ball)

A sharp tip will give you best control of the arc. Start there. As you progress you can try other tip grinds.

Sharpening

Sharpening Electrodes



Dipping the Electrode

This is when the Electrode contacts the weld puddle (or you touch it with your filler rod).

You might as well stop and re-sharpen the electrode. Nothing good happens after dipping the electrode.

This will happen to you often as you begin TIG welding, so, sharpen a few electrodes at a time and replace each time you dip.

Ceramic Cup

The Gas Cup is made out of an alumina ceramic to withstand the heat.

They come in various sizes and shapes that provide different gas flow patterns.

Generally you want a cup that will cover the size of your weld area.

There are also clear cups, but they are quite expensive.

Larger cup gives more area coverage, important for aluminum and stainless steel.

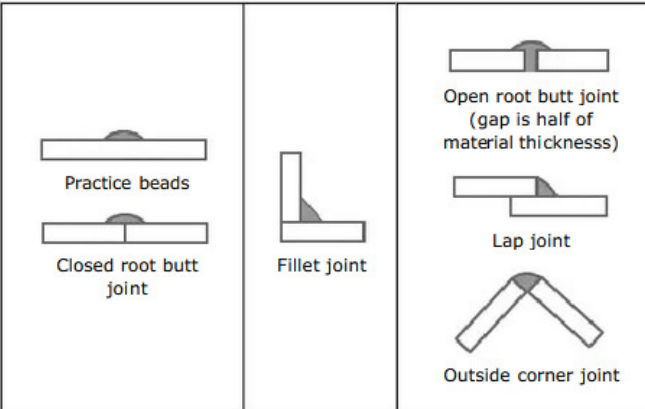
In some situations, you may need an additional gas hose to flow shielding gas to the back side of what you are welding to protect it.

Cup Size and Flow Settings

Electrode Diameter in inches (mm)	Cup Size	ARGON FLOW - FERROUS METALS		ARGON FLOW - ALUMINUM	
		Standard Body CFH (L/MN)	Gas Lens Body CFH (L/MN)	Standard Body CFH (L/MN)	Gas Lens Body CFH (L/MN)
.020 (0.50)	3,4 or 5	5-8 (3-4)	5-8 (3-4)	5-8 (3-4)	5-8 (3-4)
.040 (1.00)	4 or 5	5-10 (3-5)	5-8 (3-4)	5-12 (3-6)	5-10 (3-5)
1/16 (1.60)	4, 5 or 6	7-12 (4-6)	5-10 (3-5)	8-15 (4-7)	7-12 (4-6)
3/32 (2.40)	6, 7 or 8	10-15 (5-7)	8-10 (4-5)	10-20 (5-10)	10-15 (5-7)
1/8 (3.20)	7, 8 or 10	10-18 (5-9)	8-12 (4-6)	12-25 (6-12)	10-20 (5-10)
5/32 (4.00)	8 or 10	15-25 (7-12)	10-15 (5-7)	15-30 (7-14)	12-25 (6-12)
3/16 (4.80)	8 or 10	20-35 (10-17)	12-25 (6-12)	25-40 (12-19)	15-30 (7-14)
1/4 (6.40)	10	25-50 (12-24)	20-35 (10-17)	30-55 (14-26)	25-45 (12-21)

Power Settings Steel

Mild Steel

Steel Thickness (mm)	Filler Rod (mm)	Tungsten (mm)			
			Amps	Amps	Amps
0.8	1.0	1.0 or 1.6 ¹	25	30	20
1.0	1.0	1.0 or 1.6 ¹	30	35	25
1.2	1.0	1.6	35	45	30
1.5	1.0	1.6	45	55	40
2.0	1.0 or 1.6 ²	1.6	60	75	55
3.0	1.6	1.6	90	110	80

¹ A 1.6mm tungsten is OK down to about 30 amps. It can be used on thinner material if the tip is kept very sharp. Reduce the amps a little if using a 1.0mm tungsten.

² 2mm is the transition between 1.0mm and 1.6mm filler rod. The larger filler rod cools the weld pool more than the smaller rod so you might add about 5 amps if using 1.6mm filler rod.

Power Settings Aluminum

Thickness (in.)	Amps required
1/16	60 - 90
1/8	125 - 160
3/16	190 - 240
1/4	260 - 340
3/8	330 - 400

The rule of thumb for aluminum GTAW is to use **1 amp for every thousandth (0.001) of material thickness**. In other words, welding a base material that is 1/8 in. (0.125) thick would require about 125 amps.

Types of Joints

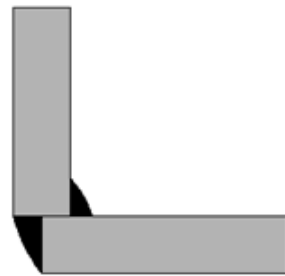
Types of Welding Joints



Butt Joint



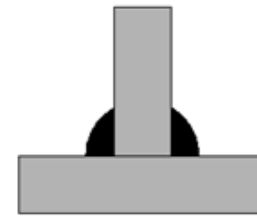
Lap Joint



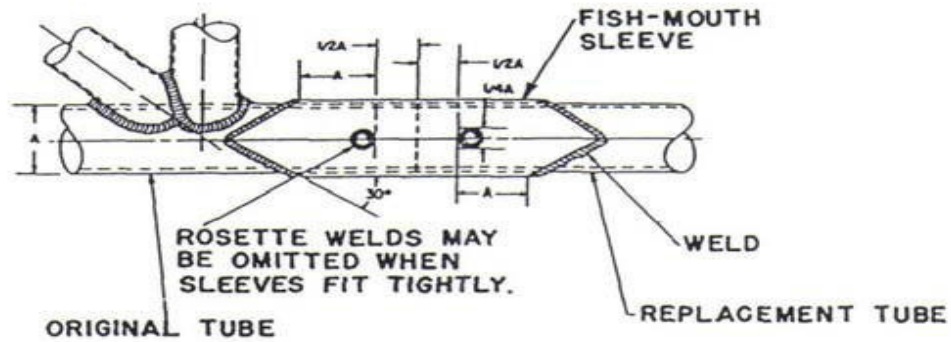
Corner Joint



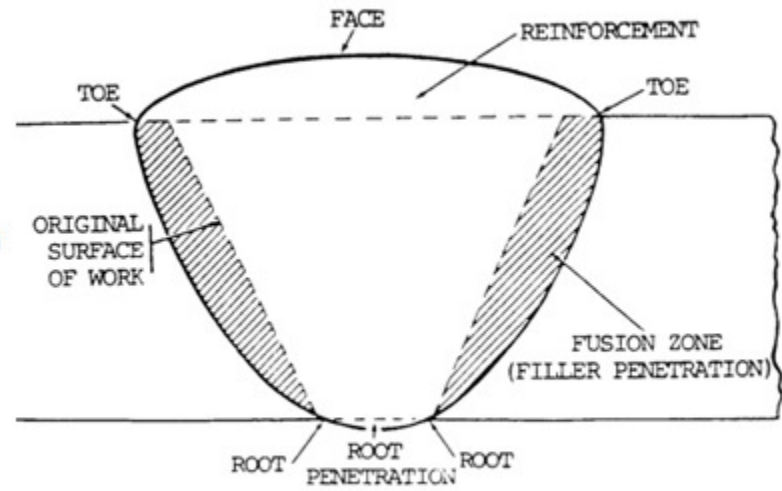
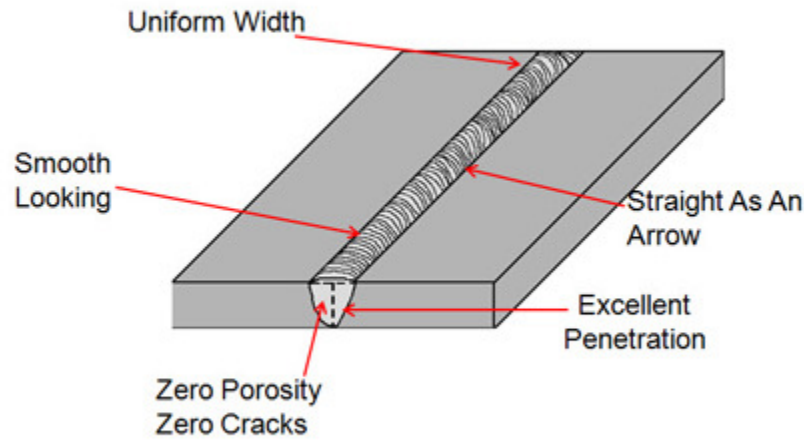
Edge Joint



Tee Joint

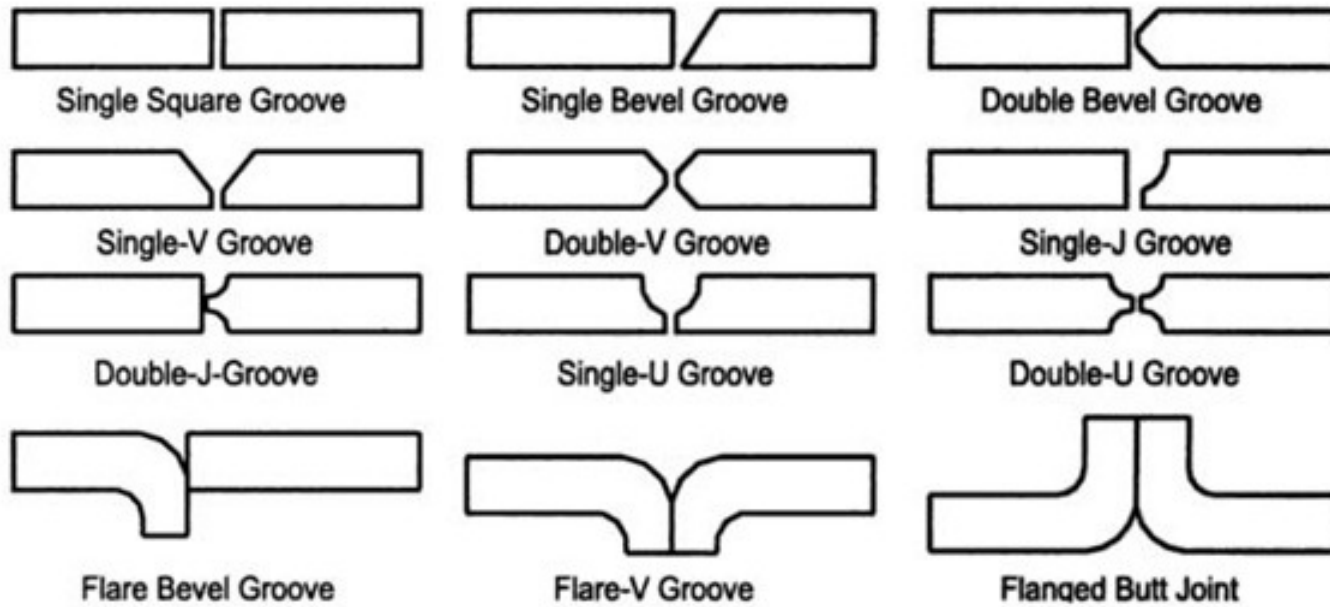


Good Welds



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

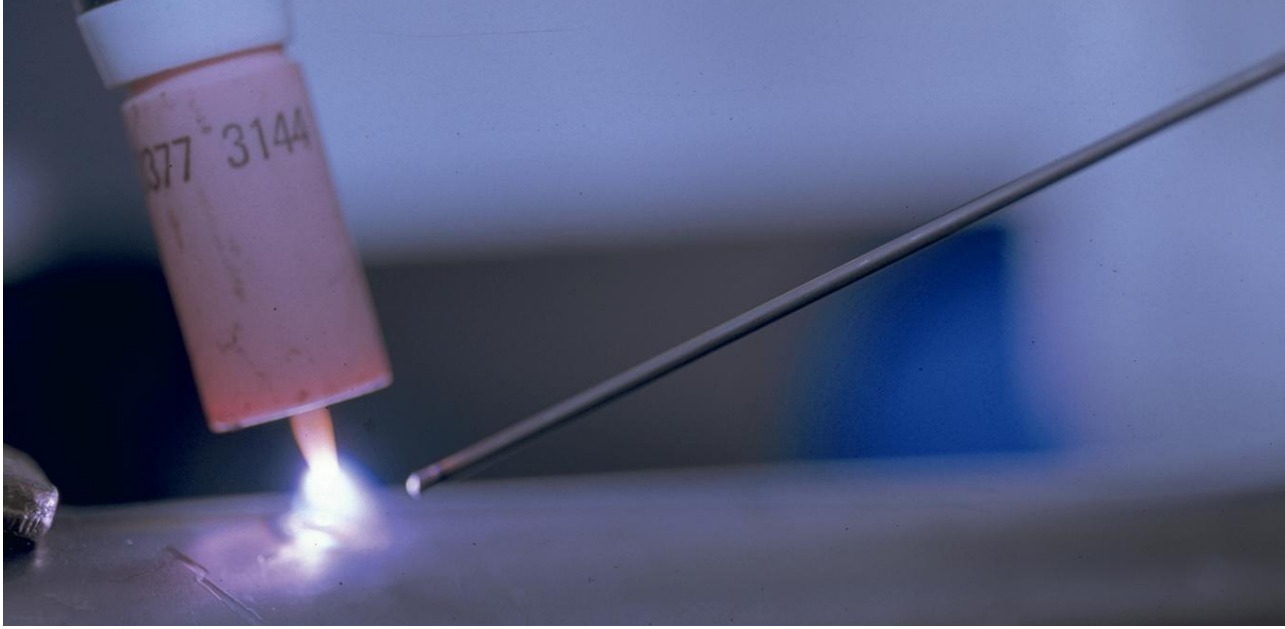
45 - tensile strength times 10,000 = 45,000 PSI

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

4043 good rod for aluminum. Use 4047 if welding aluminum castings

Use 1/16" diameter filler rod for applications where the material is 1/8" or less, and use 3/32" diameter filler rod for applications where the material is 1/8" and thicker.

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.

Control the heat of the puddle with the foot pedal

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)

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

We will make 6 welding 'coupons' (these are just sample test welds).

We will start by welding steel and then move on to Aluminum.

Running your first bead

No filler rod

Not joining 2 pieces

Just getting used to seeing the puddle and moving it along the material. Adjusting the height of the torch tip above the material and getting used to the foot pedal.

Place your first material piece on a firebrick and run a bead down the middle of the piece from one end to the other. (Be sure your piece is grounded.)

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

Strike the arc 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

A Butt Joint

Position material, tack, and weld.

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

(vid weld 2)

4th, 5th and 6th Coupon

Same 3 weld coupons as before, except in Aluminum.

Readjust the welder to the proper settings and weld.

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 dip the electrode, stop and replace or re-sharpen

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.

Check our This Old Tony – YouTube TIG videos.

<https://www.youtube.com/watch?v=svHI9nmV5nw>

<https://www.youtube.com/watch?v=aGsFdudG7Ho>

<https://www.youtube.com/watch?v=svHI9nmV5nw>

<https://www.youtube.com/watch?v=Vfhz9anpaWE>

<https://www.youtube.com/watch?v=38zP4cu8kkg>

Mr. TIG, Others.

Biggest problems

Dipping the Electrode

Dirty materials (they need to be 'really' clean)

Incorrect machine settings

Cooling the puddle with too much filler rod

Welding your work to the welding table

Picking up *hot* parts

How do I get independent access to the Welding Shop?

At a future date you must find one of the welding shop stewards and prove Proficiency

You must show that you know the safety guidelines and equipment, how to turn on the gas, adjust the flow, turn on and set the machine, strike an arc, perform a short test weld, and shut down the equipment

You must also know where the fire extinguisher is (this is a pass/fail question)

Be Safe

Be Safe.

Be Careful.

Equipment



Lincoln Electric has kindly donated a wonderful set of modern superb quality equipment to our welding shop.

If your are considering purchase of an arc welder or plasma cutter, I can recommend Lincoln as a world class solution.