LINCOLN® ELECTRIC

TIG / GTAW WELDING

Sponsored By:

HOT SHOT® OVEN & KILN

The Performance You Need.
The Quality You Expect.℠

SAFETY

- Radiation burns are a threat.
- Protect both skin and eyes.
- Shade number on welding helmet lens.
- **DO NOT** use welding goggles.
- Protect others from viewing arc.

- Free safety information available from Lincoln Electric. http://content.lincolnelectric.com/pdfs/products/literature/e205.pdf
- Request ANSI Z49.1 from the AWS

HOT SHOT OVEN & KILN

LINCOLN ELECTRIC

WHAT IS GTAW?

Gas Tungsten Arc Welding (GTAW)

Defined by the American Welding Society (AWS)

Also known as;

- Tungsten Inert Gas (TIG)
- Heli-Arc – From the early use of helium

Major Differences From Other Processes:

- Uses a non-consumable tungsten electrode.
- Requires an INERT external shielding gas.

DIFFERENCE BETWEEN INERT AND ACTIVE GASES

Inert Gas

- Chemically *Unreactive*
- Will not form a compound
- Will not React with the base metal

Active Gas

- Will have a chemical reaction with the base metal

WHERE DO WELDING GASES COME FROM

- Same air you are breathing right now.
- At very low (cryogenic) temperatures, air becomes liquid.
- Different chemicals separate out at different temperatures.
  - **- 459 Absolute Zero**
  - **- 453 Helium (from natural gas)**
  - **- 320 Nitrogen**
  - **- 302 Argon**
  - **- 297 Oxygen**

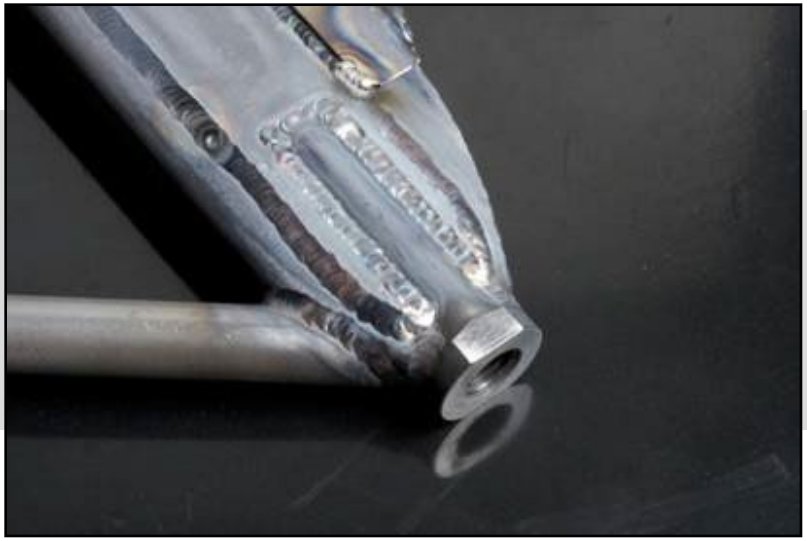
SHIELDING GASES FOR GTAW

Argon (Ar) & Helium (He) Most Popular

Any Inert gas can be used

Advantages to Argon (Ar)

- Smoother, quieter arc
- Greater cleaning action in AC
- More abundant/lower cost
- Better resistance to drafts
- Transfers less heat (9-15 volts)
- Lower gas flow rates (SCFH)



SHIELDING GASES FOR GTAW

Advantages to Helium

- Smaller heat affected zone
- 1.7 times hotter arc than Argon (23-24 volts)

Helium & Helium/Argon Mixes

Recommended For:

- Thick sections
- Materials having high thermal conductivity
- Higher weld speeds

WHAT IS SCFH?

SCFH - Standard Cubic Feet per Hour

Used to measure gas flow

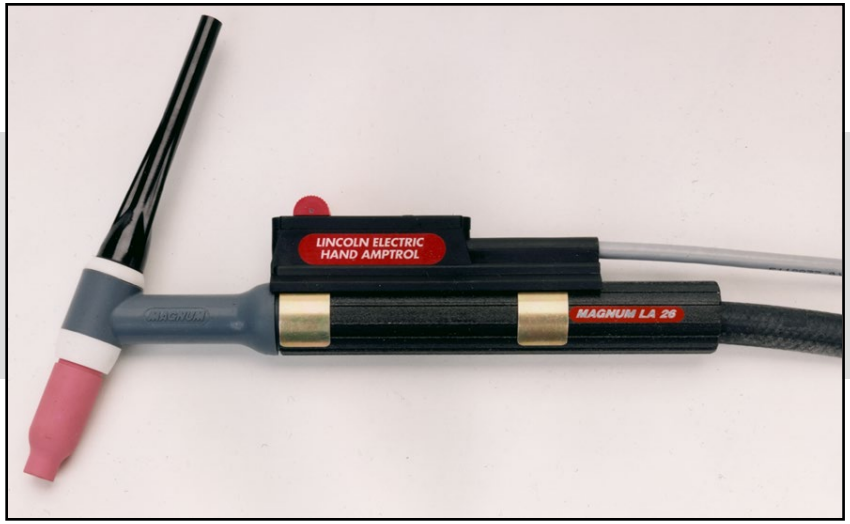
Argon is 10 times heavier than Helium

- Argon flow rate – 15 to 20 SCFH
- Helium flow rate – 45 to 60 SCFH

GTAW TORCH PARTS

REMOTE CONTROL DEVICES

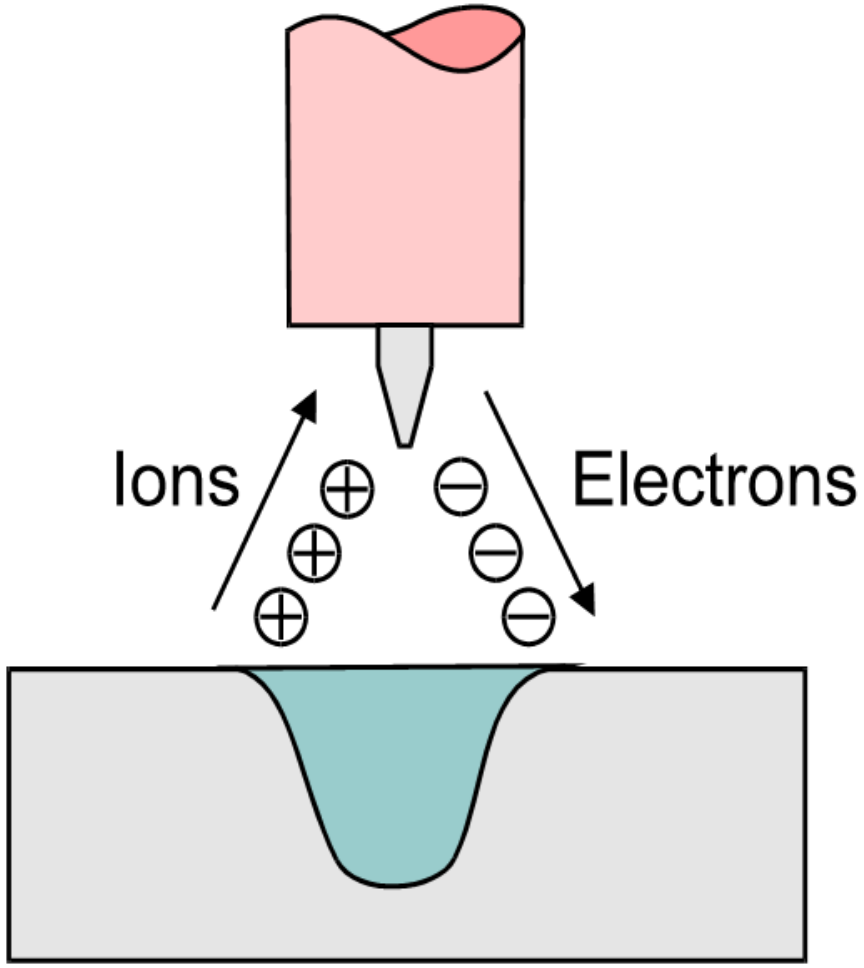
Hand Amptrol



Foot Amptrol

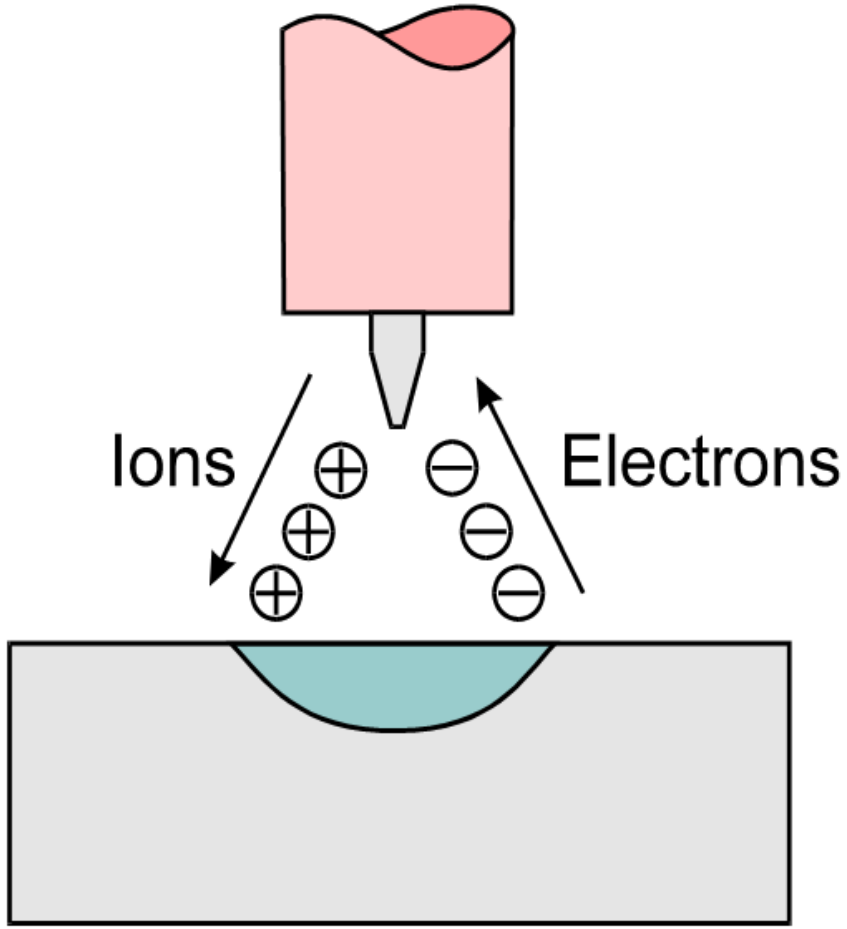
DC- POLARITY

- 70% of heat at plate
- 30% of heat at electrode
- Deep, but narrow penetration
- Excellent electrode capacity
- 1/8” Electrode can carry 400 Amps



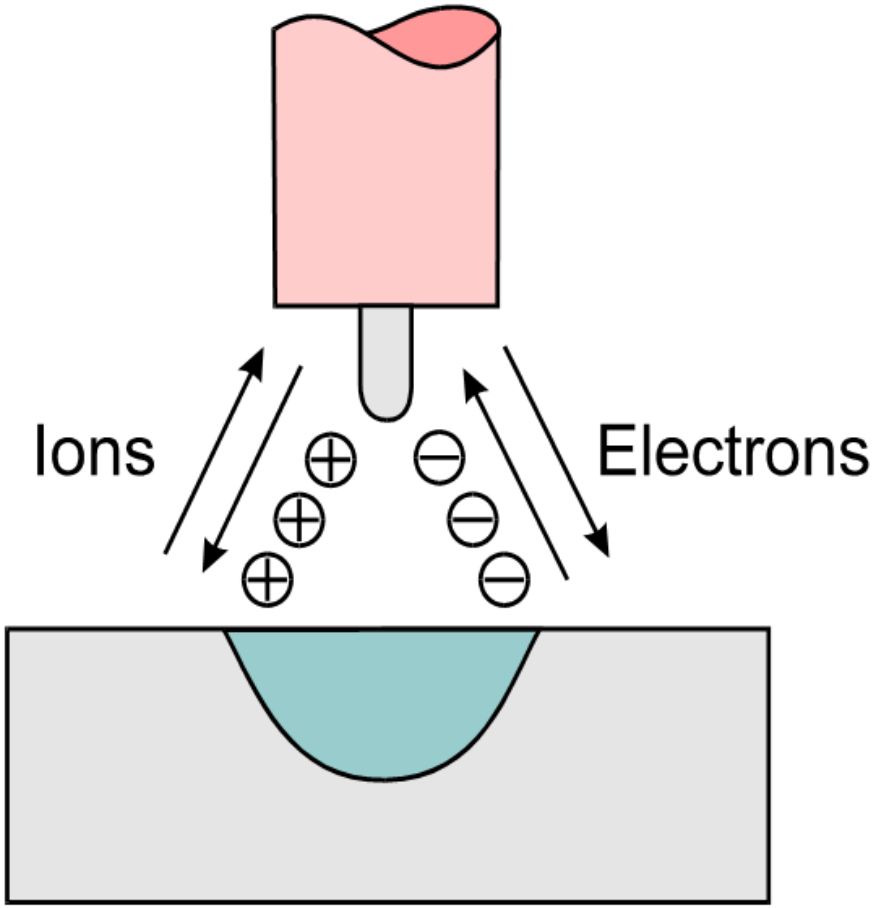
DC+ POLARITY

- 30% of heat at plate
- 70% of heat at electrode
- Shallow penetration
- Poor electrode capacity
  - 1/8” electrode can carry 40 Amps

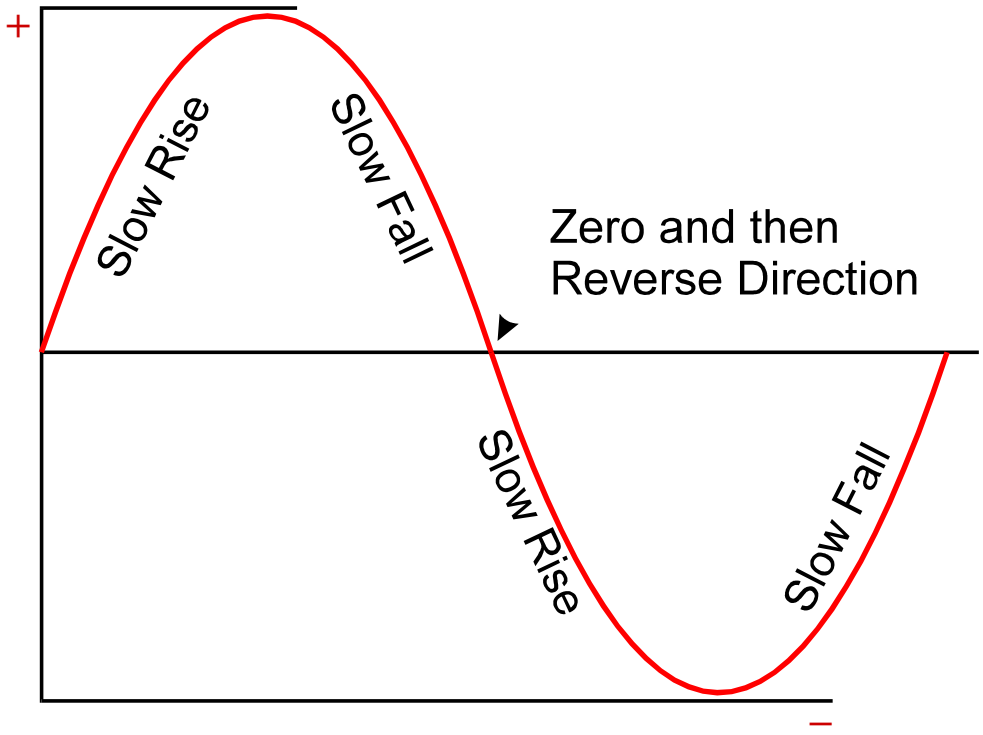


AC POLARITY

- 50% of heat at plate
- 50% of heat at electrode
- Medium penetration
- Oxide cleaning once every half cycle
- Good electrode capacity
  - 1/8” electrode can carry 225 Amps



AC SINE WAVE



- 60 Hz
- Positive half is cleaning cycle.
- Negative half is penetration cycle.
- As the arc crosses zero, it is extinguished and re-ignited.
- Current reversed 120 times per second.

AC SQUARE WAVE

In AC sine wave, zero is crossed (relatively) slowly

- This can cause weld discontinuities

AC square wave crosses zero rapidly

- Maintains optimal amperage longer
- Arc re-ignition enhanced
- Weld arc improved

AC SQUARE WAVE

Asymmetric Wave Shapes

Possible in square wave

Balanced

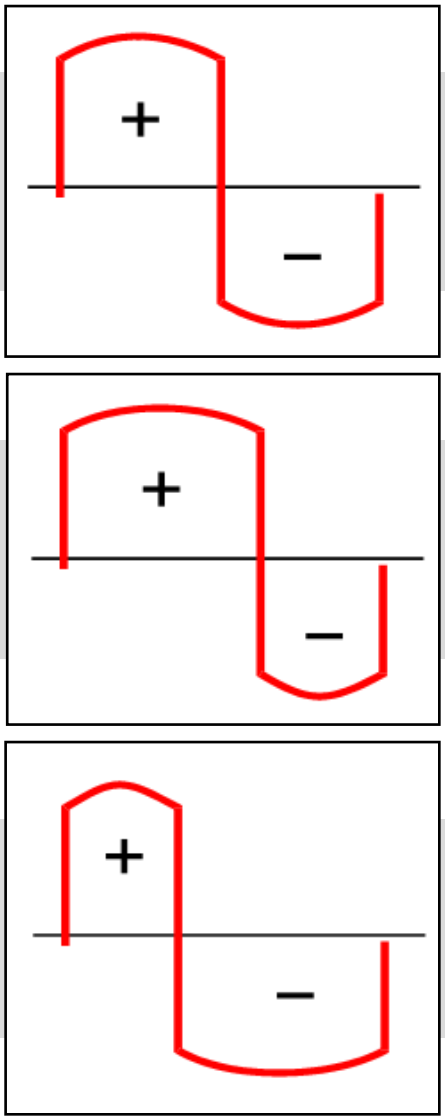
- Equal Cleaning & Penetration

Cleaning

- More wave time on positive side
- Wide arc
- Lower current carrying capacity

Penetration

- More time on negative side
- More focused arc
- Higher current carrying capacity

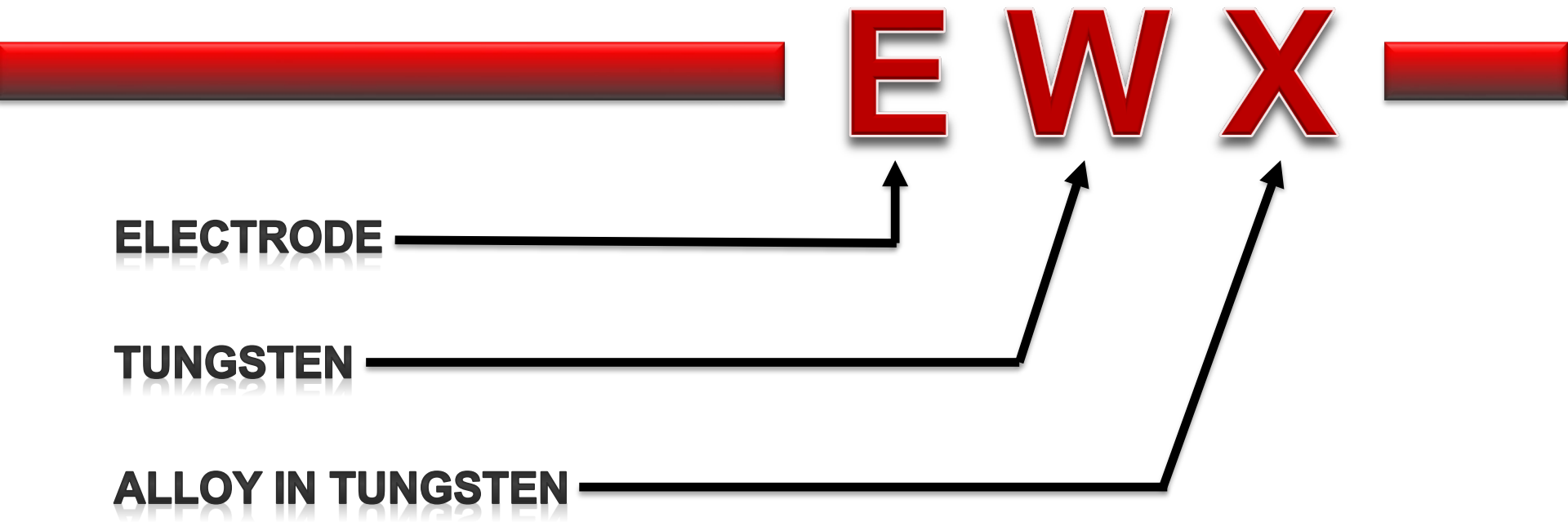


HIGH FREQUENCY

High Frequency: An Elevated Frequency Superimposed Over the Welding Current.

- Allows arc starts without touching the electrode to the work & keeps the arc established during AC TIG welding.
- High frequency start only: DC
- High frequency on continuously: AC
- High frequency off: SMAW & Scratch Start TIG

AWS CLASSIFICATION FOR TUNGSTEN ELECTRODES



COMMON GTAW ELECTRODES

Type	AWS	Color	Polarity
Pure	EWP	Green	AC
1% Thoriated	EWTh-1	Yellow	AC & DC-
2% Thoriated	EWTh-2	Red	AC & DC-
Zirconiated	EWZr	Brown	AC
Ceriated	EWCe-2	Orange	AC & DC-
Lanthanated	EWLa-1	Black	AC & DC-
Lanthanated	EWLa-1.5	Gold	AC & DC-
Lanthanated	EWLa-2	Blue	AC & DC-
Rare Earths	EWG	Gray	AC & DC-

RECOMMENDED CURRENT RANGES FOR GAS TUNGSTEN ARC WELDING

The Performance You Need.
The Quality You Expect.℠

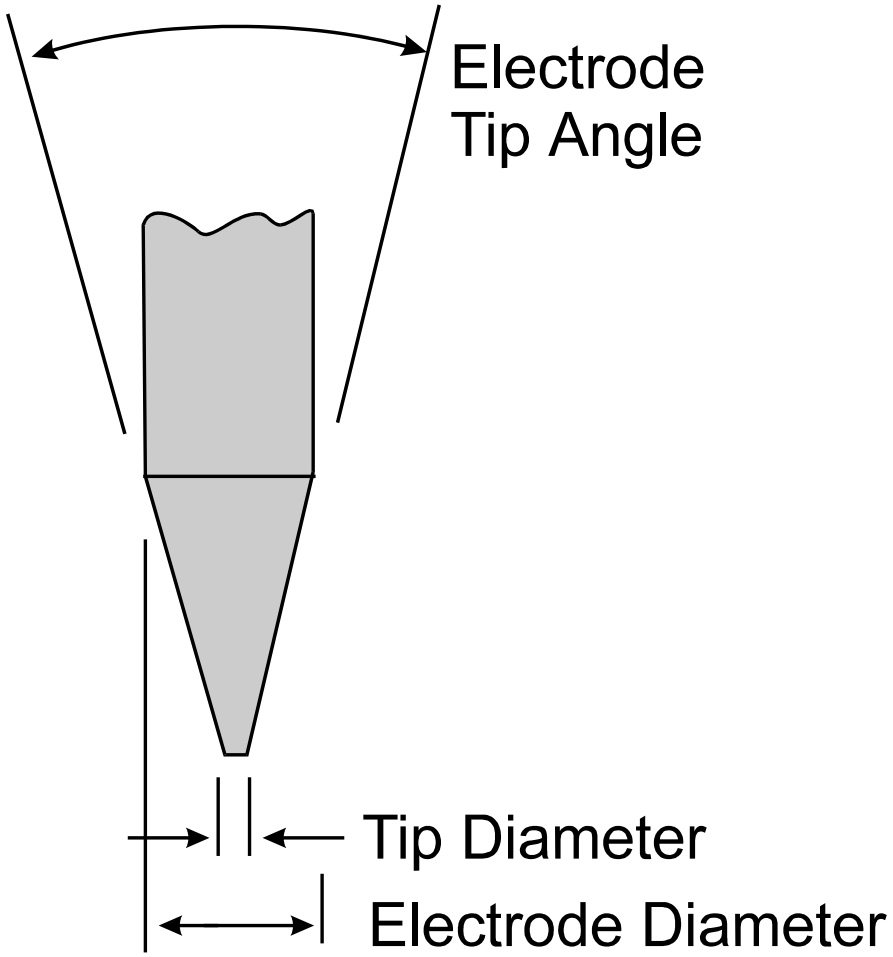
CURRENT - AMPERES				
Electrode	**A.C.H.F**		**D.C.E.N.**	**D.C.E.P.**
Diameter (in)	**Alternating Current with High Frequency**		**Direct Current, Electrode Negative (Straight Polarity)**	**Direct Current, Electrode Positive (Reverse Polarity)**
	Pure Tungsten*	**Thoriated*** or Zirconium ****	**Thoriated*****	**Thoriated*** or Zirconium****
0.02	---	---	5-35	---
0.04	10-40	15-60	30-100	---
0.0625	30-70	60-100	70-150	10-20
0.09375	70-100	100-160	150-225	15-30
0.125	100-150	140-220	200-275	25-40
0.15625	150-225	200-275	250-350	40-55
0.1875	200-300	250-400	300-500	55-90
0.25	275-400	300-500	400-650	80-125

* Pure Tunsten - green color band
** Zirconium - brown color band
*** Thoriated tungsten - 1% yellow color band, 2% red color band

PREPARING THE TUNGSTEN FOR DC TIG

Shape Tungsten to a Tip

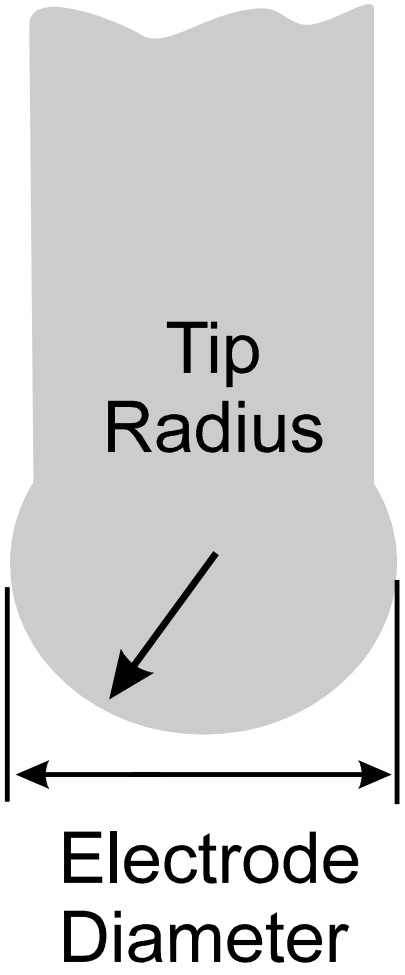
- Conical angle 2-3 times tungsten diameter
- Do not grind to a sharp point
- Grind parallel to electrode
- Use grinding wheel dedicated for tungsten



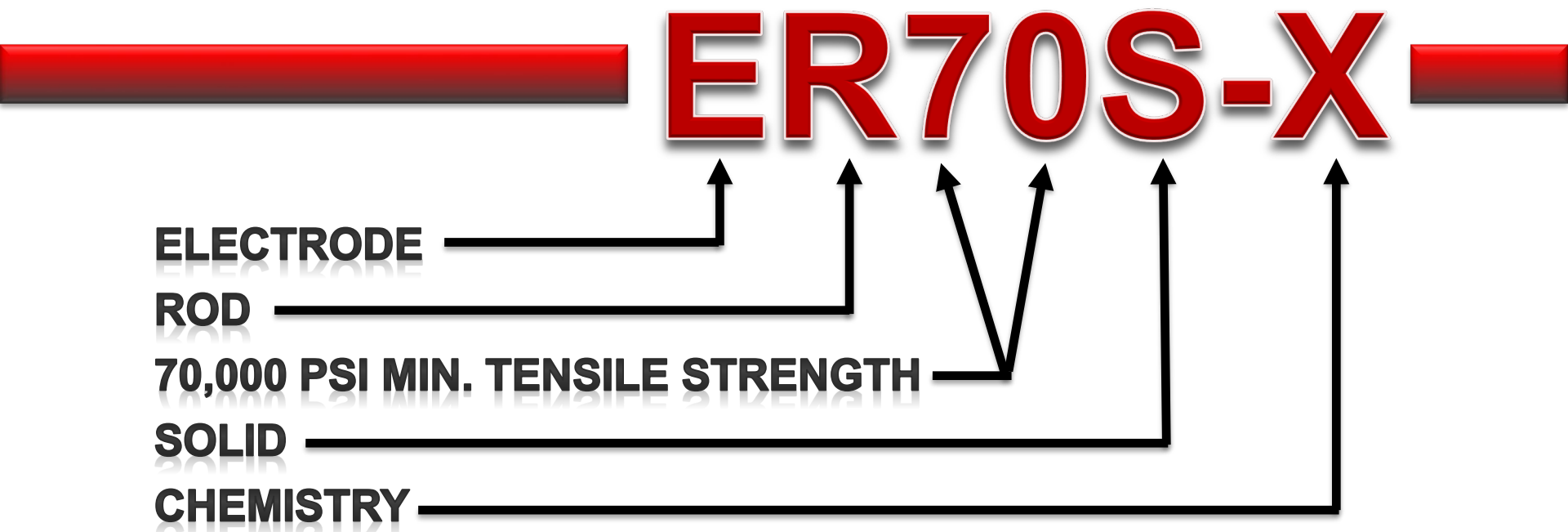
PREPARING THE TUNGSTEN FOR AC TIG

Shape Tungsten to a "Ball"

- Also called hemisphere
- Shaped 1 to 1 ½ times the diameter of the tungsten



AWS FILLER METAL CLASSIFICATION



- Amount of deoxidizers such as silicon, manganese and/or aluminum, zirconium and titanium)
- **X= 2,3,4,6 OR 7**

Classified by AWS with GMAW wires because they both use the same wire chemical compositions.

LINCOLN ELECTRIC CARBON STEEL CUT LENGTHS

ER70S-2

- Triple deoxidized rod *(Si, Mn, Al, Zr, Ti).*
- Produces x-ray quality welds over most surface conditions.
- Allows welding on some rust, scale and dirt.
- Less fluid pool for out of position welding.
- Deoxidizes older rimmed steels.

ER70S-3

- High quality rod with intermediate levels of Mn and Si.
- For general fabrication on clean steel.

ER70S-6

- High quality rod with higher Mn and Si levels.
- Improved mechanical properties and bead appearance.
- Higher hardness.

TIG WELD 4130

Can I weld 4130 using the TIG process?

Yes, 4130 Chrome-Moly has been TIG welded in the aerospace and aircraft industries for years. As with all welding, proper procedures and techniques must be followed.

Do I need to pre-heat?

Thin wall tubing (< 0.120" wall) applications do not typically require the normal 300ºF to 400ºF pre-heat to obtain acceptable results. However, tubing should be at room temperature (70ºF) or above before welding.

What filler material do I use?

Although there are several good filler materials, ER80S-D2, is one you should consider. This filler material is capable of producing welds that approximate the strength of 4130. ER-70S-2 is an acceptable alternative to ER80S-D2, as is ER70S-6, although the weld strength will be slightly lower.

When I use ER70S-2 filler material, do I give up strength for elongation?

Yes. The filler material, when diluted with the parent material, will typically under match the 4130. However, with the proper joint design (such as cluster or gusset, for example), the cross-sectional area and linear inches of weld can compensate for the reduced weld deposit strength.

Why is 4130 filler metal not recommended?

4130 filler typically is used for applications where the weld will be heat treated. Due to its higher hardness and reduced elongation, it is not recommended for sporting applications such as experimental airplanes, race car frames, roll cages, etc.

TIG Weld 4130

Can I weld 4130 using any other filler metals?

Some fabricators prefer to use austenitic stainless steel fillers to weld 4130 tubing. This is acceptable provided 310 or 312 stainless steel fillers are used. Other stainless steel fillers can cause cracking. Stainless filler material is typically more expensive.

Do I need to heat treat (stress relieve) 4130 after welding?

Thin wall tubing normally does not require stress relief. For parts thicker than .120", stress-relieving is recommended and 1,100ºF is the optimum temperature for tubing applications. An Oxy/Acetylene torch with neutral flame can be used. It should be oscillated to avoid hot spots.

Do I have to pre-clean 4130 material?

Remove surface scale and oils with mild abrasives and acetone. Wipe to remove all oils and lubricants. All burrs should be removed with a hand scraper or de-burring tool. Better welding results with clean materials.

Do I need to back-purge 4130 material?

Back purging is not normally necessary, although some fabricators do. It will not hurt the weld and may improve the root pass of some welds

Should I quench the metal after I finish welding?

ABSOLUTELY NOT! Rapid quenching of the metal will create problems such as cracking and lamellar tearing. **Always** allow the weld to slow cool.

TIG WELD 4130

PARENT MATERIAL:	4130
MATERIAL CONDITION:	Condition (N)
MATERIAL THICKNESS:	.035" Wall Thickness
FILLER MATERIAL:	ER80S-D2 .035" Diameter
JOINT TYPE:	90º Tube to Tube.
JOINT PREP:	Abrasive Clean/Acetone Wipe
JOINT GAP:	.000-.010
CURRENT TYPE:	D.C.E.N. (DC Electrode Negative)
AMPERAGE:	20 - 40 amps
VOLTAGE:	9-12 Volts
TORCH TYPE:	LA-9 or LW-20 Magnum
CUP SIZE:	Gas Lens 7/16" Orifice
CUP TYPE:	Ceramic
TUNGSTEN TYPE:	2% Thoriated
TUNGSTEN SIZE:	1/16" Diameter
TUNGSTEN SHAPE:	Pointed
SHIELDING GAS:	Argon
FLOW RATE:	15-25 C.F.H.
BACK-UP GAS:	Argon
FLOW RATE:	5-10 C.F.H.
TACKING SEQUENCE:	4-Places (min.)

TIG WELD 4130

Filler Metal Options

1. ER80S-D2
2. ER70S-2
3. ER70S-6

FOOTNOTE: Welding properties change from operator to operator. Techniques such as travel speed, filler type, filler deposition rates, amperage, gas shielding, and arc voltage (distance between tungsten and weld puddle) all have an effect towards heat input, weld strength, and elongation

SUMMARY

Gas Tungsten Arc (TIG) Welding

- High quality welds on a variety of alloys and plate thicknesses.
- Deposits x-ray quality, low hydrogen welds.
- Uses non-consumable tungsten electrode with an external shielding gas.
- Filler rod may or may not be used.
- Uses DC- or AC polarity.
- Requires skilled operator.
- No slag or spatter.

Thank You for Attending The Lincoln Electric Welding Work Shop!

Safe Travels

Notes