TECHNICAL SPECIFICATIONS FOR TIG WELDING

CK WORLDWIDE

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Form 116

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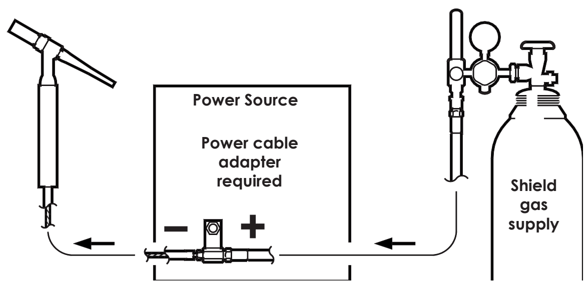
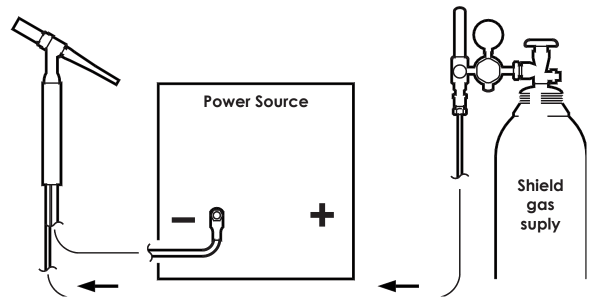


2 PIECE CABLE ASSEMBLY



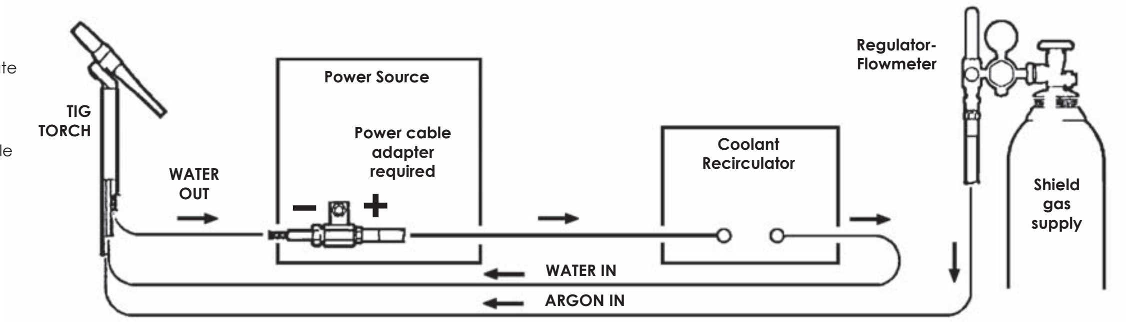
CONNECTION DIAGRAM FOR WATER COOLED TORCHES

NOTE:

1 Quart (1 liter) per min. flow rate

Water ***in*** through water line

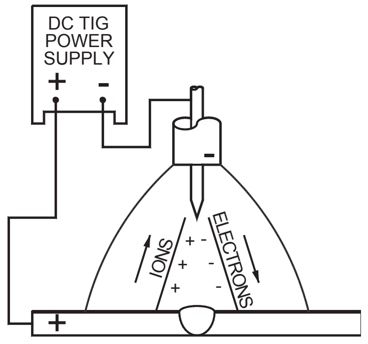
Water ***out*** through power cable



CHARACTERISTICS OF CURRENT TYPES FOR GAS TUNGSTEN ARC WELDING

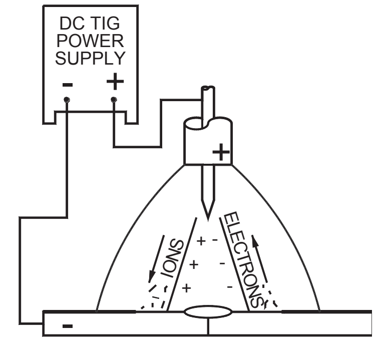
When TIG welding, there are three choices of welding current. They are: **D**irect **C**urrent **S**traight **P**olarity, **D**irect **C**urrent **R**everse **P**olarity, and **A**lternating **C**urrent with **H**igh **F**requency stabilization. Each of these has its applications, advantages, and disadvantages. A look at each type and its uses will help the operator select the best current type for the job. The type of current used will have a great effect on the penetration pattern as well as the bead configuration. The diagrams below, show arc characteristics of each current polarity type.

TIG welding with **DCSP** (direct current straight polarity) produces deep penetration because it concentrates the heat in the joint area. No cleaning action occurs with this polarity.



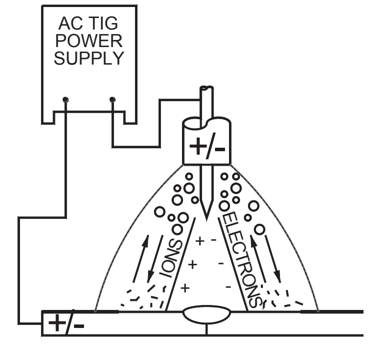
CURRENT TYPE	DCSP
ELECTRODE POLARITY	Electrode Negative
OXIDE CLEANING ACTION	No
HEAT BALANCE IN THE ARC	70% at work end 30% at electrode end
PENETRATION PROFILE	Deep, narrow
ELECTRODE CAPACITY	Excellent

TIG welding with **DCRP** (direct current reverse polarity) produces good cleaning action as the argon ions flowing towards the work strike with sufficient force to break up oxides on the surface.



CURRENT TYPE	DCRP
ELECTRODE POLARITY	Electrode Positive
OXIDE CLEANING ACTION	Yes
HEAT BALANCE IN THE ARC	30% at work end 70% at electrode end
PENETRATION PROFILE	Shallow, wide
ELECTRODE CAPACITY	Poor

TIG welding with **ACHF** (alternating current high frequency) combines the good weld penetration on the negative half cycle with the desired cleaning action of the positive half cycle. High frequency reestablishes the arc which breaks each half cycle.



CURRENT TYPE	ACHF
ELECTRODE POLARITY	Alternating
OXIDE CLEANING ACTION	Yes (once every half cycle)
HEAT BALANCE IN THE ARC	50% at work end 50% at electrode end
PENETRATION PROFILE	Medium
ELECTRODE CAPACITY	Good

SHIELD GAS SELECTOR CHART

BASE METAL TYPE	THICKNESS RANGE	WELD TYPE	SHIELD GAS TYPE	CHARACTERISTICS
ALUMINUM ALLOYS AND MAGNESIUM ALLOYS	Thin	Manual	Pure argon	Best arc starts, control of penetration, cleaning and appeaerance on thin gauges.
	Thick	Manual	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
	General Purpose	Manual	Pure argon	Best overall for good arc starts, control of penetration, cleaning and appearance.
	Thin	Mechanized	50 Ar - 50 He	Higher weld speed under 3/4" thick, with good arc stability and starting.
	Thick	Mechanized	Pure helium	Highest weld speeds, deeper penetration with DCSP, demanding arc starting and fixturing requirements, high flow rates needed.
COPPER ALLOYS Cu-NI ALLOYS NICKEL ALLOYS	Thin	Manual	Pure argon	Good control of weld puddle, bead contour, and penetraion on thin gauges.
	Thick	Manual	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
	General Purpose	Manual	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
	Thin	Mechanized	25 Ar - 75 He	Higher weld speed under 3/4" thick, with good arc stability and starting.
	Thick	Mechanized	Pure Helium	Highest weld speeds, deeper penetration with DCSP, demanding arc starting and fixturing requirements, high flow rates needed.
LOW CARBON ALLOYS AND LOW ALLOY STEELS	Thin	Manual	Pure Argon	Best arc starts, control of penetration, cleaning and appearance on thin gauges.
	Thick	Manual	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
	General Purpose	Manual	Pure argon	Best overall for good arc starts, control on penetration, cleaning and appearance.
	Thin	Mechanized	Pure argon	Best overall for good arc starts, control on penetration, cleaning and appearance.
	Thick	Mechanized	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
STAINLESS STEELS AND DUPLEX ALLOYS	Thin	Manual	Argon under 1/16" 95 Ar- 5 H over 1/16"	Argon with hydrogen added increases heat input and improves bead contour with lower gas flows, improves weld puddle wetting and minimizes undercutting.
	Thick	Manual	75 Ar - 25 He	Increase heat input with good arc starts of argon, but with faster welding speeds.
	General Purpose	Manual	Argon or 95 Ar - 5 H	Argon or 95 Ar - 5 H can be used interchangably on austeritic stainless steel.
	Thin	Mechanized	Argon or 85 Ar - 15 H	Argon provides stable arc control, 85 Ar - 15 H doubles argons welding speeds.
	Thick	Mechanized	75 Ar - 25 He or 65 Ar - 35 H	Increase heat input with good arc starts of argon, but with faster welding speeds.
TITANIUM ALLOYS	Thin	Manual	Pure argon	Argon's high density provides optimum shielding and arc stability.
	Thick	Manual	Argon or 75 Ar - 25 He	Argon with helium addition adds penetration for manual welding of thick sections.
	General Purpose	Manual	Pure argon	Best overall for good arc starts, control of penetration, cleaning and appearance.
	Thin	Mechanized	Pure argon	Best arc starts, control of penetration, cleaning and appearance on thin gauges.
	Thick	Mechanized	Argon or 75 Ar - 25 He	Argon with helium increases penetration and welding speed for thick sections.
	Thick	Mechanized	Pure argon	Argon's high density provides needed shielding of exposed areas at back of weld.

GUIDE FOR SHIELD GAS FLOWS, CURRENT SETTINGS AND CUP SELECTION

Electrode Diameter in inches (mm)	Cup Size	WELDING CURRENT (AMPS) - TUNGSTEN TYPE				ARGON FLOW - FERROUS METALS		ARGON FLOW - ALUMINUM	
		AC Pure	AC Thoriated	DCSP Pure	DCSP Thoriated	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 - 15	5 - 20	5 - 15	5 - 20	5-8 (3-4)	5-8 (3-4)	5-8 (3-4)	5-8 (3-4)
.040 (1.00)	4 or 5	10 - 60	15-80	15 - 70	20 - 80	5-10 (3-5)	5-8 (3-4)	5-12 (3-6)	5-10 (3-5)
1/16 (1.60)	4, 5 or 6	50 - 100	70 - 150	70 - 130	80 - 150	7-12 (4-6)	5-10 (3-5)	8-15 (4-7)	7-12 (4-6)
3/32 (2.40)	6, 7 or 8	100 - 160	140 - 235	150 - 220	150 - 250	10-15 (5-7)	8-10 (4-5)	10-20 (5-10)	10-15 (5-7)
1/8 (3.20)	7, 8 or 10	150 - 210	220 - 325	220 - 330	240 - 350	10-18 (5-9)	8-12 (4-6)	12-25 (6-12)	10-20 (5-10)
5/32 (4.00)	8 or 10	200 - 275	300 - 425	375 - 475	400 - 500	15-25 (7-12)	10-15 (5-7)	15-30 (7-14)	12-25 (6-12)
3/16 (4.80)	8 or 10	250 - 350	400 - 525	475 - 800	475 - 800	20-35 (10-17)	12-25 (6-12)	25-40 (12-19)	15-30 (7-14)
1/4 (6.40)	10	325 - 700	500 - 700	750 - 1000	700 - 1100	25-50 (12-24)	20-35 (10-17)	30-55 (14-26)	25-45 (12-21)

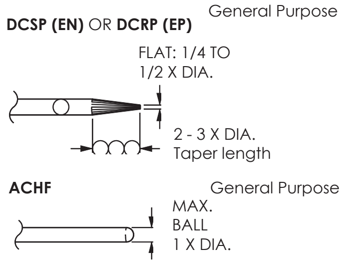
For pure helium shielding gas, double flow rates shown. For argon-helium mixes with below 30% helium content, use figures shown. Always adjust gas flows to accommodate best shielding results.

TUNGSTEN SELECTION AND PREPARATION

TUNGSTEN ELECTRODE SELECTOR CHART

BASE METAL TYPE	THICKNESS RANGE	DESIRED RESULTS	WELDING CURRENT	ELECTRODE TYPE	SHIELD GAS	TUNGSTEN PERFORMANCE CHARACTERISTICS
ALUMINUM ALLOYS AND MAGNESIUM ALLOYS	All	General Purpose	ACHF	Pure (EW-P)	Argon	Balls easily, low cost, tends to spit at higher currents, used for non-critical welds only.
				Zirconiated (EW-Zr)	Argon	Balls well, takes higher current, with less spitting and with better arc starts and arc stability than pure tungsten.
				2% Thoriated (EW-Th2)	75 Argon 25 Helium	Higher current range and stability, better arc starts, with lower tendency to spit, medium erosion.
	Only thin sections	Control penetration	DCRP	2% Ceriated (EW-Ce2)	Argon Helium	Lowest erosion rate, widest current range, AC or DC, no spitting, best arc starts and stability.
	Only thick sections	Increase penetration or travel speed	DCSP	2% Thoriated (EW-Th2)	75 Argon 25 Helium	Best stability at medium currents, good arc starts, medium tendency to spit, medium erosion rate.
				2% Ceriated (EW-Ce2)	Helium	Low erosion rate, wide current range, AC or DC, no spitting, consistent arc starts, good stability.
COPPER ALLOYS, Cu-NI ALLOYS AND NICKEL ALLOYS	All	General Purpose	DCSP	2% Thoriated (EW-Th2)	75 Argon 25 Helium	Best stability at medium currents, good arc starts, medium tendency to spit, medium erosion rate.
				2% Ceriated (EW-Ce2)	75 Argon 25 Helium	Low erosion rate, wide current range, AC or DC, no spitting, consistent arc starts, good stability.
	Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)	Argon	Use on lower currents only, spitting on starts, rapid erosion rates at higher currents.
	Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)	75 Argon 25 Helium	Low erosion rate, wide current range, AC or DC, no spitting, consistent arc starts, good stability.
MILD STEELS, CARBON STEELS, ALLOY STEELS, STAINLESS STEELS AND TITANIUM ALLOYS	All	General Purpose	DCSP	2% Thoriated (EW-Th2)	75 Argon 25 Helium	Best stability at medium currents, good arc starts, medium tendency to spit, medium erosion rate.
				2% Ceriated (EW-Ce2)	75 Argon 25 Helium	Low erosion rate, wide current range, AC or DC, no spitting, consistent arc starts, good stability.
				2% Lanthanated (EWG-La2)	75 Argon 25 Helium	Lowest erosion rate, widest current range on DC, no spitting, best DC arc starts and stability.
	Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)	Argon	Use on lower currents only, spitting on starts, rapid erosion rates at higher currents
	Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)	75 Argon 25 Helium	Low erosion rate, wide current range, no spitting, consistent arc starts, good stability.
				2% Lanthanated (EWG-La2)	Helium	Lowest erosion rate, highest current range, no spitting, best DC arc starts and stability.

TUNGSTEN TIP PREPARATION



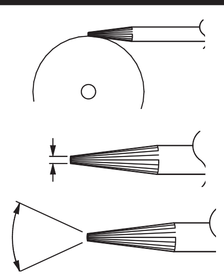
Ball tip by arcing on clean metal at low current **DCRP** (EP) then slowly increase current to form the desired ball diameter. **Return setting to AC**.

TUNGSTEN GRINDING

Shape by grinding longitudinally (never radially). Remove the sharp point to leave a truncated point with a flat spot. Diameter of flat spot determines amperage capacity. (See below)

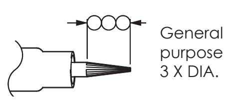
The included angle determines weld bead shape and size. Generally, as the included angle increases, penetration increases and bead width decreases.

Use a medium (60 grit or finer) aluminum oxide wheel.

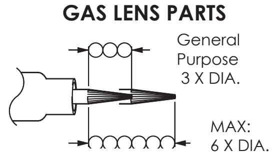


TUNGSTEN EXTENSION

STANDARD PARTS



GAS LENS PARTS



(IN DRAFT-FREE AREAS)

TUNGSTEN ELECTRODE TIP SHAPES AND CURRENT RANGES

Thoriated, ceriated, and lanthanated tungsten electrodes do not ball as readily as pure or zirconiated tungsten electrodes, and as such are typically used for **DCSP** welding. These electrodes maintain a ground tip shape much better than the pure tungsten electrodes. If used on AC, thoriated and lanthanated electrodes often spit. Regardless of the electrode tip geometry selected, it is important that a consistent tip configuration be used once a welding procedure is established. Changes in electrode geometry can have a significant influence not only on the weld bead width, depth of penetration, and resultant quality, but also on the electrical characteristics of the arc. Below is a guide for electrode tip preparation for a range of sizes with recommended current ranges.

ELECTRODE DIAMETER MM	IN	DIAMETER AT TIP MM	IN	CONSTANT INCLUDED ANGLE, DEGREES	CURRENT RANGE A	PULSED CURRENT RANGE A
1.0	.040	.125	.005	12	2-15	2-25
1.0	.040	.250	.010	20	5-30	5-60
1.6	1/16	.500	.020	25	8-50	8-100
1.6	1/16	.800	.030	30	10-70	10-140
2.3	3/32	.800	.030	35	12-90	12-180
2.3	3/32	1.100	.045	45	15-150	15-250
3.2	1/8	1.100	.045	60	20-200	20-300
3.2	1/8	1.500	.060	90	25-250	25-350

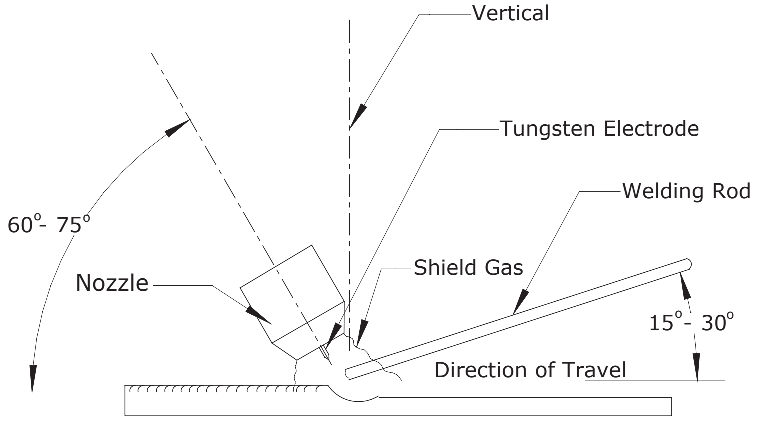
TUNGSTEN COLOR CODE AND PROPER TORCH USE

COLOR CODE AND ALLOYING ELEMENTS FOR VARIOUS TUNGSTEN ELECTRODE ALLOYS

AWS CLASSIFICATIONS	COLOR*	ALLOYING ELEMENT	ALLOYING OXIDE	NOMINAL WEIGHT OF ALLOYING OXIDE PERCENT
EWP	Green	-	-	-
EWCe-2	Orange	Cerium	CeO_2	2
EWLa-1	Black	Lanthanum	La_2O_3	1
EWTh-1	Yellow	Thorium	ThO_2	1
EWTh-2	Red	Thorium	ThO_2	2
EWZr-1	Brown	Zirconium	ZrO_2	.25
EWG	Gray	Not Specified**	-	-

***Color may be applied in the form of bands, dots, etc., at any point on the surface of the electrode.**
****Manufacturers must identify the type and nominal content of the rare earth oxide additions.**

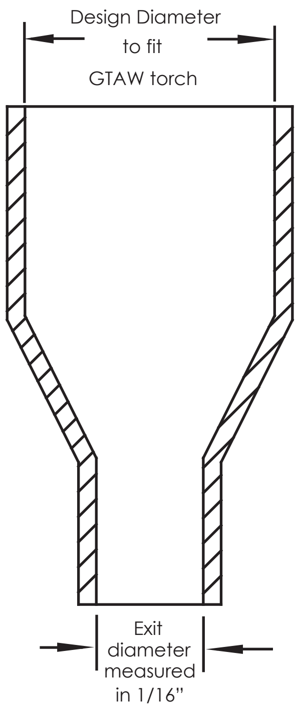
CORRECT TORCH AND ROD POSITIONING



The suggested electrode and welding rod angles for welding a bead on plate. The same angles are used when making a butt weld. The torch is held 60º - 75º from the metal surface. This is the same as holding the torch 15º - 30º from the vertical.

Take special note that the rod is in the shielding gas during the welding process.

SELECTING THE CORRECT TORCH NOZZLE



Most nozzles used for GTAW are manufactured from ceramic materials, alumina (pink colored) and lava (white colored). The exit diameter (diameter closest to the arc) is manufactured in a variety of sizes. GTAW nozzles are also made in various lengths from short nozzles to extra-long nozzles.

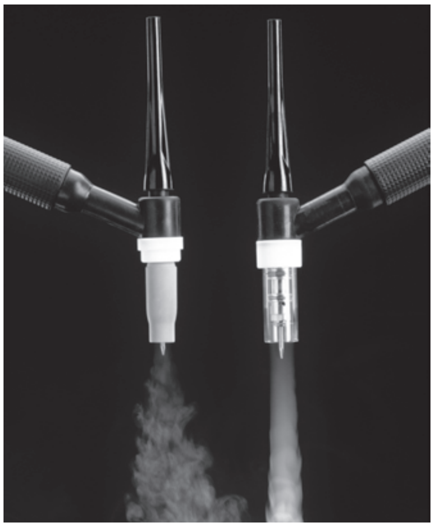
Alumina nozles are the most commonly used nozzles in GTAW. Alumina nozzles are molded from alumina oxide and the density of the alumina oxide determines the quality of the nozzle in relationship to impact resistance and thermal shock. Alumina nozzles are more impact resistant than lava nozzles. The impact resistance of the alumina nozzles makes them more durable and are used for general applications.

Ceramic (lava) cups are recommend for use in applications where high reflective heat is present. Alumina nozzles tend to break when used in confined areas or when high reflective heat is present. If this type of usage is contemplated, we recommend the use of ceramic (lava) cups. When alumina nozzles are fired in the oven at 3000° F during manufacturing, they shrink 18% in length and 27% in diameter. If the nozzle is subsequently used in a confined area, excessive heat is transferred back into the nozzle causing it to expand. Cooling shrinks the nozzle back to normal. The large difference between expansion and contraction results in breakage.

The exit diameter for any nozzle is specified with a number that represents the diameter in 1/16" (1.6mm) increments. A number 5 nozzle is therefore 5/16" inside diameter. A number 6 nozzle is 3/8" or 6/16" and so on.

The diameter for any nozzle must be large enough to allow the entire weld area to be covered by the shielding gas. The exit diameter can be neither too large nor too small, or poor shield gas coverage will result. (Refer to page 3 for correct cup size.)

GAS LENS BENEFITS



A collet body with a gas lens can be very useful to a welder. The purpose of a gas lens is to make the shielding gas exit the nozzle as a column instead of as a turbulent stream of gas that begins to spread out after exiting. The column of gas allows the electrode to stick out farther for visibility, allowing for better access to the weld area, and a reduction in gas flow (CFH/L/Min).

ALUMINIUM (ACHF)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	1/16 (1.6 mm)	4, 5, 6	ARGON	15 (7)	20	60-80	12 (307.2 mm)
	FILLET							70-90	10 (256 mm)
1/8 (3.2 mm)	BUTT	3/32 (2.4 mm)	3/32 (2.4 mm)-1/8 (3.2 mm)	6, 7	ARGON	17 (8)	20	125-145	12 (307.2 mm)
	FILLET		3/32 (2.4 mm)-1/16 (1.6 mm)					140-160	10 (256 mm)
3/16 (4.8 mm)	BUTT	1/8 (3.2 mm)	1/8 (3.2 mm)	7, 8	ARGON/ HELIUM	21 (10)	20	190-220	11 (258.6 mm)
	FILLET							210-240	9 (230.4 mm)
1/4 (6.4 mm)	BUTT	3/16 (4.8 mm)	1/8 (3.2 mm)	8, 10	ARGON/ HELIUM	25 (12)	20	260-300	10 (256 mm)
	FILLET							280-320	8 (204.8 mm)

WELDING ALUMINUM

The use of TIG welding for aluminum has many advantages for both manual and automatic processes. Filler metal can be either wire or rod and should be compatible with the base alloy. Filler metal must be dry, free of oxides, grease, or other foreign matter. If filler metal becomes damp, heat for 2 hours at 250°F before using. Although ACHF is recommended, DCRP has been successful up to 3/32", DCSP with helium shield gas is successful in mechanized applications.

TITANIUM (DCSP)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	NONE	4, 5, 6	ARGON	15 (7)	20	90-110	10 (256 mm)
	FILLET							110-150	8 (204.8 mm)
1/8 (3.2 mm)	BUTT	3/32 (2.4 mm)	1/16 (1.6 mm)	5, 6, 7	ARGON	15 (7)	20	190-220	9 (230.4 mm)
	FILLET							210-250	7 (179.2 mm)
3/16 (4.8 mm)	BUTT	3/32 (2.4 mm)	1/8 (3.2 mm)	6, 7, 8	ARGON	20 (10)	20	220-250	8 (204.8 mm)
	FILLET							240-280	7 (179.2 mm)
1/4 (6.4 mm)	BUTT (2)	1/8 (3.2 mm)	1/8 (3.2 mm)	8, 10	ARGON	30 (15)	20	275-310	8 (204.8 mm)
	FILLET (2)							290-340	7 (179.2 mm)

WELDING TITANIUM

Small amounts of impurities, particularity oxygen and nitrogen, cause embrittlement of molten or hot titanium. The molten weld metal in the heat-affected zones must be shielded by a protective blanket of inert gases. Titanium requires a strong, positive pressure of argon or helium as a backup on the root side of the weld, as well as long, trailing, protective tail of argon gas to protect the metal while cooling. Purge chambers and trailing shields are available from CK Worldwide to assist in providing quality results.

MAGNESIUM (ACHF)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	3/32 (2.4 mm)-1/8 (3.2 mm)	5, 6	ARGON	13 (5)	15	60	20 (512 mm)
	FILLET							60	
1/8 (3.2 mm)	BUTT	3/32 (2.4 mm)	1/8 (3.2 mm)-5/32 (4.0 mm)	7, 8	ARGON	19 (9)	15	115	17 (435.2 mm)
	FILLET							115	
1/4 (6.4 mm)	BUTT	3/16 (4.8 mm)	5/32 (4.0 mm)	8	ARGON	25 (12)	15	100-130	22 (563.2 mm)
	BUTT (2)							110-135	20 (512 mm)
1/2 (12.8 mm)	BUTT (2)	1/4 (6.4 mm)	3/16 (4.8 mm)	10	ARGON	35 (17)	15	260	10 (256 mm)

WELDING MAGNESIUM

Magnesium alloys are in three groups, they are: (1) aluminum-zinc-magnesium, (2) aluminum-magnesium, and (3) maganese-magnesium. Since magnesium absorbs a number of harmful ingredients and oxiodize rapidly when subjected to welding heat, TIG welding in an inert gas atmosphere is distinctly advantageous, the welding of magnesium is similar, in many respects, to the welding of aluminum. Magnesium was one of the first metals to be welded commercially by TIG. Magnesium requires a positive pressure of argon as a backup on the root side of the weld.

STAINLESS STEEL (DCSP)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	1/16 (1.6 mm)	4, 5, 6	ARGON	11 (5.5)	20	80-100	12 (307.2 mm)
	FILLET							90-100	10 (256 mm)
1/8 (3.2 mm)	BUTT	1/16 (1.6 mm)	3/32 (2.4 mm)	4, 5, 6	ARGON	11 (5.5)	20	120-140	12 (307.2 mm)
	FILLET							130-150	10 (256 mm)
3/16 (4.8 mm)	BUTT	3/32 (2.4 mm)	1/8 (3.2 mm)	5, 6, 7	ARGON	13 (6)	20	200-250	12 (307.2 mm)
	FILLET	3/32 (2.4 mm)-1/8 (3.2 mm)						225-275	10 (256 mm)
1/4 (6.4 mm)	BUTT	1/8 (3.2 mm)	3/16 (4.8 mm)	8, 10	ARGON	13 (6)	20	275-350	10 (256 mm)
	FILLET							300-375	8 (204.8 mm)

WELDING STAINLESS STEEL

In TIG welding of stainless steel, welding rods having the AWS-ASTM prefixes of E or ER can be used as filler rods. However, only bare uncoated rods should be used. Stainless steel can be welded using ACHF, however, recommendations for DCSP must be increased 25%. Light gauge metals less then 1/16" thick should always be welded with DCSP using argon gas. Follow the normal precautions for welding stainless such as: Clean surfaces; dry electrodes; use only stainless steel tools and brushes, carefully remove soap from welds after pressure testing; keep stainless from coming in contact with other metals.

DEOXIDIZED COPPER (DCSP)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	1/16 (1.6 mm)	4, 5, 6	ARGON	18 (9)	15	110-140	12 (307.2 mm)
	FILLET							130-150	10 (256 mm)
1/8 (3.2 mm)	BUTT	3/32 (2.4 mm)	3/32 (2.4 mm)	4, 5, 6	ARGON	18 (9)	15	175-225	11 (258.6 mm)
	FILLET							200-250	9 (230.4 mm)
3/16 (4.8 mm)	BUTT	1/8 (3.2 mm)	1/8 (3.2 mm)	8, 10	HELIUM	36 (17.5)	15	190-225	10 (256 mm)
	FILLET							205-250	8 (204.8 mm)
1/4 (6.4 mm)	BUTT (2)	3/16 (4.8 mm)	1/8 (3.2 mm)	8, 10	HELIUM	36 (17.5)	15	225-260	9 (230.4 mm)
	FILLET							250-280	7 (179.2 mm)

WELDING DEOXIDIZED COPPER

Where extensive welding is to be done, the use of deoxidized (oxygen-free) copper is preferable over electrolytic tough pitch copper, although TIG welding has been used occasionally to weld zinc-bearing copper alloys, such as brass and commercial bronzes, it is not recommended because the shielding gas does not suppress the vaporization of zinc. For the same reason zinc bearing filler rods should not be used. There is some preference of helium for the inert atmosphere in welding thickness above 1/8" because of the improved weld metal fluidity. Preheating recommendations should be followed.

LOW ALLOY STEEL (DCSP)

METAL GUAGE	JOINT TYPE	TUNGSTEN SIZE	FILLER ROD SIZE	CUP SIZE	SHIELD GAS FLOW			WELDING AMPERES	TRAVEL SPEED
					TYPE	CFH (L/MN)	PSI		
1/16 (1.6 mm)	BUTT	1/16 (1.6 mm)	1/16 (1.6 mm)	4, 5, 6	ARGON	15 (7)	20	95-135	15 (384 mm)
	FILLET							95-135	15 (384 mm)
1/8 (3.2 mm)	BUTT	1/16 (1.6 mm)-3/32 (2.4 mm)-	3/32 (2.4 mm)	4, 5, 6	ARGON	15 (7)	20	145-205	11 (281.6 mm)
	FILLET							145-205	11 (281.6 mm)
3/16 (4.8 mm)	BUTT	3/32 (2.4 mm)	1/8 (3.2 mm)	7, 8	ARGON	16 (6.5)	20	210-260	10 (256 mm)
	FILLET							210-260	10 (256 mm)
1/4 (6.4 mm)	BUTT	1/8 (3.2 mm)	5/32 (4.0 mm)	8, 10	ARGON	18 (8.5)	20	240-300	10 (256 mm)
	FILLET (2)							240-300	10 (256 mm)

WELDING LOW ALLOY STEEL

Mild and low carbon steels with less then 0.30% carbon and less than 1" thick, generally do not require preheat. An exception to this allowance is welding on highly restrained joints. These joints should be preheated 50 to 100°F to minimize shrinkage cracks in the base metal. Low alloy steels such as the chromium-molybdenum steels will have hard heat affected zones after welding, if the preheat temperature is too low. This is caused by rapid cooling of the base material and the formation of martensitic grain structures. A 200 to 400°F preheat temperature will slow the cooling rate and prevent the martensitic structure.

TROUBLE SHOOTING GUIDE FOR GTA (TIG) WELDING

TROUBLESHOOTING GUIDE

PROBLEM	CAUSE	SOLUTION
EXCESSIVE ELECTRODE CONSUMTION	1. Inadequate gas flow. 2. Improper size electrode for current required. 3. Operating of reverse polatiy. 4. Electrode contamination. 5. Excessive heating inside torch. 6. Electrode oxidizing during cooling. 7. Shield gas incorrect.	1. Increase gas flow. 2. Use larger electrode. 3. Use larger electrode or change polarity. 4. Remove contaminated portion, then prepare again. 5. Replace collet, try wedge collet or reverse collet. 6. Increase gas post flow time to 1 sec. per 10 amps. 7. Change to proper gas (no oxygen or Co2).
ERRATIC ARC	1. Incorrect voltage (arc too long). 2. Current too low for electrode size. 3. Electrode contaminated. 4. Joint too narrow. 5. Contaminated shield gas, dark stains on the electrode or weld bead indicate contamination. 6. Base metal is oxidized, dirty or oily.	1. Maintain short arc length. 2. Use smaller electrode or increase current. 3. Remove contaminated portion, then prepare again. 4. Open joint groove. 5. The most common cause is moisture or aspirated air in gas stream. Use welding grade gas only. Find the source of the contamination and eliminate it promptly. 6. Use appropriate chemical cleaners, wire brush, or abrasives prior to welding.
INCLUSION OF TUNGSTEN OR OXIDES IN WELD	1. Poor scratch starting technique.. 2. Excessive current for tungsten size used. 3. Accidental contact of electrode with puddle. 4. Accidental contact of electrode to filler rod. 5. Using excessive electrode extension. 6. Inadequate shielding or excessive drafts. 7. Wrong gas. 8. Heavy surface oxides not being removed.	1. Many codes do not allow scratch starts. Use copper strike plate. Use high frequency arc starter. 2. Reduce the current or use larger electrode. 3. Maintain proper arc length. 4. Maintain a distance between electrode and filler metal. 5. Reduce the electrode extension to recommended limits. 6. Increase gas flow, shield arc from wind, or use gas lens. 7. Do not use Ar-02 or Ar-Co2 GMA (MIG) gases for TIG welding. 8. Use ACHF, adjust balance control for maximum cleaning, or wire brush and clean the weld joint prior to welding.
POROSITY IN WELD DEPOSIT	1. Entrapped impurities, hydrogen, air, nitrogen, water vapor. 2. Defective gas hose or lose connection. 3. Filler material is damp (particulary aluminum). 4. Filler material is oily or dusty. 5. Alloy impurities in the base metal such as sulpher, phosporus, lead and zinc. 6. Excessive travel speed with rapid freezing of weld trapping gases before they escape. 7. Contaminated shield gas.	1. Do not weld on wet material. Remove condensation from line with adequate gas pre-flow time. 2. Check hoses and connections for leaks. 3. Dry filler metal in oven prior to welding. 4. Replace filler metal. 5. Change to a different alloy composition which is weldable. These impurities can cause a tendency to crack when hot. 6. Lower the travel speed. 7. Replace the shielding gas.
CRACKING IN WELDS	1. Hot cracking in heavy section or with metals which are hot shorts. 2. Crater cracks due to improperly breaking the arc or terminating the weld at the joint edge. 3. Post weld cold cracking, due to excessive joint restraint, rapid cooling, or hydrogen embrittlement. 4. Centerline cracks in single pass welds. 5. Underbead cracking from brittle microstructure.	1. Preheat, increase weld bead cross-section size, change weld bead contour. Use metal with fewer alloy impurities. 2. Reverse direction and weld back into previous weld at edge. Use Amptrak or foot control to manually down slope current. 3. Preheat prior to welding, use pure or non-contaminated gas. Increase the bead size. Prevent craters or notches, Change the weld joint design. 4. Increase bead size. Decrease root opening, use preheat, prevent craters. 5. Eliminate sources of hydrogen, joint restraint, and use preheat.
INADEQUATE SHIELDING	1. Gas flow blockage or leak in hoses or torch. 2. Excessive travel speed exposes molten weld to atmospheric contamination. 3. Wind or drafts. 4. Excessive electrode stickout. 5. Excessive turbulence in gas stream.	1. Locate and eliminate the blockage or leak. 2. Use slower travel speed or carefully increase the flow rate to a safe level below creating excessive turbulence. Use a trailing shield cup. 3. Set up screens around the weld area. 4. Reduce electrode stickout. Use a larger size cup 5. Change to gas saver parts or gas lens parts.
ARC BLOW	1. Induced magnetic field from DC weld current. 2. Arc is unstable due to magnetic influences.	1. Change to ACHF current. Rearange the split ground connection. 2. Reduce weld current and use arc length as short as possible.
SHORT PARTS LIFE	1. Short water cooled leads life. 2. Cup Shattering or cracking in use 3. Short collet life. 4. Short torch head life. 5. Gas hoses ballooning, bursting, or blowing off while hot.	1. Verify coolent flow direction, return flow must be on the power cable lead. 2. Change cup size or type, change tungsten position, refer to chart. 3. Ordinary style is split and twists or jams. change to wedge style. 4. Do not operate beyond rated capacity, use water cooled model, do not bend rigid torches. 5. Incorrect flowmeter, TIG flowmeters operate at 35 psi with low flows. MIG flowmeters operate with high flows at 65 psi of more.

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