Airgas
an Air Liquide company

Oxy-Fuel Welding Processes

Oxy-Fuel Processes Overview

Thermal processes that use oxygen and fuel gas (such as acetylene, propane, MAPP, propylene and natural gas) to fuse together materials. Oxy-fuel welding involves joining work pieces by heating them to a temperature that produces a shared pool of molten metal. It can be used on thin to medium thickness metals of many types, steels and nonferrous in all positions. The process is applied manually and requires a relatively high degree of welding skill.

Burning Ratios and Velocities for Oxy-Fuel Processes

Fuel Gases	O2: Fuel Gas Ratio	Velocity in Feet Per Second	BTU	Flame Temp
Acetylene	1.1:1	22.7	1,470	5,720°F
Natural Gas	3.1:1	15.2	1,000	4,500°F
Propane	2.9:1	12.2	2,498	4,700°F
Propylene	2.6:1	15.0	2,372	5,340°F

Fuel Gas Uses

Fuel Gases	Cutting	Welding	Brazing	Heating
Acetylene	✓	✓	✓	✓
Natural Gas	✓		✓	✓
Propane	✓		✓	✓
Propylene	✓		✓	✓

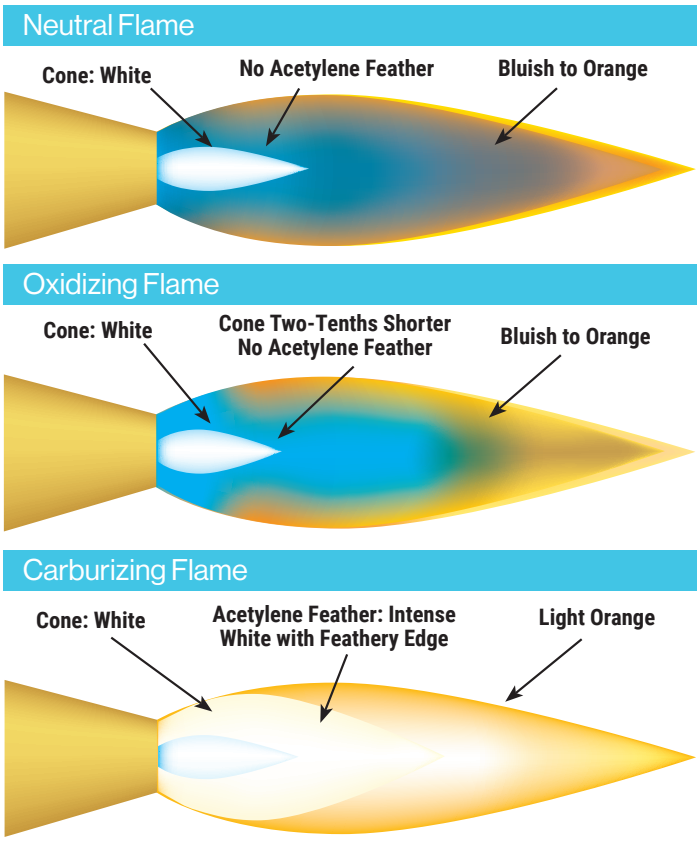
Maximum LPG Withdrawal Rate (%) of Propane per Hour

Pounds in Cylinder (8.67 cf per lb)		0˚F	20˚F	40˚F	60˚F	70˚F
100	SCFH	45	67	85	110	120
	BTU	112,410	167,366	212,330	274,780	299,760
90	SCFH	42	61	80	99	110
	BTU	104,916	152,378	199,840	247,302	247,780
80	SCFH	38	55	72	86	95
	BTU	94,924	137,390	179,856	214,828	237,310
70	SCFH	33	49	64	80	86
	BTU	82,434	122,402	159,872	199,840	214,828
60	SCFH	30	43	56	70	77
	BTU	74,940	107,414	139,888	174,860	192,346
50	SCFH	26	38	50	62	67
	BTU	64,948	94,924	124,900	154,876	167,366
40	SCFH	22	32	42	52	56
	BTU	54,956	79,936	104,916	129,896	139,888
30	SCFH	18	26	34	43	47
	BTU	44, 964	64,948	84,932	107,414	117,406
20	SCFH	14	20	27	33	37
	BTU	34,972	49,960	67,446	82,434	92,426
10	SCFH	11	15	20	24	26
	BTU	27,478	37,470	49,960	59,952	64,948

Maximum LPG Withdrawal Rate (%) of Propylene per Hour

Pounds in Cylinder (9.1 cf per lb)		-0.5˚F	10˚F	20˚F	40˚F	60˚F
105	SCFH	28	56	74	112	148
	BTU	66,416	132,832	176, 002	265,664	352,005
90	SCFH	26	52	69	104	138
	BTU	61,672	123,344	163,431	246,688	326,862
80	SCFH	24	48	64	96	127
	BTU	56,928	113,856	150,859	227,712	301,708
70	SCFH	22	44	58	88	117
	BTU	52,184	104,368	138,288	208,736	276,575
60	SCFH	20	40	53	80	106
	BTU	47,440	94,880	125,716	189,760	251,432
50	SCFH	18	36	48	72	95
	BTU	42,696	85,392	113,144	170,784	226,289
40	SCFH	16	32	42	64	85
	BTU	37,952	75,904	99,624	151,808	201,620
30	SCFH	14	28	37	56	74
	BTU	33,208	66,416	88,001	132,832	176,002
20	SCFH	12	24	32	48	64
	BTU	28,464	56,928	75,904	113,856	151,808
10	SCFH	10	20	27	40	53
	BTU	23,720	47,440	62,858	94,880	125,716

Oxy-Acetylene Flame Characteristics



Soldering

Soldering is a low-temperature analog to brazing. By the American Welding Society's definition, soldering takes place with fillers (also known as solders) that melt at, or below, 840°F (450°C). Metals that can be soldered include gold, silver, copper, brass and iron. The filler, or solder, melts and when it solidifies, it is bonded to the metal parts and joins them. The bond is not as strong as a brazed joint or welded one. Solder was once made mainly of lead, but environmental concerns are pushing the industry to lead-free alternatives.

Preparing Copper before Soldering

1. Measure twice, cut once.
2. Always clean the copper before soldering.
3. Always debur the copper to get rid of burrs caused from cutting copper tubing. If burrs are not removed, flow is restricted and the copper connection will not last.
4. Always use a flux. Apply the flux correctly. Do not over flux.
5. Assembly and support.

Brazing

Torch brazing, or gas brazing is similar to oxy-acetylene welding except the base metal is not melted, and the filler metal is usually a nonferrous metal. The filler metal flows into the joint by capillary attraction. Brazing can be done in all positions on most metals and is especially popular for repair work on cast iron. The process is normally applied manually and requires a relatively high degree of welding skill.

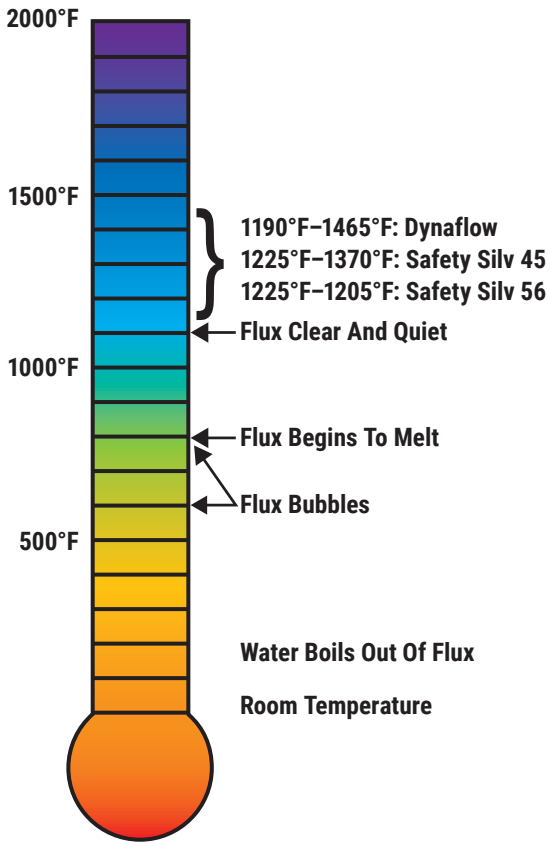
Preparing Copper before Brazing

1. Measure twice, cut once.
2. Always clean the copper before brazing – no exceptions.
3. Always debur the copper to get rid of burrs caused from cutting copper tubing. If burrs are not removed, flow is restricted and the copper connection will not last.
4. Always use a flux. Harris O®, Stay-Silv® 5, 15 and Dynaflow® are self-fluxing on copper. Safety-Silv® 45 and 56 require separate chemical flux.
5. Always purge copper tubing with nitrogen. Nitrogen replaces the oxygen inside the pipe so it does not oxidize the inside of the copper tubing.
6. Assembly and support.

Information on Flux

- Flux prevents copper from oxidizing when copper is heated (Copper oxidizes when exposed to air or heated by a flame).
- Flux acts as a bonding agent for the filler and copper.
- Do not use too much flux.
- Do not touch copper after cleaning.
- Do not apply flux with fingers.

Behavior of Flux During Brazing Cycle



Estimated Amounts of Brazing Alloy Required

1. Locate the tube diameter to be joined and the wire size to be used. Where the row and the column intersect is the approximate length (in inches) of alloy required per joint.
2. Multiply the length of alloy needed per joint by the total numbers of joints.
3. To convert the total length to pounds or troy oz, divide by the inch of alloy/lb in row A, or the inch of alloy/troy oz in row B.

Tube Diameter	3/64 Wire	1/16 Wire	3/32 Wire	1/8"x 0.050" Rod	Tip Size Number	Estimated Acetylene Use (C.F.H.)
1/4"	1 1/4"	3/4"	–	–	4	10–17
3/8"	1 1/2"	1"	–	–	4	10–17
1/2"	2"	1 1/2"	3/4"	7/8"	5	17–30
3/4"	3"	2"	1"	1 1/8"	5	17–30
1"	–	3"	1 1/2"	1 5/8"	6	30–40
1 1/4"	–	4"	2"	2 1/2"	6	30–40
1 1/2"	–	–	2 1/2"	2 3/4"	7	40–50
2"	–	–	3 3/4"	4 1/2"	8	50–75
2 1/2"	–	–	6"	7 1/2"	8	50–75
3"	–	–	10"	11 1/2"	9	65–90
3 1/2"	–	–	12"	13 3/4"	9	65–90
4"	–	–	14"	16"	10	75–100
6"	–	–	21"	23 3/4"	10	75–100
A	1,900"	1,068"	475"	513"	inch of alloy/lb	–
B	118"	67"	29"	–	inch of alloy/troy oz	–

A – Phos/copper/silver alloys Dynaflow®, Stay-Silv®15
B – Silver Brazing alloys. Safety-Silv® 45, 56, etc.

The above figures are approximate and will vary depending on joint clearance and operator technique.

Welding vs. Brazing

Welding

- Acetylene only
- Base metal melted
- Filler metal applied along joint
- Slow
- Greater heat input/larger Heat Affected Zone (HAZ)

Brazing

- Base metal not melted
- Filler metals flows via capillary action
- Rapid process
- Most brazing filler metals melt from 1,100°F to 1,500°F so heat input is minimized