

**LESSON PLAN**

Date\_\_\_\_\_

Trade:- Welder

Name\_\_\_\_\_

Unit/Lesson:-Forty One

**Subject:-** Argon/helium gas properties and uses. GTAW defects ,causes and remedies.**Motivation:-** In previous lesson we discuss GTAW process and other details like Tungsten electrode , welding parameters and equipments ,polarity, Torches etc.**PREPARATION**

- 1) (Materials, Tools, Models, Charts and other aids)

**INTRODUCTION:-** Argon and helium gases are inert gases and use for shield the weld area. GTAW defects are causes due to wrong selection of electrode , positions and filler metals.

Topic	Information Point	Spot Hint	
Argon gas	Argon and helium gases are inert gases and shielding the weld area during Welding from oxidations.		
<b>Properties of Argon and Helium gases</b>			
<b>Chemical Formula</b>	Ar		
<b>Minimum Purity</b>	99.997%		
<b>Normal Boiling Point</b>	-302 °F (-185 °C)		
<b>Liquid Cylinder Outlet CGA</b>	295 (Liquid)		
<b>MSDS</b>	P-4564		
<b>CAS Number</b>	7440-37-1 (R)		
<b>UN Number</b>	1951		
<b>US DOT Name</b>	Argon, Refrigerated Liquid		
<b>US DOT Label</b>	Nonflammable Gas		
<b>US DOT Class</b>	2.2 Nonflammable Gas		
<b>Cylinder Style</b>	<b>Volume (ft<sup>3</sup>)</b>	<b>Pressure (psig)</b>	<b>Part Number</b>
160 Liter	4,460	230	AR LC160-230
200 Liter	4,961	230	AR LC200-230
230 Liter	5,290	230	AR LC230-230
250 Liter	6,080	230	AR LC250-230
450 Liter Microbulk	12,478	350	AR LC450-350
1000 Liter Microbulk	28,225	350	AR LC1000-350
1500 Liter Microbulk	42,950	350	AR LC1500-350

Property	Helium	Neon	Argon	Krypton	Xenon	Radon
Density (g/dm <sup>3</sup> )	0.1786	0.9002	1.7818	3.708	5.851	9.97
Boiling point (K)	4.4	27.3	87.4	121.5	166.6	211.5
Melting point (K)	0.95	24.7	83.6	115.8	161.7	202.2
Enthalpy of vaporization (kJ/mol)	0.08	1.74	6.52	9.05	12.65	18.1
Solubility in water at 20 °C (cm <sup>3</sup> /kg)	8.61	10.5	33.6	59.4	108.1	230
Atomic number	2	10	18	36	54	86
Atomic radius (calculated) (pm)	31	38	71	88	108	120
Ionization energy (kJ/mol)	2372	2080	1520	1351	1170	1037
Allen electronegativity	4.16	4.79	3.24	2.97	2.58	2.60

	Xe	Ar	He	N <sub>2</sub>
Atomic number	54	18	2	7
Atomic mass, amu	131.29	39.948	4.003	14.01
Atomic radius, pm	131	88	49	75
Gas density, (liquid density), kg/m <sup>3</sup>	5.54, (3057)	1.784, (1394)	0.1785, (122)	1.251, (806.5)
Ratio of molar heat capacities, ( $\gamma$ )	1.667	1.667	1.667	1.4
T <sub>crit</sub> , °C @ atm	16.6, (8°C @ 50bar)	(-122°C @ 50bar)	-267.96	(-146.9°C @ 50bar)
T <sub>boil</sub> , °C	-108	-186	-268.785	-195.8
T <sub>melt</sub> , °C	-111.7	-189.3	-272.05	-210.1
Thermal conductivity, W/mK	0.00565	0.01772	0.14	0.02583

## GTAW Defects and Remedies

<p><b>porous welds</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Short arc with exception of low hydrogen and stainless</li> <li>2. Insufficient puddling time</li> <li>3. Impaired base metal</li> <li>4. Poor electrode</li> <li>5. Improper shield coverage</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Check impurities in base metal</li> <li>2. Allow sufficient puddling time for gases to escape</li> <li>3. Use proper current</li> <li>4. Weave your weld to eliminate pin holes</li> <li>5. Use proper electrode for job</li> <li>6. Hold longer arc</li> <li>7. Check shield gas</li> </ol>	<p><b>cracked welds</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Wrong electrode</li> <li>2. Weld and parts sizes unbalanced</li> <li>3. Faulty welds</li> <li>4. Faulty preparation</li> <li>5. Rigid joint</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Design structure to eliminate rigid joints</li> <li>2. Heat parts before welding</li> <li>3. Avoid welds in string beads</li> <li>4. Keep ends free to move as long as possible</li> <li>5. Make sound welds of good fusion</li> <li>6. Adjust weld size to parts size</li> <li>7. Allow joints a proper and uniform gap</li> <li>8. Work with amperage as low as possible</li> </ol>
<p><b>poor penetration</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Speed too fast</li> <li>2. Electrode too large</li> <li>3. Current too low</li> <li>4. Faulty preparation</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Use enough current to obtain desired penetration—weld slowly</li> <li>2. Select electrode according to welding groove size</li> <li>3. Leave proper gap at bottom of weld</li> </ol>	<p><b>poor appearance</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Faulty electrode</li> <li>2. Overhang</li> <li>3. Improper use of electrode</li> <li>4. Wrong arc voltage and current</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Use a proper welding technique</li> <li>2. Avoid overheating</li> <li>3. Use a uniform weave</li> <li>4. Avoid overly high current</li> </ol>
<p><b>warping</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Shrinkage of weld metal</li> <li>2. Faulty clamping of parts</li> <li>3. Faulty preparation</li> <li>4. Overheating at joint</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Peen joint edges before welding</li> <li>2. Weld more rapidly</li> <li>3. Avoid excessive space between parts</li> <li>4. Preform parts before welding</li> <li>5. Use proper sequence</li> <li>6. Clamp or tack parts properly—back-up to cool</li> <li>7. Adopt a proper welding procedure</li> <li>8. Use high speed, moderate penetration process</li> </ol>	<p><b>poor fusion</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Wrong speed</li> <li>2. Current improperly adjusted</li> <li>3. Faulty preparation</li> <li>4. Improper electrode size</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Adjust electrode to match joint</li> <li>2. Weave must be sufficient to melt sides of joint</li> <li>3. Select proper current and voltage</li> <li>4. Keep weld metal from flowing away from plates</li> </ol>
<p><b>undercutting</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Faulty electrode or gun manipulation</li> <li>2. Faulty electrode usage</li> <li>3. Current too high</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Use a uniform weave in butt welding</li> <li>2. Avoid using an overly large electrode</li> <li>3. Avoid excessive weaving</li> <li>4. Use moderate current, weld slowly</li> <li>5. Hold electrode at safe distance from vertical plane in making horizontal fillet weld</li> </ol>	<p><b>brittle welds</b></p> <p><b>WHY</b></p> <ol style="list-style-type: none"> <li>1. Wrong electrode</li> <li>2. Faulty preheating</li> <li>3. Metal hardened by air</li> </ol> <p><b>WHAT TO DO</b></p> <ol style="list-style-type: none"> <li>1. Preheat at 300° to 500° F. if welding on medium carbon steel or certain alloy steels</li> <li>2. Make multiple layer welds</li> <li>3. Stress relieving after welding</li> <li>4. Use low hydrogen processes for increased weld ductility</li> </ol>

<h1>Weld Joint Discontinuities</h1>		
<b>Misalignment (hi-lo)</b>	▪ <b>Inclusions</b>	• <b>Base Metal Discontinuities</b>
<b>Undercut</b>	• Slag	– Lamellar tearing
<b>Underfill</b>	• Wagon tracks	– Laminations and Delaminations
<b>Concavity or Convexity</b>	• Tungsten	– Laps and Seams
<b>Excessive reinforcement</b>	▪ <b>Spatter</b>	
<b>Improper reinforcement</b>	▪ <b>Arc Craters</b>	
<b>Overlap</b>	▪ <b>Cracks</b>	• <b>Porosity</b>
<b>Burn-through</b>	• Longitudinal	– Uniformly Scattered
<b>Incomplete or Insufficient Penetration</b>	• Transverse	– Cluster
<b>Incomplete Fusion</b>	• Crater	– Linear
<b>Surface irregularity</b>	• Throat	– Piping
– Overlap	• Toe	
<b>Arc Strikes</b>	• Root	• <b>Heat-affected zone microstructure alteration</b>
	• Cold or delayed	• <b>Base Plate laminations</b>
	• Underbead and Heat-affected zone	• <b>Size or dimensions</b>

Questions:-

1. Write the boiling point of argon gas?
2. What is penetration and how it is important?
3. Write two GTAW defects and their causes?

Next Lesson:- Friction Welding process, equipments and application. Laser beam welding and electron beam welding.

Assignments:- Argon/helium gas properties and uses. GTAW defects ,causes and remedies.

Checked by.....

Instructor.....