

UNIT III - ARC WELDING

Job Sheet 3.1: Prewelding and Postwelding Procedures for GTAW

Objective

At the completion of this job sheet, the student will be able to set up, adjust, and shut down the machine used for gas tungsten arc welding.

Tools and Equipment Needed

1. GTAW machine and accessories
2. Protective clothing
3. Safety goggles*
4. Helmet
5. Adjustable wrench or appropriate open-end wrench
6. Shielding gas cylinder
7. Tungsten
8. Pliers

* CAUTION: Everyone participating in or observing this procedure should wear appropriate protective eyewear. Safety precautions should be observed while in the shop area.

Materials Needed

1. Metal plates - type and size to be determined by the instructor
2. Filler metal - per instructor

Prewelding Procedures

1. Be sure all equipment is in safe working condition and that proper safety precautions are followed at all times.
2. With the power off, attach the torch hoses to the machine.
3. Check that the gas cylinder is safely secured in an upright position. Remove the cylinder cap. Crack the cylinder to clear the cylinder valve fitting.
4. Attach the flowmeter and regulator to the cylinder valve. Tighten the regulator fitting nut with the wrench, but do not overtighten.
5. Attach the gas hose from the flowmeter to the machine.
6. With the power still off, switch the machine to GTAW, select the type of current, and set the current range according to metal thickness.
7. Set the high frequency switch.
8. Set the spark control for soft start. Set up the remote control, depending on the machine's accessories.
9. Set the shielding gas postflow timer according to electrode size.

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10. Check to be sure that the flowmeter adjusting valve is shut off. If it isn't, turn it clockwise until it is tight.
11. Stand to one side and turn on the cylinder valve.
12. Adjust gas flow according to the size of the electrode.
13. Check for proper and complete circulation in the cooling system and verify that there are no leaks.
14. Select the correct size collet body, collet, and nozzle according to the electrode size.
15. Select and prepare the tungsten.
16. Adjust electrode extension (the length the electrode extends beyond the nozzle opening).
17. Attach the ground clamp to the base metal.
18. Switch on the machine.
19. Position the base metal and hold the torch with the dominant hand. Move the torch so that the nozzle rests on the metal with the electrode about 3/16 in. off the surface.
20. Cover up and remind others in the area to do so as well. Depress the foot control until an arc jumps the gap. Correct the electrode angle as soon as the arc is established.
21. Preheat the starting point until a small molten puddle is formed.
Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
22. Withdraw the filler rod about 1/2 in. from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
23. Move the puddle forward while using the torch to maintain a uniform bead width, then reinsert the filler rod into the center of the molten puddle at the point of the arc, letting a drop or two of filler metal fill the puddle.
24. Repeat the procedure until the stringer bead is completed.
25. Stop at the edge of the plate and release the foot control. Keep the torch in place for a few seconds after the weld is completed.
26. Ask the instructor to check the results of the procedure.

Postwelding Procedure

1. When welding is complete, close the gas cylinder valve. Depress the foot control to bleed the gas line.
2. Shut off the flowmeter, cooling system, and power switch.
3. Remove the electrode from the torch and return it to its proper storage.
4. Remove the collet, collet body, and nozzle and return them to their proper storage.
5. Disconnect the ground clamp.
6. Roll cables neatly. Return any remaining materials and equipment to their proper places.
7. Clean the work area.
8. Ask the instructor to check the results of the procedure.

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Job Sheet 3.2: Welds in the Flat Position

Objective

At the completion of this job sheet, the student will be able to perform butt, lap, and T-fillet welds in the flat position using a GTAW welder.

Tools and Equipment Needed

1. GTAW machine and accessories
2. Protective clothing
3. Safety goggles*
4. Helmet
5. Adjustable wrench or appropriate open-end wrench
6. Shielding gas cylinder
7. Tungsten
8. Pliers

* CAUTION: Everyone participating in or observing the procedure should wear appropriate protective eyewear. Safety precautions must be observed while in the shop area.

Materials Needed

1. Filler metal - per instructor
2. Mild steel plates - size to be determined by the instructor

Prewelding Procedure

Refer to JS 3.1 for prewelding procedures.

Welding Procedure

BUTT JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a butt joint. "Cover" should be said before striking an arc. If the metal is thicker than 1/8 inch, the edges of the joint should be beveled to increase penetration. A space, approximately 1/16 inch, should be left between the metal plates to increase penetration of the weld.
2. Position the metal so that the joint to be welded will be in flat position.
3. The electrode should be perpendicular to the surface of the weld and pointed forward with the torch approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.

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5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

LAP JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a lap joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in flat position.
3. The electrode should be held at a 45 degree angle to the surface of the weld and pointed forward at approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

T-FILLET JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a T joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in flat position.
3. The electrode should be held at a 45 degree angle to the surface of the weld and pointed forward at approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.

7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

Postwelding Procedure

Refer to JS 3.1 for postwelding procedures.

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Job Sheet 3.3: Welds in the Horizontal Position

Objective

At the completion of this job sheet, the student will be able to perform a butt, lap, and T-fillet weld in the horizontal position using a GTAW welder.

Tools and Equipment Needed

1. GTAW machine and accessories
2. Protective clothing
3. Safety goggles*
4. Helmet
5. Adjustable wrench or appropriate open-end wrench
6. Shielding gas cylinder
7. Tungsten
8. Pliers

* CAUTION: Everyone participating in or observing the procedure should wear appropriate protective eyewear. Safety precautions must be observed while in the shop area.

Materials Needed

1. Filler metal - per instructor
2. Mild steel plates - size to be determined by the instructor

Prewelding Procedure

Refer to JS 3.1 for prewelding procedures needed to prepare for horizontal position welding.

Welding Procedure

BUTT JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a butt joint. "Cover" should be said before striking an arc. If the metal is thicker than 1/8 inch, the edges of the joint should be beveled to increase penetration. A space, approximately 1/16 inch, should be left between the metal plates to increase penetration of the weld.
2. Position the metal so that the joint to be welded will be in the horizontal position.
3. The torch should be held 75 to 80 degrees to the surface of the weld and the back of the torch should be tipped downward so that the electrode is pointing up toward the weld at a 15 degree angle. The filler rod is held at a 20 degree angle to the plate.
4. Lower the helmet and strike the arc.

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5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

LAP JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a lap joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in the horizontal position.
3. The electrode should be held 45 degrees to the surface of the weld and pointed forward at 70 to 80 degrees from the weld axis. The filler rod is held at a 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

T-FILLET JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a T joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in the horizontal position.
3. The electrode should be held 45 degrees to the surface of the weld and pointed forward at 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.

7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

Postwelding Procedure

Refer to JS 3.1 for postwelding procedures.

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Job Sheet 3.4: Welds in the Vertical Position

Objective

At the completion of this job sheet, the student will be able to perform a butt, lap, and T-fillet weld in the vertical position using a GTAW welder.

Tools and Equipment Needed

1. GTAW machine and accessories
2. Protective clothing
3. Safety goggles*
4. Helmet
5. Adjustable wrench or appropriate open-end wrench
6. Shielding gas cylinder
7. Tungsten
8. Pliers

* CAUTION: Everyone participating in or observing the procedure should wear appropriate protective eyewear. Safety precautions must be observed while in the shop area.

Materials Needed

1. Filler metal - per instructor
2. Mild steel plates - size to be determined by the instructor

Prewelding Procedure

Refer to JS 3.1 for prewelding procedures.

Welding Procedure

BUTT JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a butt joint. "Cover" should be said before striking an arc. If the metal is thicker than 1/8 inch, the edges of the joint should be beveled to increase penetration. A space, approximately 1/16 inch, should be left between the metal plates to increase penetration of the weld.
2. Position the metal so that the joint to be welded will be in the vertical position. For thicker metal, it is best to weld with the weld pool moving from the bottom to the top, or vertically up. For thinner metal, it is best to weld with the pool moving from the top to the bottom, or vertically down.
3. The torch should be held perpendicular to the surface of the weld and tipped down so that the torch is 75 to 80 degrees from the base metal. The filler rod is held at an angle of approximately 35 to 45 degrees to the plate.

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4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in weld to the instructor for grading.

LAP JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a lap joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in the vertical position. For thicker metal, it is best to weld with the weld pool moving from the bottom to the top, or vertically up. For thinner metal, it is best to weld with the pool moving from the top to the bottom, or vertically down.
3. The torch should be centered over the root of the weld and tipped down so that the torch is 75 to 80 degrees from the base metal. The filler rod is held at an angle of approximately 35 to 45 degrees to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in weld to the instructor for grading.

T-FILLET JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a T joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in the vertical position. For thicker metal, it is best to weld with the weld pool moving from the bottom to the top, or vertically up. For thinner metal, it is best to weld with the pool moving from the top to the bottom, or vertically down.
3. The torch should be centered over the root of the weld and tipped down so that the torch is 75 to 80 degrees from the base metal. The filler rod is held at an angle of approximately 35 to 45 degrees to the plate.

4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in weld to the instructor for grading.

Postwelding Procedure

Refer to JS 3.1 for postwelding procedures.

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Job Sheet 3.5: Welds in the Overhead Position

Objective

At the completion of this job sheet, the student will be able to perform a butt, lap, and T-fillet weld in the overhead position using a GTAW welder.

Tools and Equipment Needed

1. GTAW machine and accessories
2. Protective clothing
3. Safety goggles*
4. Helmet
5. Adjustable wrench or appropriate open-end wrench
6. Shielding gas cylinder
7. Tungsten
8. Pliers

* CAUTION: Everyone participating in or observing the procedure should wear appropriate protective eyewear. Safety precautions must be observed while in the shop area.

Materials Needed

1. Filler metal - per instructor
2. Mild steel plates - size to be determined by the instructor

Prewelding Procedure

Refer to JS 3.1 for prewelding procedures.

Welding Procedure:

BUTT JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a butt joint. "Cover" should be said before striking an arc. If the metal is thicker than 1/8 inch, the edges of the joint should be beveled to increase penetration. A space, approximately 1/16 inch, should be left between the metal plates to increase penetration of the weld.
2. Position the metal so that the joint to be welded will be in the overhead position.
3. The electrode should be perpendicular to the surface of the weld and pointed forward with the torch approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.

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5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in weld to the instructor for grading.

LAP JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a lap joint. "Cover" should be said before striking an arc. If the metal is thicker than 1/8 inch, the edges of the joint should be beveled to increase penetration.
2. Position the metal so that the joint to be welded will be in the overhead position.
3. The electrode should be held at a 45 degree angle to the surface of the weld and pointed forward at approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.
6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in the weld to the instructor for grading.

T-FILLET JOINT

1. Lower the helmet. Tack weld two pieces of mild steel together to form a T joint. "Cover" should be said before striking an arc.
2. Position the metal so that the joint to be welded will be in the overhead position.
3. The electrode should be held at a 45 degree angle to the surface of the weld and pointed forward at approximately 70 to 80 degrees from the weld axis. The filler rod is held at a 15 to 20 degree angle to the plate.
4. Lower the helmet and strike the arc.
5. Move the filler rod into the leading edge of the molten puddle and let a drop or two of molten filler metal fill the puddle.

6. Withdraw the filler rod about 1/2 inch from the arc so the torch and puddle can be moved in the direction of travel; be sure to keep the end of the rod in the shielded area.
7. Advance the puddle while using the torch to maintain a uniform bead width. Then reinsert the filler rod into the center of the molten puddle at the point of the arc; let a drop or two of molten filler metal fill the puddle.
8. Repeat the procedure until the weld is complete.
9. Stop just as you reach the end of the plate and let off the foot control. Keep the torch in place for a few seconds after the end of the weld.
10. Examine the weld for penetration and bead appearance.
11. Turn in weld to the instructor for grading.

Postwelding Procedure

Refer to JS 3.1 for postwelding procedures.

