Brief Information of

Aluminium and Aluminium Alloy Welding Wire (Rod)

A) Choosing Welding Wire (Rod)

The choice of aluminium and aluminium alloy welding wire (rod) mainly depends on the type of base metal and the required degree of crack resistance, tensile strength and corrosion resistance of the welded joint. When contradiction arises between certain terms, then the choice of welding wire (rod) shall emphasize on solving the relevant contradiction and at the same time considering the other requirements. Normally the welding wire (rod) should be of same composition or similar specification norm as the base metal in order to achieve higher corrosion resistance. But in welding heat treatment strengthened aluminium alloy which has a high tendency of crackle, the wire (rod) should emphasize on crack resistance, in which case there will be great difference in the composition between the welding wire (rod) and the base metal.

Points to be considered in choosing aluminium alloy welding wire (rod):

a) Crack sensitivity of the welded joint
   The matching of base metal and welding wire (rod) will directly affect the crack sensitivity. To chose the wire (rod) which melting temperature is lower than the base metal will reduce the crack sensitivity of the weld metal as well as the heat affected area. For instance, when welding 6061 aluminium alloy containing 0.6% Si, if we use the same alloy to be the consumable, the crack sensitivity will be higher and if we use ER4043 one, which containing 5% Si, due to its melting temperature is lower than 6061 alloy, it has a higher plasticity during the cooling process and hence the crack resistance is higher. Besides, it is important to avoid the combining of Mg and Cu in the weld metal because Al-Mg-Cu combination has very high crack sensitivity.
b) Mechanical properties of the welded joint
   Pure industrial aluminium has the lowest tensile strength and tensile strength of 4000 series alloy is medium while 5000 series alloy has the higher tensile strength. Even though silicon-aluminium welding wire (rod) has higher crack resistance but it has a poorer plasticity. Hence, for the welded joints which require plastic deformation processing after welding the wire (rod) containing silicon should not be chosen.
c) Usability of welded joint
   Choice filler metal not only depends on the composition of the base metal but also depends on the geometry of the welded joint and the corrosion resistance of the welded joint during daily operation as well as the required appearance of weldment, e.g. in order to have a good corrosion resitance of a container or to prevent polluted by the contained material, welded container for hydrogen peroxide requires a high purity aluminium alloy, in this case, purity of the filler metal should at least be equal to the base metal.

B) Choosing Shield Gas

a) Quality requirement of shield gas

Shield gas	Purity (%)	Moisture (%)	Others
Ar	99.99	0.002	N2≤0.007%, H2≤0.002%

b) Shield Gas

The Shield Gas used for aluminium and aluminium alloy welding are argon (Ar), helium (He) or their mixture. AC current with high frequency TIG welding should use pure Ar gas. For MIG welding, when plate thickness less than 25mm Ar gas should be used, when plate thickness between 25mm~50mm Ar+10%~35%He gas should be used, when plate thickness between 50mm~75mm, Ar+30~50%He gas should be used and when plate thickness is more than 75mm the Ar+50%~75%He gas is recommended. Argon should meet the requirement of pure and when pressure of the gas in the cylinder drop below 0.5MPa it is insufficient for use.

C) Defects in Welding and preventive measures

a) Blowholes

Causes of its occurrence:

1) Base metal or welding wire (rod) contaminated by oil contamination, rust, oxide coating, moisture, etc.
2) Strong air circulation around welding site affects the gas shielding.
3) Over Arc length will lower the effect of gas shielding.
4) Distance between the nozzle and weldment is too far, hence lowering the effect of gas shielding.
5) Inappropriate choice of welding parameter.
6) The point of repeated arc starting easy to produces blowholes.
7) Low shield gas purity causing poor gas shielding effect.

Preventive Measures:

1) Thorough cleansing of welding wire (rod) and the surface to be welded from oil contamination, rust, oxide coating, moisture, etc. and using welding wire (rod) that with higher deoxidant.
2) Choosing an ideal welding site.
3) Appropriately reduce the arc length.
4) Maintaining appropriate distance between the nozzle and the weldment.
5) As far as possible choosing welding wire (rod) with larger diameter and increase thickness of root face of the groove. At the same time to allow using higher current to reduce the ratio of consumable in the weld metal. It will be effectively reduce the occurrence of blowholes.
6) As far as possible, do not repeat arc starting at the same point and if need be, it is necessary to grind and scrap the point of arc starting. After arc starting, as much as possible to extend the welding length or should not current interruption unnecessarily in order to reduce amount of joints and at the joints should have weld overlap area.
7) Changing pure shield gas.
8) Checking the strength of airflow of the shield gas.
9) Preheating the base metal.
10) Checking the gas dewpoint (air humidity should be ≤70% preferably), and checking the case of gas leak and gas hose damage also.

b) Crack

Causes of its occurrence:

1) Inappropriate structural design, weld lines laid out too closely causing the welded joints are subjected by over restraint intensity.

2) The alloy elements in the weld joint are burned loss too much due to oversize and overheat molten pool.
3) Rapid cooling of the crater at the terminal of the weld joint.
4) Incompatible composition of welding wire (rod) and base metal;
5) The ratio of depth with width of the weld joint is too large.

Preventive Measures:

1) Proper structural design of the weldment, appropriate lay out of the weld lines to stay away from the region of stress concentration and welding in proper order.
2) Reducing welding current or appropriately increase the welding speed.
3) Take correct processing in ending stage of welding and add in run-off tab or using a facility of current decay to fully fill up the crater.
4) Choosing welding wire (rod) properly.

c) Poor Appearance of weld joint

Causes of its occurrence:

1) Improper choice of welding specification.
2) Incorrect inclination angle of the welding gun.
3) Inexperience of welding operator.
4) Over-sized diameter of nozzle hole of the contact tube.
5) Presence of moisture attaches on welding wire (rod) and weldment or there is moisture in shield gas.

Preventive Measures:

1) Repeated testing and adjusting to choose an appropriate welding specification.
2) Maintain proper inclination angle of welding gun.
3) Choosing suitable diameter of nozzle hole of the contact tube.
4) Pre-welding cleaning of welding wire (rod) and welded metal and ensure purity of the shield gas.

d) Burn Through

Causes of its occurrence:

1) Excessive heat input.
2) Incorrect groove machining or welding gap of the weldment is too large.
3) Over distance of the interval of the welding spots during spot welding and higher deflection emerged during welding operation.

Preventive Measures:

1) Appropriately reducing the welding current, arc voltage and increasing welding speed.
2) Amplifying the height of root face and decreasing root interval of the groove.
3) In spot welding, suitably reduce the interval distance of the welded spot.

e) Incomplete Penetration

Causes of its occurrence:

1) Welding speed is too fast or welding arc is too long.
2) Incorrect groove machining and welding gap of the weldment is narrow.
3) Welding current is too small.

4) Welding current is unstable.

Preventive Measures:

1) To reduce welding speed and adjusting welding arc to suitable level.
2) To reduce the height of root face or increase root interval of the welding groove.
3) To increase the welding current and Arc voltage to ensure sufficient heat input to the base metal.
4) To add current stabilizer.
5) Smaller diameter wire (rod) helps in increasing depth of penetration and bigger one will increase the deposition efficiency.

f) Lack of Fusion

Causes of its occurrence:

1) Welded surface is not cleaned with oxide coating or rust.
2) Insufficient of heat input.

Preventive Measures:

1) Pre-welding cleaning the surface to be welded.
2) To increase the welding current and arc voltage, and to reduce welding speed.
3) For thick plate, single U butt joint should be adapted and usually do not adapt single V butt joint.

g) Slag Inclusion

Causes of its occurrence:

1) Pre-welding Cleaning is not thorough.
2) Excessive welding current causing partial of the contact tube melted into the molten pool and resulted in slag inclusion.
3) Welding speed is too fast.

Preventive Measures:

1) Thorough pre-welding cleaning. For multi-pass welding, the welding groove should be cleaned after completing each and every pass.
2) While ensuring proper penetration, suitably reduce welding current. During high current welding the contact tube should not be too close to the weldment.
3) Suitably reduce welding speed and using welding wire with higher deoxidant. To increase arc voltage.

h) Undercut

Causes of its occurrence:

1) Excessive welding current and welding voltage is too high.
2) Welding speed is too fast so consumable deposited too little.
3) Uneven weaving of welding gun.

Preventive Measures:

1) To adjust to suitable welding current and arc voltage.
2) Suitably increase wire (rod) feeding speed and/or lowering welding speed.
3) Ensuring weave welding gun well-distributed.

i) Welding joint contamination

Causes of its occurrence:

1) Inappropriate shield gas covering.
2) Welding wire (rod) is not clean.
3) Base metal is not clean.

Preventive Measures:

1) To check for any leakage of the gas delivering hose, loosening of gas nozzle and using correct shield gas.
2) Ensure proper storage of the wire.
3) First step to clean the oil and/or oily substances from the welding region then applying any other mechanical cleaning.
4) To remove any oxidate from the welding region before using stainless steel brush.

j) Unstable arc

Cause of its occurrence:

1) Joining, dirt or windy.

Preventive Measures:

1) To check all current conducting parts and keeping their surface clean.
2) To clean out all dirt at the joint.
3) As far as possible to avoid welding at places where the air current are not stable.

k) Poor Wire (rod) Feeding

Cause of its occurrence:

1) Contact tube is jammed by melting wire (rod).
2) Welding wire (rod) damaged by abrasion.
3) Fluctuating voltaic arc.
4) Wire delivery tube too long or too tight.
5) Inappropriate or damaged wire feeder.

Preventive Measures:

1) To lower tensile force of the wire feeder and uses slower starting system.
2) To check condition of all welding wire contacting surfaces and to minimize metal to metal contact.
3) To check the condition of the contact tube, wire delivery tube and the wire feed roll.
4) To check whether the diameter of the contact tube is compatible with the wire (rod).
5) To use good quality contact tube to prevent broken wire during wire delivery process.
6) To check condition of damage of the welding wire spool.
7) To choose suitable size, shape and good surface condition of the wire feed roll.

l) Weak Arc Striking

Causes of its Occurrence:

1) Poor earth connection.
2) Inappropriate diameter of contact tube.
3) No shield gas.

Preventive Measures:

1) To check whether earth connections are proper. Using slower starting or heat starting method to ensure easier arc starting.
2) To check whether the contact tube is jammed by melting wire or not.
3) Using air pre-cleaning function.
4) Changing welding parameters.

D) Storage for Welding Wire (rod) and Preventive Measures for Oxidation

a) The storeroom should be arefaction and ventilated. The temperature is better 10℃-40℃ and relative humidity (RH) ≤60%. Moisture should be avoided and repulsing any liquid or mordant effumability materials, such as water, acid, alkali and so on, far away from fire also.

b) The welding wire (rod) can not be put on ground directly and it should be put on pallets that made by wooden/metal/ plastic and the distance of the wire (rod) against the wall of storeroom at least 300mm.

c) Moving wire (rod) must be careful and do not damage any package of the wire. Shifting a full spool/reel of uncovered wire with short distance should use fingers of two hands to hook two ends of the inner bore instead to shift it when it flatwise.

d) When open a package of the wire (rod) it is better to run out of it in short time and it can not be exposed in atmosphere exceed 40 hours if not it easy be oxidation particularly in the environment with moisture and mordant.

e) Take the principle of first-in, first-out to use the wire (rod) to shorten the storage time.

f) It is important to store the wires (rods) respectively according to the types and specifications and do not misapplication.