Reducing Porosity in Aluminium Welds

Caused predominantly by the absorption of hydrogen in the weld pool, porosity can be a significant problem when welding aluminium. While there are a number of causes of porosity, minimising its effect is possible, with the proper cleaning, preparation, tools and techniques.

Causes of Porosity
While solid aluminum has a very low solubility for hydrogen, molten aluminum has a very high solubility. When the weld metal is in a molten state, it absorbs a significant amount of hydrogen. It will then try to expel this hydrogen as the weld metal solidifies. If the weld is solidifying quickly, it is unable to purge the hydrogen, which forms porosity.

Sources of Hydrogen
Common sources of hydrogen include moisture and hydrocarbons from contaminants (such as oil, grease, solvents and lubricants) on the parent metal, filler metal, the atmosphere, and even surfaces that come in contact with the weld area.

If any of these contaminants come into contact with the welding arc, the heat from the arc breaks them down, reducing them to hydrogen and a number of other foreign substances.

Another common source of hydrogen in welding aluminium is its resilient refractory oxide film—the material that makes aluminium resistant to corrosion. Oxide film must be removed prior to welding, not only to eliminate the risk of hydrogen absorption, but also because of its high melting point—over 2,000°C, compared to the 660°C melting point of aluminium.

Avoiding Porosity in Welding
In order to avoid porosity while welding aluminium, it is essential that the surface of the material is thoroughly cleaned, either through mechanical cleaning or chemical etching. This cleaning process will remove the oxide film, as well as other surface contaminants. Particular care should be taken to remove all oil, other hydrocarbons, and loose particles from sheared edges.

Once all surfaces have been thoroughly cleaned, welding should occur as soon as possible; the interval between cleaning and welding should not exceed six hours. If it does, oxide film will re-form, and the cleaning process will need to be repeated.

MIG or TIG Welding Aluminium
When MIG or TIG welding, it is also important to check the cleanliness of filler wire. Ideally, filler wires should be kept in their packaging until needed; wire that is left out in the open in workshops has a tendency to absorb moisture into its oxide layer. Wipe each filler wire prior to use with a clean rag dipped in acetone to ensure its cleanliness.

All filler wire should be purchased in accordance with the recognised standard (in either a shaved or double-shaved format) to ensure that the residues from drawing lubricants (the primary source of hydrogen in aluminium filler wire) are removed.

Tools for Welding Aluminium
When it comes to tools for cleaning and welding aluminium, the most important thing to remember is to use specific tools for aluminium only. This will help reduce cross contamination, thereby reducing one of the most common sources of hydrogen.

Special attention should also be given to the gas supply system, including the quality and integrity of welding torches. Gas supply lines and hoses should be of a high quality and, where possible, made from non-hygroscopic materials (like neoprene) or metal.
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Tips to Prevent Porosity in Aluminium Welding

Sound Preparation. To avoid porosity, maintain a clean workspace and materials. Ensure that the part and filler wires are degreased before welding commences—wipe down the surface of the material with a clean rag dipped in degreasing solvent, such as acetone. Alcohols are not good degreasers and should not be used for pre-weld cleaning. Following degreasing, deoxidize the aluminum by using a stainless steel wire brush.

Correct Shielding Gas Flow Rate. For gas metal arc welding, the flow rate should be at least 10 to 35 Litres/min, depending on the thickness of the material. Argon and helium gas mixtures require even higher flow rates. For gas tungsten arc welding, the flow rate should be 6 to 15 Litres/min, depending on the thickness of the material.

Reduce Nozzle-to-Work Distance. The distance between the nozzle and the material should be as small as possible, preferably 1cm to 2cm. Larger distances can draw in air and other contaminants.

Ensure Proper Gun Angle. Aluminum welding requires a leading gun angle. If a drag angle or 90-degree angle is used, porosity will appear.

Sources:
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