The management of welded aluminium fabrication – Part II

In the second part of this series, Tony Paterson discusses the welding of aluminium at workshop management and fabrication level, and the challenges faced by the welder.

Aluminium welding requires more skill and attention to detail than does mild steel welding.

At a workshop management level, the choice of the appropriate alloy and the associated filler wire and diameter is important from the points of view of weld integrity, strength and avoiding hot cracking.

The filler wire may be chosen to facilitate weld integrity or to improve the strength of the weld. The distinction between the two is in the method of welding. If procedures have been developed, as is the case with series production, and the fabrication suits automation, a matched filler will ensure improved strength in the weld. However, because aluminium does not change colour when welded, it is difficult for welders to use matched fillers to avoid burning through the parent material and achieving correct penetration and fusion.

This is where the filler choice of higher alloyed filler is better, as the melting point of the more highly alloyed filler is lower than the parent material. It assists welders in achieving the required penetration and fusion, and ensures weld integrity at the expense of some strength. In the case of fatigue, weld integrity is a better choice than strength.

At a fabrication level, aluminium is intolerant of fit up or alignment problems. The reason for this is a combination of the thermal conductivity of aluminium plus the development of the heat affected zone. Simply, unlike mild steel where, while it is not good practice, gaps can be filled, aluminium is far more gap sensitive. Time spent in good attention to fit and alignment is well worthwhile. This applies particularly to critical joints.

Welding cannot be checked simply by looking at it. The appearance tells little.

The welder faces several issues, and these sets of influences include:

External issues: Both hydrogen and oxygen are problems affecting welding. Hydrogen has a high absorption in molten aluminium; this reversing as the metal solidifies leaving porosity. Aluminium has a high melting point leaving unwetted solids in the weld. Both oxygen and hydrogen are derived from water.

Thus humidity in excess of 75% is a problem; this implies weld metal temperatures at least 3° above dew point. Wind can be a problem as aluminium welding is under an inert gas, normally argon. The inert gas shield is fragile as the gas flow needs to be high enough to keep oxygen away and low enough not to disturb the weld pool.

Internal issues: The welder must assume that the designer has selected a weldable alloy. However, equipment conditions do need to be ensured. In particular, contamination in the form of moisture, say from leaking tool cooling water or from dirty filler wire, will cause trouble. If wire is removed from the Teflon-lined wire feed without care, succeeding welding can pick up Teflon particles.

The inert gas needs to be the purest possible, purer than medical purity, to avoid contaminants.

Weld planning: The weld significance forms a guide to the degree of care required on a specific joint. About 5% of welds are those which are the highest stressed and likely to fail first. Weld procedures are normally developed for these welds. Normally, the design assumption is that welds are downhand. This is particularly important with key welds. The welding sequence plan is developed to best avoid the effects of heat leading to distortion. This is particularly important with thin panels as the volume to surface area ratio is high.

Welding: The welding machine needs to be set for the operation. Modern machines include pre-programmed settings that are suited to differing materials, fillers and wire diameters. The filler wire should be clean, grease and moisture free. Dirty filler wire will not give an adequate weld. As far as the weld area is concerned, given that the fit up is correct, the joint area may need to be prepared to introduce a 70-80° internal, single or double V with a 1,0 mm thick landing.

Fabrication degreasing and oxide removal (in the same half shift as the welding process) are essential processes.

However, as discussed above, one of the more important aspects remains that the welder is not assisted by colour change in the material. Pressed not to burn through the parent material, the tendency is to weld with insufficient fusion and/or penetration.

Procedures that assist the welder such as regular bend testing of test pieces and, possibly more modern welding machines (which do not cost much more than simple machines and which, in my view, pay for themselves in avoiding rework) are worth considering.

Conclusion

As can be seen, there is more to welded fabrication that meets the eye. Aluminium welding requires more skill and more attention to detail than does mild steel welding. If we do not get the full set of welding and welding circumstances right, we will fail in our endeavour to develop markets.