Utilizing Advantages of Electron Beam Welding to Join Aluminum Components

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The high energy-density electron beam welding process, both the vacuum and nonvacuum segments of the process, offers distinct advantages for welding high thermal conductivity materials such as aluminum. The high energy density of the electron beam welding process and efficiency of energy transfer from beam to part produces welds with minimal distortion and low thermal effects. This is of particular importance for welding parts with heat sensitive components (seals, electronics, etc.) or complex part geometries with long weld lengths that can take advantage of the precision of the electron beam welding process, especially under CNC control.

When performed in vacuum, electron beam welding (EBW) can produce very narrow welds with a minimum of heat input but minimal gap and careful preparation of the joint faying surfaces is generally required. Puddling of the beam in vacuum allows for more joint tolerance but with more heat input which may or may not be acceptable for the component or the alloy being welded. When electron beam welding out of a vacuum – i.e. when employing the nonvacuum EBW (NVEBW) mode of electron beam welding, the diffused beam that results is inherently capable of adapting to a much lower degree of joint preparedness but again at the expense of additional heat input. In both cases, though, the welding of aluminum is accomplished at a relatively high joining speed and with a 99% efficient transformation of the beam's energy into workpiece input energy providing far less thermal distortion and overall heating of the part during welding compared with more conventional welding processes. Examples of the application of the electron beam welding process both in and out of vacuum are provided in industries including automotive, semi-conductor, aerospace and others. Autogenous welding of aluminum alloys as well as the use of filler materials to improve the metallurgical properties are shown for both complicated weld paths and simple circumferential welds. Beam parameters are adjusted to compensate for joint types, weld depth requirements (which may range from 2mm to 25mm), and the heat tolerance of the part being welded in order to provide the optimal weld geometry for the particular component. In having the capability to adjust the parameters for different part and joint geometries, the process has unique versatility for welding aluminum components.