

1.4 Ultrasonic Stir Welding

Statement: Ultrasonic stir welding technology to join large pieces of very high-strength metals such as titanium and Inconel.

Problem addressed: There exists a need for a tool and method for performing stir welding which must rely primarily on a single unique rate of revolution to control the coupled stir pin and shoulder, shoulder pressure and heat input.

Solution: Ultrasonic stir welding, a solid-state weld process, improves current thermal stir welding processes by adding high power ultrasonic energy at 20 kHz frequency. The addition of ultrasonic energy significantly reduces axial, frictional, and shear forces; increases travel rates; and reduces wear on the stir rod, which results in extended stir rod life.

Technology description: Ultrasonic stir welding is a solid state stir welding process where the weld work piece does not melt during the welding process. The process uses a stir rod to stir the plasticized abutting surfaces of two pieces of metallic alloy that forms the weld joint. The heating is done using a specially designed induction coil. The control system has the capability to pulse the high-power ultrasonic energy of the stir rod on and off at different rates. This pulsing capability allows the stir rod to act as a mechanical device (moving and stirring plasticized nugget material) when the high-power ultrasonic energy is off and allowing the energized stir rod to transfer energy into the weld nugget (to reduce forces, increase stir rod life, etc.) when the ultrasonic energy is on. The process can be used to join high-melting-temperature alloys such as titanium, Inconel, and steel.

Benefits of the product: This new technology presents several advantages over existing technologies. These are:

- Improved weld's properties.
- Increased tool life (stir rods, bushings, containment plates).
- Automated closed-loop feedback control.
- Potential for integration into robotic welders.
- Reduced axial and shear consolidation forces.
- Potential for handheld version.
- Reduced friction without lubricants.

Areas of application: This technology offers a wide array of industrial applications, including:

- Aerospace - hardware for severe environments, launch vehicles, aircraft.
- Automotive - pistons, struts, vehicle structure.
- Marine - shipbuilding, platforms.
- Civil - bridges, trains, pressure vehicles.