Tool Geometry and Pressure Influence on Thermal Profiles in FSSW joints Using a Custom-Built Welding Machine

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Friction Stir Welding (FSW) is a solid-state joining technique known for producing high-quality welds without melting the base material. However, its industrial adoption is limited due to the bulky nature of conventional FSW equipment. This study presents the design and fabrication of a portable Friction Stir Spot Welding (FSSW) machine intended for flexible and cost-effective use in small-scale industries. The system integrates a drill motor, hydraulic actuator, machine bed, and headrest, with a pressure capacity of up to 120 kPa. Experimental investigations were carried out on 1 mm thick AA6063 aluminum alloy sheets using three tool geometries—circular, triangular, and square—at different pressures. Joint variants such as Double Spot FSW (DSFSW) and Double spot Zigzag FSW (DSZFSW) were also explored to analyze the peak temperature generated during the welding of aluminium alloy sheets using circular, triangular, and square tool profiles at applied pressures of 100KPa, 110KPa, and 120 KPa. The temperature was measured in heat affected zone where the square pin consistently produced the highest temperatures, followed by triangular and circular tools. This study contributes to the advancement of FSSW technology by exploring new approaches to joint design and fabrication.

Index Terms—Friction Stir Spot Welding (FSSW), Temperature Analysis, Dwell Time, DSZFSW, DSFSW, Friction Welding Machine