Chapter 9
Maximization of Tensile Strength of Aluminum 6061 Alloy T6 Grade Friction Welded Joints by Using the Desirability Function

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ABSTRACT

Various joining techniques are consistently used in fabrications and maintenance applications of numerous parts in manufacturing industries. Typically, the friction welding technique acquired attention in joining of aluminum and its different alloys for very general structural usages in small to medium to large-scale manufacturing sectors. This is an experimental attempt to weld aluminum 6061 alloy T6 grade of 3mm thickness metal sheets. The hexagonal-shaped steel pin of grade H13 is used. The experiment is performed by using the Taguchi L9 approach, and nine welded specimens are prepared. The chosen factors are rotating speed of the tool, tilting angle, and feed. After the welding, the tensile testing is followed for the measurement of strength of the welded samples. The analysis suggested that the chosen working limits of feed and rotational speed is significant and having impacts on weld strength. The maximum strength is obtained as 212MPa when the ranges of above said factors are 560RPM, 0degree, and 20mm/min.

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INTRODUCTION OF FRICTION WELDING TECHNIQUE AND LITERATURE STUDIES

The friction welded joints were notably fabricated initially by the insertion of a rotated and not consumable tool in the adjoining interfaces of the two metal sheets (Maneiah & Debashis Mishra, 2020). The welding actions performed were named such as plunging, dwelling, welding by the traverse of the tool, dwelling, and to the end dragging the tool out. Aluminum alloy 6061-T6 grade is a non-ferrous alloy commonly contents aluminium as larger percentages and 0.8 to 1.2% magnesium, copper 0.15 to 0.4%, 0.8% silicon and 0.04 to 0.35% chromium. The wide availability and exceptional mechanical properties like low-density 2.7gm/cc, 310MPa tensile with 12% elongation, and 95BHN hardness make it very functional material for various use as fittings and frames in different products and assemblies. These alloys were also become very useful material because of its strength, lighter in weight, excellent welding, machinability, workability, and corrosion resistive characteristics. Many researchers attempted in friction stir and various issues, concerns about the efficiency and effectiveness of the process, and findings are reported widely. Few from such reports were discussed below to get a thorough understanding of the key concepts of the welding process and experimental investigations done on it. In one report, aluminum alloy AA2219 grade was welded by the friction welding method. Hexagon profile found to be good among all the profiles (Venkata Rao et al., 2015). Aluminum and silicon carbide metal matrix composites were fabricated with the use stir casting process. The maximum strength of the composite was reported as 170MPa with addition of 10% silicon carbide into the aluminum (Mishra & Tulasi, 2020). The factors like tool rotation and weld speed were exceedingly dominant for the welding of aluminum alloys 6061 and 7075 grades (Ugrasen et al., 2018). A mathematical model was formulated to recognize the impact of chosen welding conditions upon the tensile and yield strength of the welded joints (Elatharasan & Kumar Senthil, 2013). The important factors were feed, tool rotational and traverse speed, geometry and tilting of the tool in friction welding and processing. These factors have a major account for heat generation, material plasticization, and its movement from the receding towards the progressing side. Thus, the optimization of various factors should be performed to identify the impressions of chosen factors on the weld and base metal zone (Padhy et al., 2018). It was stated that weld travel speed was a highly influential factor in the friction welding of the aluminum 6061 alloy T6 grade of thickness 4mm metal sheets (Liu et al., 2013). The aluminum AA 2014-T6 grade alloy of 300×80×5mm sheet size was welded with the help of different pin profile geometries like conical, square, pentagonal, triangular, and hexagonal. A regression model was developed at a 95% confidence interval to state the impacts of change in factors on the tensile strength of the welded joints. The hexagon tool profile was produced as an exceptional tensile strength than other profiles (Ramanjaneyulu et al., 2015). A report is presented as aluminum alloy of two different grades A356 and 6061 was welded by changing the factors. The results were shown that the rotational speed was highly desirable to in welding of aluminum alloys (Ghosh et al., 2010). Aluminum alloys AA6061 and AA 5086 grades were welded by the help of different probe profiles like cylindrical, tapered, and threaded cylindrical. The threaded probe produces welds with higher material flow and thus the hardness value was obtained maximum as 83HV and tensile strength as 169MPa (Ilangovan et al., 2015). Aluminum alloys welding that may similar or dissimilar was in ever raising a requirement for various structural uses. One of the studies revealed the dissimilar welding of AA6061-T6 and AA8011-h14 aluminum alloy grades. It was reported that the tensile strength of the welded joints was obtained as 77MPa with the elongation of 21.96%. The effective factors and their values were like 1070RPM tool rotational speed, 2degree tool tilting angle, and 50mm/min tra-

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