Extended hybrid statistical tools ANFIS- GA to optimize underwater friction stir welding process parameters for ultimate tensile strength amelioration

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***Abstract*—The qualities of functional parts produced by underwater friction stir welding (UWFSW) with additive water are significantly reliant on standard FSW process parameters. To improve the goal function, hybrid statistical tools can be used to optimize operation parameters. This work investigates the tensile strength(σ UTS)of tests ASTM D3039 specified parts manufactured using UWFSW by Al 6063 material. Three parameters were varied in the fabrication of test specimens: speed of rotation from 1000 to 1800 rpm, speed of traveling from 4 to 10 mm/s, and shoulder diameter from 10 to 20 mm. Using a Hybrid optimization methodology such as artificial neural network- genetic algorithm (ANN-GA).The ANN-GA achieved the highest precision of 98.99 %, resulting in optimum parameters like rotational speed 1800 rpm, travelling speed 4 mm/s, and shoulder diameter 15 mm to produce a maximum tensile strength of 199.0212 MPa. The hybrid models developed could be used to predict and maximize specific process parameters and impacts for a variety of industrial situations.**

Keywords*—*UWFSW, AFISN-GA, GA, ANN

I. Introduction

FSW stands for friction stir welding and is a solid-state joining method. FSW is a novelty welding method that has a variety of applications around the world, including the connecting of aluminum structural components in the railway rolling stock business. FSW is also utilized in the fabrication of huge prefabricated aluminum panels. FSW is increasingly utilized in the high-volume production of components in the automotive industry. In FSW, the abutting edges of the materials to be welded are forced into the surface with a cylindrical, rotating tool with a shoulder and projecting pin. The material is softened enough for the tool pin to descend into the material until the shoulder meets the surface through frictional and adiabatic heating. The tool then transverses the line contact, causing localised severe plastic deformation in the stir zone to produce a weld[[1-2].

UWFSW has grown in popularity in recent years. This novel method is a variation of the FSW method in which the sample and sample-tool contact are totally immersed in water. Despite the fact that the heat dissipated in an FSW process is found minimum than that of arc welding, the primary goal of the research community in investigating the UWFSW method is to lower the heat generated and hence predict an improved mechanical characteristic weld joint. The complication of the weld path and the fixture are two main drawbacks to marketing the UWFSW technology

[3-7]. Ibrahim Sabry [3] On AA 6063 pipe couplings with custom-designed fittings, UWFSW and FSW are conducted. The FSW's results on mechanical charactricity employing rotation and travel speeds have also been discussed. The investigation design was utilized to see how process parameters affected the ductile characteristics of FSW manufactured parts [15-16]. The researchers studied the UWFSW of Al 6061 alloy plate by a high-speed rotating tool is pressed,, and comparative UWFSW and FSW the outcome revealed that the joint had same fatigue strength than that made FSW[8] [9]. The thermal cycles can have a negative effect on the mechanical properties of the joints by coarsening or dissolving the strengthening precipitates [10]. While its decreased heat input generated during UWFSW does not melt the pattern metal, the thermal cycles can coarsen or dissolve the strengthening precipitates. Controlling the temperature level appears to be of interest and possible for improving the mechanical characteristics of conventional FSW joints. Several studies have used external liquid cooling during FSW to accomplish this. During UWFSW, Fratinil et al. [11] investigated heat treatment with water flowing on the top surfaces of welding samples.The current authors conducted UWFSW of Al 7075, during which the entire pipes were immersed in the water environment, to fully exploit the Water's ability to absorb heat. El-Kassas, A. M. [12-31] Investigate by creating a new mechanism that allows FSW to be welded to the rotational motion of the pipe underwater, the UWFSW for Pipes Welding with Al 1050 pipes was successfully completed. Moreover, using multi criteria decision making (MCDM) techniques, investigate how to improve the FSW while taking into account the tool pin diameter effect. Mohd A. Wahid [13] The impact of UWFSW parameters of the procedure on the mechanical characteristics of the aluminium alloy 6082-T6 joint is examined, and the process is further simulated using evolutionary optimisation algorithms. Particle swarm optimization, firefly optimization, and non-dominated sorting are three evolutionary optimisation systems based on the genetic algorithm (NSGA-II), ere used to simulate this UWFSW method. In comparison to particle swarm optimization and the NSGA-II, the simulation centred on firefly optimization performed the best with the least mean squared error while estimating variable response values. The effects of FSW input variables such as orientation, rotation speed, and travelling speed on the mechanical characteristics of welded component test pieces were explored using analysis of variance (ANOVA) and response surface methods for optimum parametric