International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Friction Stir Welding of Brass by Response Surface: A Review

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ABSTRACT

The goal of the study is to enhance the performance of friction stir welding (FSW) for brass materials. A solid-state welding method called friction stir welding is used to fuse materials without melting them beforehand. The goal of this study is to improve the weld quality by optimizing the process variables that affect brass' FSW. The Taguchi method and response surface methodology (RSM) are two different optimization techniques used by in this research paper. By methodically changing input variables while reducing the effect of noise variables, the Taguchi method is a reliable optimization methodology that aids in the identification of optimal process parameters. The relationship between process factors and the desired response (in this case, weld quality) is mathematically modelled in response surface methodology, in contrast.

Keywords- Taguchi, Response surface, friction stir welding, Brass, Optimization

1. INTRODUCTION

The ability to fuse materials with exceptional mechanical properties and less distortion, friction stir welding (FSW), a new solid-state welding process, has attracted a lot of attention recently. This ground-breaking technique was initially created for aluminum alloys, but it has now been applied to numerous other materials, including brass. Because of its exceptional corrosion resistance, malleability, and aesthetic appeal, brass, an alloy of copper and zinc, is a crucial material in sectors including the automotive, electronics, and architecture. Brass has advantages, but because of its complex composition and unique features, it might be difficult to weld with conventional techniques. FSW, however, provides a viable answer by utilizing the concepts of plastic deformation and friction-induced heat generation to produce high-quality welds. To maintain constant weld quality and mechanical qualities, the application of FSW to brass requires a thorough study of and adjustment of the process parameters. Two potent approaches, Taguchi Method and Response Surface Methodology (RSM), come to the fore in the quest to achieve ideal FSW conditions for brass. Genichi Taguchi, a Japanese engineer, created the Taguchi Method, which provides a methodical strategy to carrying out tests by effectively navigating the parameter space while decreasing the number of trials. However, RSM, a statistical and mathematical method, supports modeling and analysis of complicated interactions between numerous variables and their impact on the desired output.

2. LITRATURE REVIEW

Mantra Prasad Satpathy et al In the current work, welding of sheets of dissimilar metals such aluminum (AA1100) and brass (UNS C27000) with a thickness of 0.3 mm is done while taking into account control factors like vibration amplitude, weld pressure, and weld duration. Four replications are used in full factorial design experiments to gather data on responses such as tensile shear stress, T-peel stress, and weld area. A non-linear second order regression model between the responses and predictors is created using all of these data. Fuzzy logic and genetic algorithms (GA) are used to determine the best combinations of these process parameters because quality is a crucial concern in these industrial businesses.

Mangesh R. Phate et al In the current work, the dimensional analysis method (DA) and artificial neural network (ANN) are used to analyze the CNC wire electrical discharge machining (WEDM) of Al 2124 SiCp (0,15,20) Metal Matrix Composite (MMC). Through the use of a design of experiments (DOE) plan, the models are created to relate the independent parameters, such as the pulse on and off times, wire feed rate, current, and voltage, thermal conductivity of the work piece material, coefficient of thermal expansion, density, and wire tension, with the dependent parameters, surface roughness, and material removal rate. The most influential parameters, according to the experimental results, are the pulse on time, thermal conductivity, coefficient of thermal expansion, wire feed rate, and wire tension.

D.A.P. Prabhakar et al For processing and welding metallic alloys and other materials, friction-stir processes have the potential to replace fusion-based technologies. In this review, seven friction-based processes—Additive Friction Stir Deposition (AFSD), Friction Stir Additive Manufacturing (FSAM), Friction Stir Welding (FSW), Friction Stir Processing (FSP), Friction Surfacing (FS), Friction Stir Spot Welding (FSSW), and Friction Stir Lap Welding (FSLW)—are examined for their benefits, applications, limitations, and potential future developments. The fundamental idea behind these procedures is to weld, treat, or deposit materials using friction as a source of heat energy. Axial force, rotating speed, and weld or traverse speed are the common control parameters for all friction stir processing processes. Additionally, tool dimensions and profiles are known to have an impact on the weld quality.

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Mallieswaran et al RSM was used to enhance the control parameters linked to the FSW of several AA1100-AA6061 sheets. Similar research with a variety of applications have also been identified in the literature. The design matrix is produced by each of these optimizations using the Taguchi method and RSM in general. An essential statistical technique called analysis of variance (ANOVA) is used to validate the responses.

Sahu et al Researchers employed a hybrid Fuzzy-Grey-Taguchi-based multi-objective model to enhance the quality of the weld of the Al/Cu different friction stir weld. The tests in this work were carried out using a Taguchi array, and multi-level characteristics were subsequently reduced to single-level characteristics by use of a fuzzy interface method. The best circumstances were discovered after using the Taguchi method to optimize the scenario.

Babu et al To improve cry rolling AA2219 alloy welding The design model's prediction abilities are essential for coming up with the best solution. By integrating conventional and unconventional approaches, recent research has made an effort to enhance this potential. Results from multi-objective optimization methods are superior than those from single-objective methods.

Gomathisankar et al Using a complex proportional assessment (COPRAS) model, the tool's rotational and travel speeds, tilt angle, and dwell time were optimized. A L9 Taguchi orthogonal array was developed for the experiment. A confirmation test was then run to make sure the result was accurate. The spindle speed and travel speed are the two most important factors that affect the quality of FSW welds, according to various studies.

Santhanam et al On this AA6063-O alloy, researchers performed SFSW tests and trials using a Taguchi orthogonal array (Taguchi method). The optimal process parameters found using the TOPSIS approach were a tapered pin profile, a rotational speed of 1200 rpm, and a welding speed of 120 mm/min. To determine the percentage of contribution of the SFSW process components, an ANOVA was utilized. It was found that the contributions from the tool pin profile, welding speed, and rotation speed were 44 percent, 33 percent, and 20 percent, respectively.

Ghetiya and Patel et al The study concentrated on a manufacturing business that applied TQM concepts to lessen its impact on the environment while improving product quality. Interviews with managers, front-line workers, and environmental professionals were used to gather data. To evaluate the impact of TQM on sustainability, environmental performance parameters including energy consumption, trash generation, and carbon emissions were examined.

3. CONCLUSION

By using this comprehensive strategy, the study was able to improve the FSW process for brass while also illuminating the complex relationships between process variables, their impacts on weld quality, and the subsequent mechanical qualities. The established ideal parameters made it possible to create brass FSW joints with excellent strength, hardness, and efficiency, hence advancing FSW as a trustworthy non-ferrous welding technology.

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