

# A Review of Friction Stir Welding Plate and Pipes

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## Abstract

*Friction Stir Welding (FSW) is a comparatively new joining process that has exhibited many advantages over traditional arc welding processes, including greatly reducing distortion and eliminating solidification. Friction stir welding used to join high strength joints aluminum pipes. The present work explains review and overview of Friction stir welding pipes and plate which contain the basic connotation of the process, mechanical properties and Suggested model in FSW process. This paper gives the review of basic concepts of Friction Stir Welding for pipes and plates on process parameters. It is established that FSW of aluminum pipes is appropriate an increasingly overripe technology with many commercial applications.*

## Keywords

*FSW, Aluminum pipes, and plates*

## Introduction and literature survey

The aluminum alloys are increasingly used in many significant industrialization areas, such as the automobile industry, aeronautic and military, because of their less density and good mechanical properties; however, the welding of aluminum alloys has always represented a great challenge for designers and technologists. Many difficulties are correlating with this kind of joint process. It is clear that earnest problems, such as tenacious oxide layer cavities, hot cracking sensitivity, and porosity, may occur when fusion welding is applied to aluminum alloys. Furthermore, the conventional techniques, such as fusion welding, often lead to significant strength deterioration in the joint because of a dendritic structure formed in the weld zone. Friction Stir Welding (FSW) was invented by Wayne Thomas at TWI (The Welding Institute), and the first patent applications were filed in the UK in December 1991. Then it was developed friction stir welding (FSW) with Khoureshid and Sabry in 2013. For use in welding aluminum pipes.

**E. Gerçekcioglu et al. (2014)** in this process uses the non-consumable specially designed rotating tool which is incorporated into the material by granting the axial force and then explicit along the joint line to make the weld. thermal mechanical effected zone (TMAZ) is formed due to thermo-mechanical cycles and HAZ is the zone which is affected by the frictional heat produced by the shoulder. weld zone is the region formed due to the stirring action of the pin. Frictional heat generated by the tool makes the plastic deformation of material and grain boundary sliding. exaggerated heat formalization leads to tool wear which outcome in the lack of material in the tool. lack of tool material will be formed as an embodiment in the weld region. Feed rate, material flow, and heat relocate corroboration the tool wear to emerge along the weld direction.

**A M Khoureshid and I. Sabry (2013)** in this study effect Friction stir welding for pipes on Al 6063 alloy. The tool rotation 485 to 1400 rpm with a traverse speed 4 mm/min was applied. The Mechanical properties of welded joints were investigated using different mechanical tests including destructive test. Based on the stir welding experiments conducted in this The resultant microstructure was characterized using optical microscopy.

**Kovacevic (2003)** In this paper friction stir welding (FSW) is a comparatively new welding operation that may have considerable advantages compared to the fusion operation as follow: joining of conventionally non-fusion weld able alloys, cut-price deformation

and afflicted mechanical properties of weld able alloys joints due to the pure solid-state joining of metals. In this paper, a three-dimensional model based on finite element analysis is used to study the thermal history and thermo-mechanical operations in the butt-welding of aluminum alloy 6061-T6.

**Ibraheem Sabry et al. (2013)**. The aim of this work determines the feasibility to weld two pieces of aluminum pipe by friction stir welding process and study the effect on the mechanical properties of welding joints. Special welding fixture fixed on conventional drilling machine has been conducted to attempt this welding and a group of welding parameters. The tool rotational speeds 485 to 1400 rpm with a traverse speed 4mm/min were applied. in this study the results show that aluminum pipe (6061) can be welded by (FSW) process with a maximum welding efficiency (78.7%) in terms of ultimate tensile strength, using 1400 (RPM) rotational speed, 4 (mm/min) traveling speed.

**Cavaliere et al. (2005)** in this study the investigated the mechanical and micro structural properties of dissimilar 2024 and 7075 aluminum sheets joined by friction stir welding (FSW). The two sheets, aligned with perpendicular rolling directions, have been successfully welded; successively, the welded sheets have been tested under tension at room temperature in order to analyze the mechanical response with respect to the parent materials.

**Kovacevic (2005)** In their paper thermo-mechanical simulation of friction stir welding can prophesy the transitory temperature area, active stresses progressing, forces in all the three dimensions and may be elongated to determine the residual stress. The thermal stresses shape a main portion of the total stress progressing during the process.

**Driver a (2005)** In this paper, a three-dimensional thermo mechanical model for Friction Stir Welding. Established on the velocity area classically used in fluid mechanics and mix heat input from the tool shoulder and the plastic strain of the bulk material, the semi-analytical model can be used to take out the strains, strain rates, and valuation of the temperatures and micro-hardness in the various weld zones. The outcome is in perfect convention with experimental measurements complete on an AA2024-T351 alloy friction stir welded joint.

**Ahmed. M. El-Kassas et al. (2015)** in this study effect to the mechanical properties in order to demonstrate the feasibility of

friction stir welding for joining Al 6061 aluminum pipes with different thickness 2 to 4mm, rotational speeds 485 to 1400 RPM and a traverse speed 4 to 10 mm/min was applied. This work focuses on two methods such as artificial neural networks(ANN) using software (Pythia) and response surface methodology (RSM) to predict the tensile strength, the percentage of elongation and hardness of friction stir welded 6061 aluminum alloy. An artificial neural network (ANN) model was developed for the analysis of the friction stir welding parameters of Al 6061aluminum pipe. Response surface methodology (RSM) also developed and the values obtained for the response Tensile strengths, the percentage of elongation and hardness are compared with measured values.

**Zhang et al. (2007)** explain the 3D material flows and mechanical countenance under different operation parameters by using the finite element method based on solid mechanics. The experimental outcome is also given to study the effect of operation parameters on joining properties of the friction stir welds. Numerical outcome set forth that the tangent flow shapes the prime part in the material flow. The shoulder can accelerate the material flow on the upper semi of the friction stir weld.

**Hwang (2010)** in this study aimed to experimentally scout about the thermal history of a work piece sustain. Friction Stir Welding (FSW) encompass butt joining with pure copper C11000. In the FSW experiments, The convenient temperatures for a prosperous FSW operation were found to be between 460 °C and 530 °C. These experimental outcome and the operation control of temperature histories can offer advantageous knowledge for an FSW based operation of copper joining.

**Hotel a (2010)** Studied that the post-welding stress state, strain history and material situation of friction stir welded joints are predominately strongly exemplify when used in hidden modeling analyses, typically by desert one or extra of the features above. But, it is apparent that the status after welding does effect the weld execution. The objective of this paper is to powwow some of the major struggles that arise when taking both the post-welding material case and stress-strain state intocalculation in a calculation structural analysis

**Kanwer S. Arora et al. (2010)** in this paper, effective friction stir welding of aluminum alloy 2219 using an adapted milling machine communicates. The downward or forging force was found to be suitable for shoulder diameter and rotational speed whilst longitudinal or welding force on welding speed and pin diameter. The tensile strength of welds was safely affected by welding speed and shoulder diameter whilst welding speed mightily affected percentage elongation.

**Hwang et al. (2010)** experimentally reconnoiter the thermal history of a work piece endure Friction Stir Welding (FSW) include butt joining with pure copper C11000. In the FSW experiments, K-type thermocouples were used to registration the temperature history at different locations on work piece. This data, concerted with the preheating temperature, tool rotation speeds and tool moving speeds allowed parameters for a prosperous weld to be determined.

**S. Rajakumar et al. (2011)** Friction-stir welding (FSW) operation is an emerging solid state joining operation in which the material

that is existence welded does not melt and modify. This operation uses a non-consumable tool to generate frictional heat in the border surfaces. The FSW operation and tool parameters play a prime say in to be decided the joint strength. Joint strength is affected by grain size and hardness of the weld nugget region. Hence, in this investigation, an endeavor was made to evolve experiential relationships to foresee grain size and hardness of weld nugget of friction-stir-welded AA6061 aluminum alloy joints. The experiential relationships are progressing by response surface methodology mix FSW tool and process parameters. A linear regression relationship was also determined between grain size and hardness of the weld nugget of FSW joints.

**Elangovan et al.(2012)** The investigators in this paper concentrate on the growth of an effective methodology to determine the optimum welding situation that maximizes the strength of joints created by ultrasonic welding using (RSM) coupled with genetic algorithm (GA).RSM is applied to create a functional analytical model for welding strength in terms of welding parameters namely pressure, weld time, and amplitude. Experiments were behaved as per central composite design of experiments for macula and seam welding of 0.3- and 0.4-mm-thick Al sample. An effective second-order response surface model is developed utilizing experimental measurements. Response surface model is moreover connected with GA to optimize the welding conditions for wished for weld strength.Optimum welding conditions produced from GA are verified with experimental results and are found to be in perfect approval.

**Mariano et al. (2012)** in this review on friction stir welding (FSW) modeling with a characteristic concentrate on the heat obstetrics due to the approach situation between the FSW tool and the work piece. A credible FSW operation modeling consists on the fine tuning of some operation and material parameters. Generally, these parameters are accomplished with abase on experimental data. The numerical modeling of the FSW operation can assist to realize such parameters with minimal potential and with theeconomic characteristic.

**ZHANG (2012)** in this studied the thermal modeling of underwater friction stir welding (FSW) was preceding with a three-dimensional heat transport model. The evaporate advantage of water was analyzed to lighten the fringe situations of underwater FSW. Temperature following properties of the material was believed for the modeling. For underwater joint, the high-temperature classified area is dramatically tightened and the welding thermal twirl in various zones is effectively striped in disparity to the normal joint.

**Bhatt (2013)** In this paper we spotted that Friction stir welding (FSW) of AA6061-T6 aluminum alloy has been anendeavor to outdo limitations of fusion welding of the same. The FSW tool, by not existence wasted, manufactures a joint with the dominant characteristic of high joint strength and minimize distortion and non-attendance of metallurgical defects. operation parameters such as tool rotational speed, tool traverse speed and axial force and tool dimensions play a significant role in earning a particular temperature allocation and next viscosity distribution within the material being welded; the former dominant the mechanical properties and posterior the flow stresses within the material in turn.

**Guo (2013)** Studied in this paper effect the Dissimilar AA6061 and AA7075 alloy have been friction stir welded with an assortment of different operation parameters. In special, the effects of materials situation and welding speed on the material flow, microstructure, micro hardness apportionment and tensile property of the joints were exact. It was discovered that the material mixing is much more effective when AA6061 alloy was located on the progress side and multiple vortexes centers created vertically in the nugget. 1 computational model.

**Ibraheem sabry(2016)** a comprehensive practical study in mechanical properties and cost welding of welded Aluminum 6061 pipe using three different types of welds, Metal Inert Gas (MIG), Tungsten Inert Gas (TIG) and Friction Stir Welding (FSW) with rotation speed (1800 RPM) and travel speed 4mm/min. The mechanical properties of the weld have been also investigated using the hardness, elongation and tensile tests. The microstructure of the welds, including the nugget zone and heat affected zone, has been compared with these three methods using optical microscopy and the basis of heat input in weld joint. The results show that FSW improves the mechanical properties of welded joints compare Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG), respectively.

#### Conclusion

- The lower paper has been thorough in the area of welding pipes by FSW.
- The present work explains review and overview of Friction stir welding pipes which contains the basic connotation of the operation, mechanical properties and Suggested model in FSW process.
- In the experiments, it could be decided that the welding was ambidextrous to aluminum pipes, subsequently, a welded seam could be successfully pat. When preparing the welded joints the strength properties of the welded seams were safely affected

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