



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

**Volume 9, Issue 9, September 2020**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# An Optimization on Friction Welding of Duplex Stainless Steel UNS S31803 Tube using Design of Experiment

Arul Prakash K<sup>1</sup>, Deepak Kumar M<sup>2</sup>, Noorullah D<sup>3</sup>

P.G. Student, Department of Metallurgical Engineering, Government College of Engineering, Salem, Tamil Nadu, India<sup>1</sup>

Assistant Professor, Department of Metallurgical Engineering, Government College of Engineering, Salem, Tamil Nadu, India<sup>2</sup>

Professor and Head of the Department, Department of Metallurgical Engineering, Government College of Engineering, Salem, Tamil Nadu, India<sup>3</sup>

**ABSTRACT:** Study the impact of boundaries for weld joint quality has been concentrated by changing contact load differing grating burden, manufacturing load, rubbing time, producing time and keeping consistent rotational speed of 1200 rpm. The idea of plan of trials (DOE) has been utilized to perform and investigate the tests, and it is that contact time has the more noteworthy bond on the joint quality. The expansion in joint quality with expanding manufacturing burden and rubbing time is watched. The most extreme joint quality of 720 MPa accomplished at Friction load 42kN and Forging load 43kN then also check the burn-off the welded samples, to analyse the optimization of the welding parameters.

**KEYWORDS:** Rotary Friction Welding, Duplex Stainless steel, Tube welding, Design of experiments

## I. INTRODUCTION

Rotary friction welding of Stainless Steels are of more noteworthy significance in the utilization of oil and gaseous petrol pipe lines, Marine and so on. Friction welding has different applications in the parts of the business, specifically building. This welding cycle gives high-caliber of the welded joint with most extreme efficiency and simple plan of the machine is conservative and consumable materials are not required. Duplex stainless steel has preferable erosion obstruction over different hardened steels with even has more prominent quality than austenitic stainless steels. The grating welding measure includes heat age at the interface between the segments by relative pivot under a tension applied typical to the interface, which creates exceptional neighborhood warming. The twisting makes a weld with increment in the end load which is adequate to twist. In rubbing welding measure the fundamental application for welding of lines is that there is no need of machining at the finishes, and uniform warming is generally the whole edge of the line and in this way forestalls the warm worries at welded joints. The principle reward of this cycle are basic methodology, capacity to join comparable and different materials, and decrease of material and vitality utilization. The point of this investigation is to discover the impact of boundary for duplex treated steel tubes welded joints by plan of trial.

## II. MATERIALS AND METHOD

### 2.1 MATERIAL

The Base Material, Duplex Stainless Steel Grade UNS S31803 Used Were Cylindrical Tubes Of Dimensions 80mm Length And Outer Diameter Of 19mm & 2 Mm Thickness. The Samples Are Prepared For The Surface Cleaning. From The Major Factor Which Had Greater Control On Tensile Strength Of Friction Welded Joints Was Identified. They Were Friction Load (L1), Forging Load (L2), Friction Time(T1) And Forging Time(T2).

Table 1 Shows The Chemical Composition Of Uns S31803 Tube And Table 2 Shows The Mechanical Property For The Base Material. Duplex stainless steel UNS S31803 material are shown in figure 3.1.



Fig 3.1 Duplex stainless steel

Table1. Chemical composition of UNS S31803

Elements	C	Si	Mn	P	S	Cr	Mo	Ni
Wt%	0.016	0.421	1.187	0.026	0.013	22.10	2.88	4.87

Table2. Mechanical properties for UNS S31803

Tensile strength	Yield strength	Vicker micro Hardness	Elongation
765 MPa	448MPa	275HV	25 %

## 2.2 METHODS

Rotary Friction Welding Method Is Done For Joining The Duplex Stainless Steel Tubes. The Duplex Stainless Steel Are Cut Into 18 Pieces With Above 80mm Length Bars By Grinding Wheel Cutting As Per Response Surface Methodology-Central Composite Design. All The Samples Are Subjected To Facing Operation In The Center Lathe Machine On Both Sides For Better Finishing

The Welding Process Chosen Here Is Friction Welding. At Present Duplex Stainless Steel Are Welding Using Friction Welding As Per Response Surface Methodology-Central Composite. The Welded Samples By Friction Welding For Tensile Testing. The Welding Is Done Based On The Experimental Design Data. Therefore The Total Number Of Experimental Is 9 Which We Have To Take The Tensile Test For Doing The Optimization.



Fig 3.2 Rotary Friction Machine



Fig 3.3 Weld samples



**Design of Experiment**

Taguchi method is used in this investigation and L9 orthogonal array was chose for minimum number of experiments to be performed and the model was tested for its satisfactoriness [6]. As the range of individual factor was wide, four-factor, three-level was selected. The design matrix is shown in the table 4 consisting 9 sets of experiments to be performed. With respect to the design matrix the welding parameters are tabulated in table 3 . The fabrication of tube joints are performed for 9 sets of parameters.

**2.3 WELDING PARAMETERS**

Exp No	Friction load (kN)	Forging load (kN)	Friction time (sec)	Forging time (sec)
1	40	40	2	2
2	40	42	2	2
3	40	44	3	3
4	42	42	3	3
5	42	44	2	3
6	42	40	2	2
7	44	40	2	2
8	44	42	2	2
9	44	44	3	2

Table 3. welding parameter

**III.RESULTS AND DISCUSSION**

**3.1 TENSILE STRENGTH**

Tensile tests were done for the samples generated from the pipe joints prepared. The prepared specimens are tested according to the ASTM standard. Tensile test was performed using a universal tensile testing machine having a capacity of 1000 kN. The test showed that failure occurs either in the welding area or in the immediate surrounding area of the base component. Table 4 shows the tensile strength values for weld parameters.

Table 4 Tensile strength

Exp No	Ultimate Tensile Strength ,Mpa
1	410
2	350
3	470
4	540
5	579
6	720
7	628
8	650
9	690



### 3.1 BURN-OFF LENGTH

The overall length loss of the components during the application of the friction force is known as burn-off length in friction welding process. At the friction pressure and friction time increases the burn-off length increases. The burn-off length for the above listed welding parameter is calculated and listed in the table.5

**Table 5 Burn-off Length for welded specimens**

S.NO	LENGTH OF THE SPECIMEN(mm)		BURN-OFF LENGTH (mm)
	Before welding	After Welding	
1	160	153	7
2	160	154	6
3	160	153	7
4	160	152	8
4	160	150	10
5	160	151	9
6	160	154	6
7	160	151	9
8	160	153	7
9	160	152	8

### 3.4 OPTIMIZED PARAMETERS

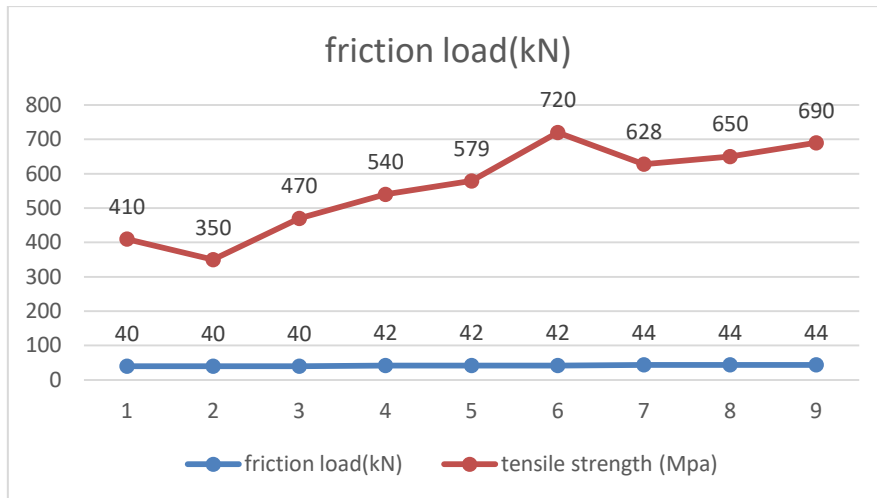
Using response optimizer of design of experiment, the optimized parameter is obtained for the friction welding of UNS S31803 tubes .Table 5 shows the optimized parameter for Tensile strength as a response.

**Table 6 Optimized parameter**

Friction load (L1) kN	42
Forging load(L2) kN	43
Friction Time(T1) sec	2
Forging Time(T2) sec	3

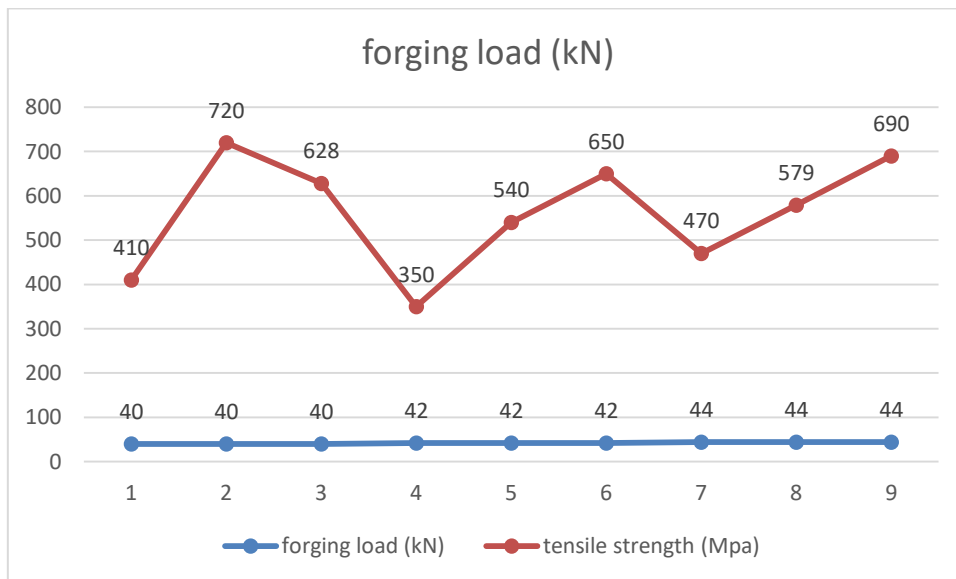
### 3.5EFFECT OF FRICTION LOAD

The effect of friction load over tensile property of weld joints is shown below. As the friction load(L1) is increases the tensile strength is decreased and for the increase in friction pressure the tensile in increase. at the 42 kN of the load the tensile strength value is increases 720Mpa.



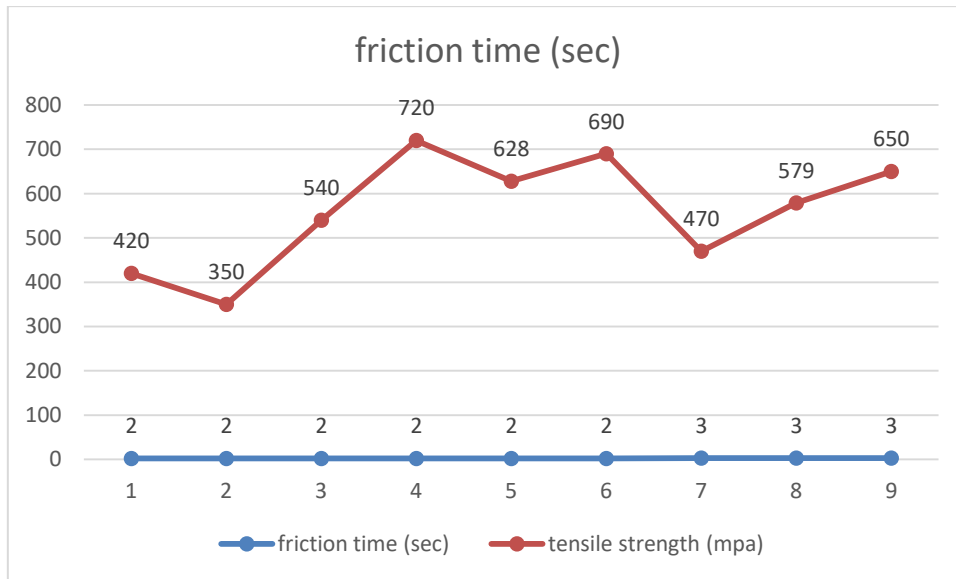
### 3.6 EFFECT OF FORGING LOAD

The effect of forging load over the tensile property of the weld joint is shown in below. As the forging load(L2) is decreases then then tensile strength is increases due to the forging load in increases the optimized value of 40 kN of the load and also the tensile value of 720 MPa constant and also plastic formation.



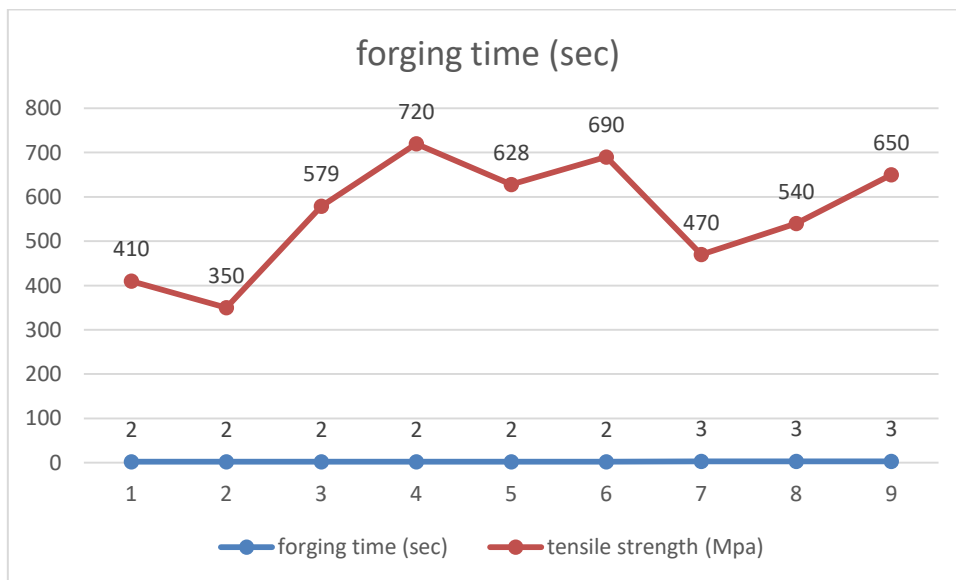
### 3.7 EFFECT OF FRICTION TIME

The effect of friction time over the tensile property of the weld joint is shown in below. As the friction time (T1) is decreases then then tensile strength is increases due to the forging load in increases the optimized value of 2 Sec of the time and also the tensile value of 720 MPa constant and also plastic formation.



### 3.8 EFFECT OF FORGING TIME

The effect of forging time over the tensile property of the weld joint is shown in below. As the forging time (T2) is decreases then then tensile strength is increases due to the forging load in increases the optimized value of 1 sec of the time and also the tensile value of 720 MPa constant and also plastic formation.



#### IV.CONCLUSION

1. The optimized parameter is used to give the best weld samples in the value of a maximum tensile strength of 720 Mpa could be obtained under the welding condition of friction load 42 kN, forging load 40 kN, friction time 2 sec and forging time 1sec. Under the welding condition the heat generation due to friction might be optimum causing the plastic deformation between the materials.
2. The burn-off length is to be measured the weld how to lack of joint and also the material strength is more effective.
3. All the weld parameters, friction time was found to have a greater effect on tensile strength of the followed by forging load and forging time and forging load.

#### REFERENCES

- [1] G.V. Beloshapkin, M.V. Beloshapkin, V.K. Pizarov, V.E. Stolberov & V.A. Chernov (2007) Friction welding of pipes, *Welding International*, 21:6, 458-459.
- [2] Riad Badjia, Mabrouk Bouabdallah, Brigitte Bacroixa, Charlie Kahlouna, Brahim Belkessac, Halim Maza, Phase transformation and mechanical behavior in annealed 2205 duplex stainless steel welds, 2008, Pg 447-453.
- [3] B. Crossland (1971) Friction welding, *Contemporary Physics*, 12:6, 559-574.
- [4] Mumin Sahin a, H. Erol Akata a, Turgut Gulmez, Characterization of mechanical properties in AISI 1040 parts welded by friction welding, 2007, Pg: 1033–1038.
- [5] Shyam Kumar Karna<sup>1</sup>, Dr. Ran Vijay Singh<sup>2</sup>, Dr. Rajeshwar Sahai<sup>3</sup> | Application of Taguchi Method in Indian Industry | *International Journal of Emerging Technology and Advanced Engineering* (ISSN 2250-2459, Volume 2, Issue 11, November 2012).
- [6] Avinash s. Pachal<sup>1</sup>, Amol bagesar<sup>2</sup>, Taguchi Optimization of Process Parameters in Friction Welding of 6061 Aluminum Alloy and 304 steel: A Review, Volume 3, Issue 4, April 2013.
- [7] S. Kannan<sup>1</sup>, S. Senthil Kumaran<sup>2,\*</sup> and L. A. Kumaraswamidhas<sup>1</sup>, Optimization of friction welding by taguchi and ANOVA method on commercial aluminium tube to Al 2025 tube plate with backing block using an external tool, *Journal of Mechanical Science and Technology* 30 (5) (2016) 2225~2235.
- [8] S. Pandiarajan a, S. Senthil Kumaran b, \*, L.A. Kumaraswamidhas a, R. Saravanan, Interfacial microstructure and optimization of friction welding by Taguchi and ANOVA method on SA 213 tube to SA 387 tube plate without backing block using an external tool, *Journal of Alloys and Compounds* 654 (2016) 534-545.
- [9] P. Sathiya · S. Aravindan · A. Noorul Haq, Mechanical and metallurgical properties of friction welded AISI 304 austenitic stainless steel, *Int J Adv Manuf Technol* (2005) 26: 505–511.





**INNO**  **SPACE**  
SJIF Scientific Journal Impact Factor

**Impact Factor:  
7.512**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
**INDIA**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details