International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 20th Sept 2021. Link
:http://www.ijiemr.org/downloads.php?vol=Volume-10&issue=ISSUE-09

DOI: 10.48047/IJIEMR/V10/I09/36

Title **EVALUATING THE MECHANICAL PROPERTIES OF SUBMERGED FRICTION STIR WELDED JOINTCOPPER PLATES (UNS-C11000)**

Volume 10, Issue 09, Pages: 332-339

Paper Authors
Pampani Naveen Srinivas, BKSVS.Madhuri, VV. Ramakrishna

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

EVALUATING THE MECHANICAL PROPERTIES OF SUBMERGED FRICTION STIR WELDED JOINTCOPPER PLATES (UNS-C11000)

Pampani Naveen Srinivas[1], BKSVS.Madhuri[2], VV. Ramakrishna[3]
[1] M.Tech student, Pydah college of engineering patavala, Kakinada
[2,]Assistant Professor, Pydah college of engineering patavala, Kakinada
[3]Associate Professor Pydah college of engineering patavala, Kakinada

Abstract

Friction stir welding is a process of joining two plates at solid state by atomic diffusion, which uses heat generated by the relative motion between tool and work piece. In this paper joining of copper plates (UNS-C11000) has carried out using friction stir welding under coolant. Formation of residual stresses was eliminated by subsequent cooling of welding portion and tool by liquid coolant such as submerged welding technique. In this process weld joint is protected by the atmospheric corrosion immediately after weld and also reduces residual stresses by dissipating heat generated by the tool and work piece. By this process mechanical properties like tensile stress, impact strength are increased with decreasing in hardness and also grain size improved to reduce residual stresses.

Keywords: Submerged Friction Stir Welding, Copper Alloys, Microstructure Studies, improvement in Mechanical Properties.

1. INTRODUCTION

In Fabrication the joining of metals has been an important issue for several decades. Generally, many problems are faced in traditional fusion welding in welding of different metals and alloys. Welding defects likeinclusions cracks, porosity and voids duringfusion welding, significantly affect the quality of the welds. Fraction stir welding (FSW) is the new solid state welding technique introduced in 1990s.

Fraction stir welding (FSW) is theprocess is competent enough to weld materials which are difficult to weld or cannot be welded by fusion welding process. The main aspect in these processes is the temperature remainsbelow the melting point of the material automatically defects associate with the fusion welding processes is not present in this FSW process which leads to the increasing in the mechanical properties and less effected by the environmental existing in fusion welding process. FSW is initially developed on aluminium alloy subsequently it is employed for many other similar and dissimilar and also employed for metals, nonmetals and alloys.

Generally the main application of FSW isshipbuildingaerospace,railway,and automobile.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

In FSW uses non-consumable rotating tool is plunged into the work pieceas the force is applied vertically downward. The friction between the tool and work piece increases temperature which is used for atomic fusion welding. Produced temperature is good enough to soften the work piece which gets plastically deformed easily.

Submerged friction stir welding (SFSW) is the modified version of friction stir welding (FSW). Coolant or water is applied over the work piece about a few mm. Water or some coolants mixed with water is employed to reduce the temperature developed during the welding process.Due to dynamic recrystallization in owing process to serve plastic leads to fine grain size in the stir region. Deformation results in change in microstructure.Basically, in submerged friction stir welding (SFSW) the weld is performed under water or coolant. During submerged friction stir welding (SFSW) high amount of heat is absorbed by the water or coolant transmitted to the work piece. As a result mechanical properties and micro structure changes.

2. EXPERIMENTAL SETUP

Factors Affecting SFSW

Mechanical properties and micro structural of the material completely depends upon many factors that affecting the material flow rate and temperature distribution.

Few major factors affecting SFSW are

1. Tool Geometry:

Tool geometry plays an important role in the FSW

a) Tool material- M2 is a high-speed steel in tungsten–molybdenum series
b) Tool pin profile

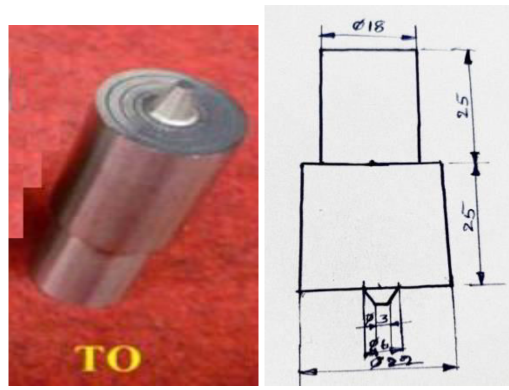

Fig-1: Tool dimensions

c) Tool speed-1000 rpm
d) Feed (transverse rate)- 25mm/min

2. Welding Parameters:

Level of water above the plates to be welded plays a critical role in heat dissipating rate during welding. (water level 5 mm above the plates)

3. Joint Design:butt joint

Fig-2: Arrangement of plates for butt joint

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

4. Work piece:
Twocopper plates (UNS-C11000).
Dimensions- 200*10*5 (length * breath * thickness)

Fig-3: Plates for welding

5. SFSW set up:

End milling machine of 15hp motor and 3000 rpm and 25kN is used for friction stir welding. Water is allowed to flow 5mm above the work piece to be welded. T-bolts and c-clams are used to hold the work piece. Work holding fixtures can move in X, Y and Z axis.max operational speed of spindle is 3000 rpm.

Fig-4: plates after clamping for welding.

Fig-5: Maintaining 5mm water level above the plates to be welded.

3. EXPERIMENTAL PROCEDURE

The work piece is clamped rigidly on the table by using fixtures T-bolts and clamps. Abutt joint is prepared by using SFSW on the work piece.

Speed: 1000 rpm.

Feed (transverse): 25mm/min

Fig-6: pieces after welding (back portion).

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Fig-6: pieces after welding (front portion).

4. PREPARING SPECIMEN FOR TESTING

Specimens are preparedaccording to ASTM standards by using CNC wire cutting machine.

Fig-7: CNC monitor indicating tool path.

Fig-8: Thread cutting of specimen.

Fig-9: Specimen for hardness test

Fig-9: Specimen for tensile test according to ASTN standards.

Fig-10: Specimen for microscopic structure.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Fig-11: Welded plate after cutting specimen.

RESULT AND DISCUSSION

The tests are performed at room temperature by using UTM, Impact test (charpy), micro Vickers hardness tester and metallurgical micro scope.

a) Tensile test (UTM2.5-21

Width of the specimen (mm): 11.92
Thickness of the specimen (mm): 2.90
Cross section area (mm^2): 34.57
Ultimate tensile load (N): 8513
Ultimate tensile strength (N/mm^2): 246.27

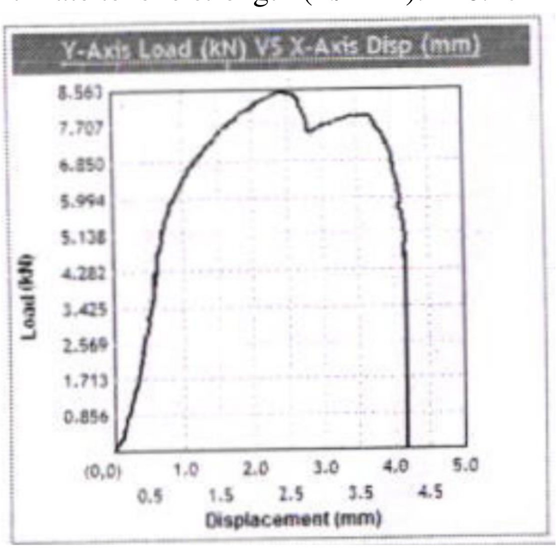

Fig-11: Stress-strain diagram of the specimen.

Observation:Comparatively the tensile strength of the specimen increased to some extent while compared to normal FSW (according ref: 1).

b) Impact test:

Notch type: V
Notch angle: 45^0
Specimen size (mm): 10*2.5*55
Test type: Charpy
Test temperature (^{0}C): room temperature
Notch depth: 2mm
Absorbed energy (J): 10
Observation: impact strength is reduced compared to normal FSW.

c) Micro Vickers Hardness Test.

Equipment: HMVG-XY-D 1631153A0692
Test Location: On Surface
Type of Indenter Diamond
Test force (kgf.) 0.1
On Base Metal: a) 101, b) 103 and c) 101
On weld: a) 157 b) 158 and c) 157
Observation: hardness is reduced to some extent

d) Microstructure Examination.

Equipment: Microscope
Specimen orientation: Cross Section
Etchant: Potassium dichromate
Magnification: 100X
Observation: Weld-Microstructure shows elongated copper grains with coarse inter-metallic particles aligned in the direction of stirring .weld is well fused and freedom from cracks, porosities and other linear defects.HAZ--Microstructure shows fine copper grains with randomly distributed inter-metallic particles in the copper matrix.

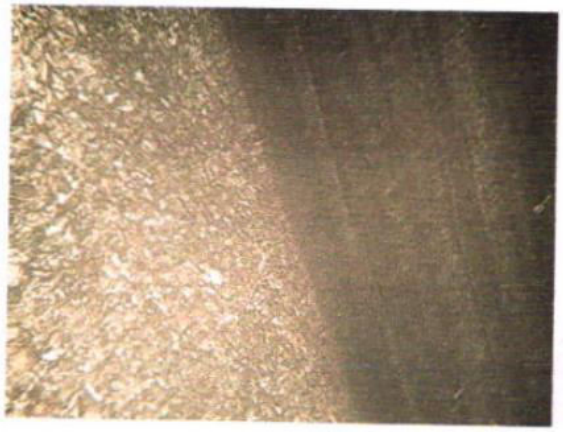

Fig 12: Micro structure of base metal after welding.

Fig 13: Micro structure of weld portion after welding

CONCLUSIONS AND RECOMMENDATIONS

Submerged Friction stir welding method is applied to joincopper plates and acquired results are as follows

1. Weld is formed by SFSW is defect free with speed 1000 rpm, 25mm/min feed at room temperature.
2. The work piece is submerged in the water during welding such that heat dissipation rate is more while compared to normal FSW.
3. Residual stresses are reduced to the maximum extent such that the weld joint is tress free to some extent.
4. Slightly soften portion was formed in the weld zone in spite of smaller grain size compare to that of base metal.
5. Hardness of SFSW copper weld zone mainly depended onthe density of dislocation rather than grain size.

REFERENCES

1) Thomas, W.M., Nicholas, E.D., Needham, J.C., Murch, M.G., TempleSmith, P., Dawes,C.J., 1991. The Welding Institute, TWI, International Patent Application No.PCT/GB92/02203 and GB Patent Application No. 9125978.8.

2) Thomas W.M., Friction stir welding recent developments, Material Science Forum, 426,432 (2003) 229-36.

3) Colligan, K.J.,Konkol, P.J., Fisher, J.J., Pickens, J.R., 2003. Friction stir welding demonstrated for combat vehicle construction. Weld. J. 82, 34–40.

4)EI-Danaf E.A., El-Rayes M. M., Microstructure and mechanical properties of friction stir welded 6082 AA in as welded and post weld heat treated conditions, Materials and Design, 46 (2013) 561-572.

5) Arbegast W.J., Jin Z., Beaudoin A., Bieler T.A., Radhakrishnan B., Hot Deformation of Aluminum Alloys III, TMS, Warrendale,
P A, USA, 2003, p. 313.

6) Ericsson M., Sandstrom R., Influence of welding speed on the fatigue of friction stir welds, and comparison with MIG and TIG. International Journal of Fatigue, 25 (2003) 1379-87.
7) Koumoulos E.P., Charitidis C.A., Daniolos N.M., Pantelis D.l., Nanomechanical properties of friction stir welded AA6082-T6 aluminum alloy, Materials Science and Engineering S, 176 (2011) 1585- 1589.
8) Bhadeshia H.K.D.H., Mathematical models in materials science. Material Science Technology, 24 (2008) 128-35.
9) Scialpi A., Filippis L.A.C., Cavaliere P., Influence of shoulder geometry on microstructure and mechanical properties of friction stir welded 6082 aluminium alloy, Materials and Design, 28 (2007) 1124-29.
10) Liu H.J., Hou J.C., Guo H., Effect of welding speed on microstructure and mechanical properties of self-reacting friction stir welded 6061-T6 aluminum alloy, Materials and Design 50 (2013) 872-78.
11) Nandan R., Lienert T.J., Deb Roy T., Toward reliable calculations of heat and plastic flow during friction stir welding of Ti- 6Al-4V alloy, International Journal of Materials Research, 99 (2008) 434-44.
12) Jata K.V., Semiatin S.L., Continuous dynamic recrystallization during friction stirwelding, Scripta Materialia 43 (2000) 743-48.
13) Nandan R., Roy G.G., Lienert T..I., Deb Roy T., Threedimensional heat and material now during friction stir welding of mild steel, Acta Matcrialia, 55 (2007) 883-95.
14) Nandan R., Roy G.G., Lienert T.J., Deb Roy T., Numerical modelling of 3D plasticflow and heat transfer during friction stir
welding of stainless steel. Science and Technology of Welding and Joining, 11 (2006) 526-37.
15) Khandkar M.Z.H., Khan J.A., Reynolds A.P., Prediction of temperature distribution and thermal history during friction stir welding: input torque based model. Science and Technology of Welding and Joining, 8 (2003) 165-74.
16) Arbegast W.J., Jin Z., Beaudoin A., Bieler T.A., Radhakrishnan B., Hot Deformation of Aluminum Alloys III, TMS, Warrendale, PA, USA, 2003, page. 313.
17) Thomas W.M., Johnson K.l., Wiesner C.S., Friction stir weldingrecent developments in tool and process technologies, Advanced Engineering Material, 5 (2003) 485-90.
18)Kakimoto, H., 2005. Study on application of FSW to aircraft. J. Jpn. Soc. Technol. Plast.46, 939–943.
19) Simar A., Brechet Y., Meester B., Denquin A., Gallais C., Pardoen T., Integrated modeling of friction stir welding of 6xxx series Al alloys: Process, microstructure and properties,Progress in Materials Science, 57 (2012) 95-183.
20) Cavaliere P., De Santis A., Panella F., Squillace A., Effect ofwelding parameterson mechanical and microstructural properties of dissimilar AA6082-AA2024 joints produced

by friction stir welding, Materials and Design 30 (2009) 609-16.

By…
Name: Pampani Naveen Srinivas(1)
Designation: (M.Tech)
Mobile No: 8333015979
Email id: vasunaveen23@gmail.com
College adress: Pydah college of engineering patavala,kakinada

Name: BKSVS.Madhuri(2)
Designation: Assistant professor
Mobile No: 8340034311
Email id : b.sivamadhuri@gmail.com
College adress: Pydah college of engineering patavala,kakinada

Name: VV. Ramakrishna(3)
Designation: Associate professor & HOD
Mobile no : 9618270225
Email id: vvrk98@gmail.com
College adress: Pydah college of engineering patavala, kakinada