FRICTIONSTIRWELDINGOFALUMINUMALLOY:A REVIEW

K.MOTHILAL, PRABHAKAR DAPPU, PARUCHURI SRIKANTH
4.D.BHARATH, 5.Dr.SARVANAN
Assistant Professor, Mechanical Engineering Department, Ellenkicollege of engineering and technology, India

Abstract:ThispaperfocusedontheMechanicalandMicrostructuralchangesof aluminumalloy 6082-T6weldedjointsformed by FrictionStir WeldingTechniqueby varyingprocess.Parameters such as tool rotational speed, welding speed,shoulder geometries, tool tilt angleetc.This paper have not anyExperimental procedure and values because it is only a Review togainknowledgeabouttheMechanicalandMicrostructuralchangesandit'sAnalysis.Theeffectofvariousprocessparameters on Micro hardness of the joints is also studied. AsFSW joining takes place below the melting temperature of thebase material Dueto which all the defects related to melting isautomaticallyremoved.Thereviewhelpsinselectionofimportant process parameters as the quality of weld joint dependson these welding input parameters and in optimization of theseparameters.

Keywords:Frictionstirwelding,Mechanicalproperties,processparameter, Microstructureprocessparameters.

I. INRODUCTION

Aluminum metal is easily available in earth crust and itis the third most abundant element in the earth's crust bymass. So now a days, Aluminum alloys are mostly used inplace of steel because Aluminum alloys have many usefulproperties as compare to steel such as excellent corrosionresistance, light in weight as having one third density ofsteel,easilymachinability,goodthermalandelectricalconductivityetc.DuetoThesepropertiesithashigh-demand in industries mainly in the automobiles, aerospace,inmakingmanyshipparts,inbuildingsformanyapplications such as roofing, etc. It isused for alltheseapplicationsduetoitshighstrengthalongwithsuitableductility. Aluminum alloys can't be directly used for theseapplication, we have to weld them for different uses. Themostsuitablemethodsforweldingaluminumalloysis FrictionStirWeldingbecausebyothermethodssuchasTungsteninertgas(TIG)andgasmetalarcwelding(GMAW)producesmany defectssuch as pores,lack of fusion ,incomplete penetration, create many crackssuchashotcrack,stresscorrosion,duetothesedefectstrength of the weld joint can be loss[1]. To overcome allthese problems, Friction Stir Welding is used for Aluminumalloys.

RevisedVersionManuscriptReceivedonJuly27, 2017.

VikasRohilla,M.techStudent,Departmentof MechanicalEngineering, University Institute of Engineering & Technology, MaharshiDayanandUniversity, Rohtak(Haryana)-124001, India.

PardeepGahlot,AssistantProfessor,DepartmentofMechanicalEngineering, University Institute of Engineering & Technology, MaharshiDayanandUniversity, Rohtak(Haryana)-124001, India.

AdarshBhoria,M.techStudent,Departmentof MechanicalEngineering, University Institute of Engineering & Technology, MaharshiDayanandUniversity, Rohtak(Haryana)-124001, India.

Shailesh Kumar Pandey, M. tech Student, Department of MechanicalEngineering,UniversityInstituteofEngineering&Technology,Maharshi

Friction stir welding is an innovative welding process inwhichwelding is done at the solid state it was invented in1991 by The Welding Institute and it is one of the mostsignificantdevelopmentsover thelastmanyyears[2].

II. WORKINGPROCESSANDPRINCIPAL

Friction Stir Welding is a solid state joining technique inwhichthematerialtobejoinedisplasticizedbyheatgenerated due tofriction between the surface of the plateand the rotating surface of a special tool. This special toolhas two parts(a)shoulder (b) pin. Both have their differentfunction. Shoulder is responsible for the generation of heat,whilepinmixesthematerialofthecomponentstobewelded,thuscreatingajoint(Fig.1).Acylindricaltoolhavingshoulderandpinrotateswithahighspeedandplungedintotheplateswhichhavetobeweldedandmovedalongthejoint.Acontinuousdownwardforceismaintained during the motion of the tool along the line ofaction. Heat is generated due to friction occur between theplateswhichistobeweldedandtherotatingtoolandjoining takes placebelow themelting temperatureof thebasematerial.AsFSWjoiningtakesplacebelowthemelting temperature of the base material. Due to which allthedefectsrelatedtomeltingisautomaticallyremoved.Thus a defect-free weldis produced with good mechanicalproperties.

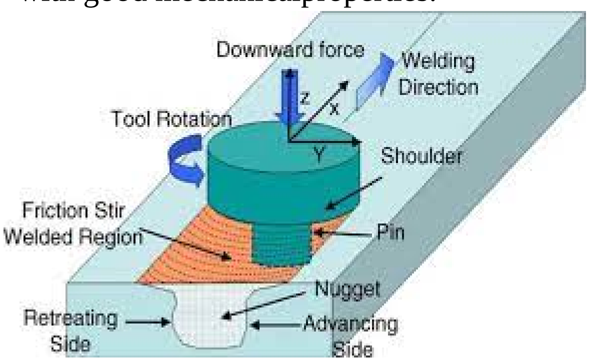

Figure 1 Schematic Diagram of the Friction Stir WeldingProcess

The shapes of the pin can be Square, Triangular, Pentagon,Hexagon etc.according toapplication.TheshapeoftheShouldershouldbeconcavebecausewhenshoulderisplunged into the plate to be welded and as they are fixed onthe another plate which is just below them then the materialfrom the specimen try to come out and adjust inside theconcaveshape oftheshoulder.

Frictionstirweldingisthegenerallyusedforsomealuminumalloysthatcannotbeweldedbythefusionwelding techniques. Sometime it produces aweld joint thatisstrongerthanbasemetal.

I. LITERATUREREVIEW

P. Cavaliever F. Panella et al (2007): studied the effect ofprocessparametersonmechanicalandmicrostructuralpropertiesofAluminumalloy6082jointsformedbyFrictionStirWeldingFSWwasproducedbykeepingrotationalspeedsat1600rpmbutweldingspeedwaschanging from 40 to 460 mm/min for the evaluation of themechanical properties tensile tests were performed at roomtemperature.Weldingparameterwasusedtoanalyzemicrostructure evolution of the materials. The base metalusedforstudiedisaluminiumalloy6082-T6with200×80 × 4 mm dimensions rectangular plates. Rotational speed ofthreaded tool was constant at 1600 rpm while speeds werevaried 40, 56, 80, 115, 165, 325 and 460 mm/min. shoulderdiameter was 14 mm and tilt angle equal to 3 □. The pin having a diameter 6.0mm. At all thesewelding speeds and at 1600 rpm rotational speeds the microstructural behavior of 6082 aluminum alloy was studied byusingopticalmicroscopy.Itwasobservedthatdifferentgrain size and distribution occurs for various travel speed;therecrystallizationinmicrostructureofthe materialappears up to 115 mm/min. but due to different temperatureit was not uniform and true strain formed at lower speed.When the travel speed increased the nugget microstructurebecomesfineaswellasuniform.Whenthespeedisincreased from 40 to 165 mm/min. a large variation wasobserved but there were no further variations when speedwas increased up to 460 mm/min. The effect of temperatureonmicrostructure of thematerial have very important role.It was observed was that if the temperature is low in thenugget zone then force acting on the material is not able toproper plastic flow for a recrystallization process but whenthe temperature is increased even at low travelling speed thematerial is soften and growth in grains after deformation onbe observed. From the experiment the yield strength and theductilityalsoobservedatthesevariousspeeds.Itwasobservedthatyieldstrengthincreasedrapidly,whenthespeed is increased from the lower value to 115 mm/min. theyield strength at maximum yield point was approximate 185MPA and starts decreasing again with increase in speed. Theductility of thematerial alsoshowed the same behavior butit started again to increase after 165 mm/min. At around 115mm/mintoolspeed elongation equal to 11.6%.[3]

Sakthivell et al (2009): Studied the influence of variouswelding speeds by varying from 50mm/min to 175 mm/minon the mechanical and metallurgical properties of the similaror dissimilar alloy. It was found that basematerial haveultimatetensilestrengthof84MPAwhereas fromtheexperimentitwasnotedthatatlowweldingspeedof50mm/min the ultimate tensile strength was around 80 MPAOn theotherhandat higherweldingspeed175mm/min,tensilestrengthwas71MPASoitconductedthatonincreasing transverse speed, tensilestrength decreased duetoinadequateheatinputasatlowerspeed,duetowhichrecrystallization takes place at lower speed, due to whichthegrainsizeincreasedandrestorationoftheductility.[4]

A. Scialpi, L.A.C. De Fillippis et al (2006): studied theeffect of various shoulder geometries on the mechanical andmicrostructures properties of Friction Stir welded joints.Inhis study, he used Aluminum alloy 6082 as a base metal ofthickness 1.5 mm and welding wasdone at 1810 rpm of tool rotational and feed rate was 460mm/min, with a 2 □ tilt angle and plunge depth 0.1 mm. Anon-threaded pin of 1.7mm diameter and 1.2mm height wasused to plunge for the experiment three different types ofshoulders geometries such as only fillet, scroll and fillet,cavity andfilletwereconsidered.From theexperimentitwas observed that toolwith fillet and cavity producedasmooth crown with very little flash as compare to other twobecausebothfilletandcavityincombinedformincreasesthelongitudinalandtransversestrengthofjointandproducesthe best crownsurface [5]

T. Minton & D.J. Mynors (2006): Investigated whetherfriction stir welding can be done on conventional millingmachine or not, on a Parkson vertical Mill type a machine,by using 6082-T6 aluminum sheets of 4.6mm thickness and6.3mmthickness.Forconductingexperiment atruncatedtool was designed for 4.6mm sheet and a single generic toolfor 6.3mmsheet having 19mm diameter of silver steel. Thepiecestobewelded,arekeptintheformofthebuttjointandfixedon the baking plate of themachine’sfeedtable.For FSW four levels A, B, D and E was designed accordingto the spindle speed, feed speed and tool tilt angle. Therewerefourpoints1,2,4&5forwhichvaluestobedetermined.Severaltrialsweredoneinthefirstsetsmaximum was speed was kept and indicated point A. Therewas reduction in feed sped in steps, working towards B. bysetting maximum spindle speed at 1550 rpm, the minimumfeed speed was observed for the 6.3 mm and 4.6 mm sheetsand feed speed is reduced in steps from 3.175 mm/sec whichwas maximum. Similarly by reducing spindle speed frommaximum to minimum (620 RPM) and setting feed speed of0.2646 mm/s, theminimum spindle speed was determined.1, 2 and 4 were determined with the coordinates of point and5 was assumed from symmetry many number of welds weredone and tested such as tensile ad hardness results indicatedthat milling machine is capable of producing good qualitywelds with less optimality for both 4.6 mm aluminum sheetsand 6.3 mm thickness sheets but the quality of welds of 4.6mmthicknessislower than6.3 mmthickness[6].

Magdy M. El-Rayes, Ehab A. El-Danaf et al (2012): Studied the effect of multiple passes on the micro structuralandmechanicalpropertiesofAA6082. Aluminumalloy6082plateshaving120mmlength,100mmwidthandthickness 6mm were used. During experiment Friction Stirprocess was used in which tool rotates at constant speedaround 850 rpm by applying one, two and three passes insuch a way that overlap each other. The tool was used with aflat shoulder of 15mm diameter and a square pin of 5mmlong. The FSP runs were performed in the perpendiculardirectiontotherollingdirection.Grainsizewereincreasedwithincreasethenumberof passes keeping transverse speed constant. It was observedthat when the number of passes is increased one by one itreduced the ultimate tensile strength and soften the material.Ontheotherhandstrengthandhardnessincreasedonincreasingthe transverse speed. [7]

P.CavaliereA.De.Santisetal(2009): Studiedtheeffectofprocessparametersonthepropertiessuchasmechanical and microstructure of dissimilar alloys AA6082-AA2024 joints produced by Friction Stir Welding for theexperiment a conical shape tool of C40 steel tool with adiameters minimum 2.8 mm and maximum 3.66 mm wasused,theshoulderdiameterwas9.5mm.Therotationalspeed remains constant at 1600 RPM but advancing speed ofthe tool changesfrom 80 to 115 mm/min. To determinemechanical properties, micro hardness tests of all the weldedzone were determined by using a Vickers indenter with a 5Nhead for 15 sec. Tensile test also done at room temperatureby using a MTS 810 testing machine. During FSW processwhen the 2024 alloy was kept on the advancing side andweldingspeedwas115mm/minthenhighestvaluesofmicro hardness were observed. But when 6082 alloy waskept on the advancing side the micro hardness profile to bemore uniform which show better mixing of material. Butminimum micro hardness is observed in heat affected zonebecausetheheataffectedzonedeformedverylless.Thetensilepropertieswerestudiedatdifferent weldingconditions of dissimilar joints obtained by FSW. When thewelding speed increased, the tensile strength also increasedbykeeping6082onadvancingside.Thebesttensilepropertiesfordissimilarjointsof AA6082&AA2024obtainedatadvancingspeedof115mm/min.Similarlyductility of thejoints also increasedwith theincrease ofweld speed[8].

II. CONCLUSION

Thepresentstudyfocusedonthemicrostructuralandmechanicalpropertiesof Friction StirWeldingjointsofaluminum alloy 6082.All the cases evaluates the weldingperformance of FSW process. It is found that mechanicalpropertiesof Friction StirWelding jointsofAA6082-T6Changingwithchangingprocessparametersandtoolgeometry. The process parameters and tool geometry alsoaffectthemicrostructuralproperties.Thusitprovesthat,properselectionofprocessparametersandsuitabletoolgeometryareimportantforgettinggoodweldedjointsformed byFrictionStirWelding.

REFERENCE

1. Debroy, T. Bhadeshia, H.K. D.H. friction stir welding of dissimilaralloys- A perspective Science technical Weld Join 2010, 15, 266-270[crossref.]
2. MishraRS,Mazy frictionStirsWelding andprocessing,MaterialScienceandEngineeringR.2005;50:PP1-78.
3. P.Cavaliere,A.SquillaceandF.Panella,"Effectofweldingparameters on mechanical and microstructure properties of AA6082jointsproducedbyfrictionstirwelding,"Journalofmaterialsprocessingtechnology, vol. 200,pp.364-372,September2007.
4. Sakthivel T, Sengar G.S, Mukhopadhyay J., 2009. Effect of weldingspeed on micro structure and mechanical properties of friction stirwelded aluminum International journals of Advanced ManufacturingTechnology43:468-473.
5. Scialpi,L.A.C.DeFillippisandP.Cavaliere,"Influenceofshoulder
6. welded 6082 aluminum alloy", Materials and Design, Vol 28, PP. 1124-1129, April 2006.
7. T. Minton and D.J. Mynors, "Utilisation of engineering workshop equipment for friction stir welding," Journal of Material Processing Technology, vol. 177, pp. 336-339, 2006.
8. Magdy M. El-RRayes and Ehab A. El-Danaf, "The influence of multi- pass friction stir processing on the micro structural and mechanical properties f aluminum alloy 6082," Journal of Materials Processing Technology, vol. 212, pp. 1157-1168, January 2012.
9. P. Cavaliere, A. De Santis, F. Panella and A. Squillace, "Effect of welding parameters on mechanical and micro structural properties of dissimilar AA6082-AA2024 joints produced by friction stir welding," Materials and Design, vol. 30, pp. 609-616, July 2008.