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Refrigeration Tube Joining by FSW with Fixture

KEYWORDS: Friction stir welding, Fixture, Refrigeration.

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ABSTRACT *In Refrigeration copper tube joining is done by brazing, to avoid numerous defects as well as cost of brazing, Friction stir welding can be done. which give high strength and good weld quality. In this paper work is done by experimental study and fixture is design for the same. Process has been developing to produce a welding fixture which will join the tube by FSW. The weld is made by a tool rotating at a design rate and moving through the metal being joined. The metal is not melted but, mixed at particular temperature. Fixture is design in a such way that whole process of rotational speed of the tool and the pressure by which the tool is pressed is well controlled. Result in high strength join can be generated by FSW fixture.*

INTRODUCTION

Welding is a fabrication process for joining usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces. There are several different ways to weld, such as: Shielded Metal Arc Welding, Gas Tungsten Arc Welding, Tungsten Inert Gas and Metallic Inert Gas. MIG or Metallic Inert Gas involves a wire fed "gun" that feeds wire at an adjustable speed and sprays a shielding gas (generally pure Argon or a mix of Argon and CO2) over the weld puddle to protect it from the outside world. TIG or Tungsten Inert Gas involves a much smaller handheld gun that has a tungsten rod inside of it. With most, you use a pedal to adjust your amount of heat and hold a filler metal with your other hand and slowly feed it. Stick welding or Shielded Metal Arc Welding has an electrode that has flux, the protectant for the puddle, around it. The electrode holder holds the electrode as it slowly melts away. Slag protects the weld puddle from the outside world. Flux-Core is almost identical to stick welding except once again you have a wire feeding gun, The wire has a thin flux coating around it that protects the weld puddle.

As During Arc welding of copper and copper alloys,oxygen segregates on grain boundaries of metal. This can lead to embrittlement of the weld joint. Precipitation hardenable copper alloys may lose their alloying elements through oxidation during interface welding. Compromising their strength copper welds frequently suffer from lack of interface because of high thermal conductivity of copper as it reduces the concentration of heat.Friction stir welding is a technology inconstant development. This technologybecomes more and more attractive as thetool technology allows for thicker sectionwelding. Currently the thickness is limited,but single-pass welding of API gradesof steel is being developed for thicknessesup to 1 in. Tool designs needed for weldingtubular geometries are more complexthan those used for linear welding and thecontrol systems needed require a higherlevel of sophistication, such as control algorithmsthat vary parameters to maintaina specific tool temperature.Trends in pipe development havemoved toward the development of higherstrengthsteels for use in pipelines. Thesenew high-strength grades provide cost savings;however, they also introduce difficultiesin welding while using conventionalwelding methods. Although FSW hasmany advantages over its fusion weldingcounterparts, careful parameter developmentis needed to understand the essentialvariables that are required for frictionstir welding in these special grades of steel.[1]

Currently there are many processes used for joining refrigeration pipe welding. But brazing is most commonly used joining process for pipe joining. Copper and its alloys are widely used in industrial applications due to their excellent electrical and thermal conductive good strength, and corrosion and fatigue resistance. Welding of copper is usually difficult by conventional interface welding process because the copper has the higherthermal diffusivity, which is about 10 to 100 times higher than in many steels and nickels alloys.[2] The heat input required is much higher than in almost any other materials and weld speeds are quit low it states that Won –bae lee (2004) to overcome these problems, the FSW -which is one of the solid state welding techniques is applied for the joining of copper.

Friction Stir Welding Process

In FSW process a non-consumable tool is used to create frictional heat and plastic deformation at the welding location, affecting the formation of a joint while material is in the solid state. FSW can be used to join high-strength aerospace aluminum alloys and other high temperature metallic alloys that are hard to weld by conventional fusion welding. FSW is considered to be the most significantdevelopment in metal joining area. This work addresses the current state of understanding and development of the FSW process.

Many critical components are involved in Friction Stir Welding (FSW) and obviously tool is mostcritical among them to the success of the process. The tool typically consists of a rotatinground shoulder and a pin that heats the work piece mostly by friction and moves the softened alloy around it in order to form the joint. There is no bulk melting of the work-piece, as such, thecommon problems of interface welding such as the solidification and liquation cracking , porosityand the loss of volatile alloying elements are avoided in FSW. These advantages attributewidespread commercial success in the field of soft alloy weld-

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ing. However, FSW tool issubjected to severe stress and high temperatures particularly for welding of hard alloys of steel,stainless steel and titanium alloys. The commercial application of FSW to these alloysis now limited by the high cost and short life of FSW tools. The localized heating softens thematerial around the pin and combination of too rotation and translation leads to movement ofmaterial from the front of the pin to the back of the pin. As a result of this process a joint isproduced in 'solid state'. Because of various geometrical features of the tool, the materialmovement around the pin can be quite complex.Challenges of Friction Stir Welding

- Application of high temperature materials
- Tool material selection
- Development of Tool Materials
- Tool design
- Complex geometries and dissimilar materials

The published literatures are available in applications, tool design. The toolmaterial usedforcopper alloy and very limited. Based on the literature view and tool materials properties,different tool materials as listed below were selected for using in FSW for joining of copper.

1) W–alloy ;2) Supper High speed steel; 3) AISIH13 steel; 4) High speed steel; 5) High carbon highchromium steel; 6) APST steel; and 7) EN 24 Steel

ADVANTAGES OF FSW OF COPPER PIPE :

In FSW for copper tube high temperature for joining of pipe is not required as temperature rise from the base temperature is very minor. For copper pipe joining by FSW no extra material for joining is required whereas brazing requires extra copper material for joining .For FSW of copper pipe no harmful flue gases is released , it is a eco friendly process. Oxygen supply and acetylene fuel which is most important in brazing is not required in FSW joining of Copper pipes. Non-consumable tool is used for FSW copper tube joining. For FSW copper tube joining , it can join any cross section of pipe with varying dimensions. The low heat input and lack of solidificationdefects in the weld provide frictionstir welding with a number of importantadvantages over fusion welding.These include the following:

1. No filler metal is used, providing significantcost savings in materials.
2. The process can be fully automated.
3. The energy input is efficient as allheating occurs at the tool/workpieceinterface.
4. Minimum postweld inspection is requireddue to the solid-state nature andextreme repeatability of FSW.
5. Depending on the target alloy, FSWis tolerant to interface gaps and requireslittle preweld preparation.
6. No weld spatter needs to be removed.
7. The postweld surface finish can beexceptionally smooth with very little to noflash.
8. No solidification-related cracking,porosity, or oxygen contamination occurs.
9. Little or no distortion is found in thebase metal.
10. No operator protection is requiredas there are no harmful emissions.
11. Weld mechanical and fatigue propertiesare improved.
12. The joint can be joined in a singlepassIn addition, FSW offers these advantagesover traditional welding methods in pipelines.

Experimental Setup

The fixture is fabricated from M S material as shown in fig: 1.1 and tool is machined on lathe as shown in fig: 1.2 In this fixture solid circular pipe of mild steel is fitted on which copper pipe for welding can be mounted. For welding purpose tool of MS having conical tip whose dimensions are 2 mm at one end and 6mm at second end.

As we know that, for FSW in which two things are required. First is pressure and second is RPM generation for plastic deformation in welding area. In our model, required RPM will be generated by using the combination of motor and battery. During the rotation process both the pipes will be rotating in the same direction without any disturbance for RPM generation.

Figure:1.1

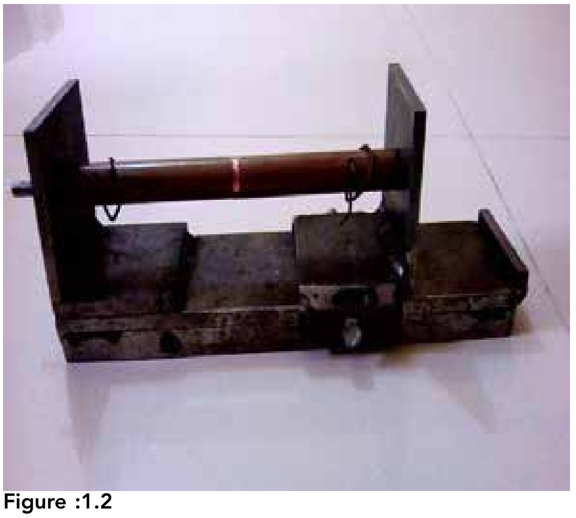

Figure :1.2

Now for pressure generation tool will be attached to drilling machine. The tool will be doing rotational movement as shown in fig:1.3. With the contact of tool and joint area with the required RPM and pressure, friction will be created at the pipe joint. Due to friction there will be a material distortion at the pipe joint. Because of rubbing action between the tool and pipe required heat for welding will be achieved as shown in fig:1.4. Experiment is conducted with different speed and time.

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Figure: 1.3

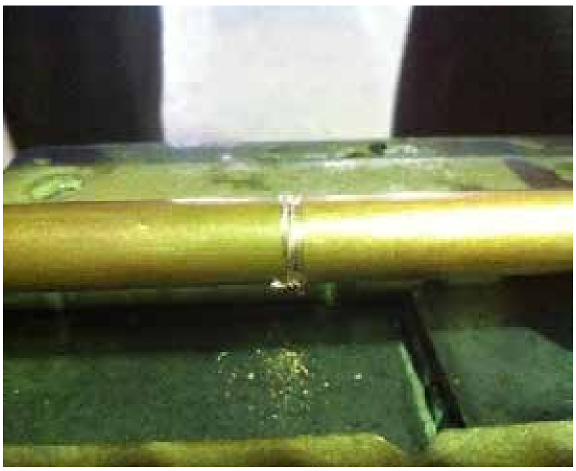

Figure : 1.4

CONCLUSION

From this work, we have provided a substitute for brazing process. By this work, we had drastically reduced various operational cost in industries. FSW process is an cost effective and eco-friendly process. we can weld various circular copper pipe of any dimension with a slight temperature rise from base temperature of copper pipe. This characteristic of minor rise in temperature will be helpful to eliminate various hurdles face during Brazing process such as high fuel cost, hazards fumes, filler material use of acetylene fuel ,oxygen supply etc. Friction stir welding of out-of-position welds such as that involved for pipe welding offers tremendous advantages in productivity and cost savings for the pipeline industry. This disruptive technology has the potential to significantly alter the way this industry does business in the coming decades.

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