DESIGN AND ANALYSIS OF ROTARY FRICTION WELDING BY USING STEEL PIPES

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ABSTRACT - Friction welding is now well established as one of the most economical and highly productive methodsin joining similar and dissimilar metals. It is widely used in automotive and aerospace industrial applications. Frictionwelding is often the only viable alternative in this field to overcome the difficulties encountered in joining the materialswith widely varying physical characteristics. This process employs a machine that is designed to convert mechanicalenergy into heat at the joint to weld using relative movement between workpieces, without the use of only other sources.This review deals with the fundamental understanding of the process. The focus is on the mechanism of friction welding, types of relative motions of the process, influence of parameters, heat generation in the process, understanding the deformation, microstructure and the properties of similar and dissimilar welded materials

I. INTRODUCTION

A method of operating on a workpiece comprises offering a probe of material harder than the workpiece material to acontinuous surface of the workpiece causing relative cyclic movement between the probe and the workpiece while urging the probe and workpiece together whereby frictional heat is generated as the probe enters the workpiece so asto create a plasticized region in the workpiece material around the probe, stopping the relative cyclic movement, andallowing the plasticized material to solidify around the probe. This technique, which we refer to as "friction welding"provides a very simple method of joining a probe to a workpiece. The method can be used for repairing cracks and the like within a workpiece or for joining members, such as studs or bushes, to a workpiece. Another aspect of the invention comprises causing a probe of material harder than the workpiece material to enter the joint region and opposed portions of the workpieces on either side of the joint. Friction welding is a type of forge welding, i.e. weldingis done by the application of pressure. Friction generates heat, if two surfaces are rubbed together, enough heat can begenerated and the temperature can be raised to the level where the parts subjected to the friction may be fused together.

In conventional friction welding, relative rotation between a pair of workpieces is caused while the work pieces are urged together. Typically thereafter once sufficient heat is built at the interface between the workpieces, relative rotation is stopped and the workpieces are urged together under forging force which may be same as or greater than the original urging force. Friction Welding" (FW) is a group of solid-state [welding] processes using heat generated through mechanical friction between a moving workpiece, with the addition of an upsetting force to plastically displacematerial. Many dissimilar metal combinations can be joined and there are a number of process variations including

A. Other Types Of Friction Welding

- Linear vibration welding.
- Inertia friction welding.
- Continuous drive friction welding.

Linear friction welding: It is the relative motion across the interface is linear, rather than rotary. It is a process of producing high strength welds with non-melting fusion. It is also a solid-state joining process special application for aerospace industry. The method involves two parts being pushed together, one oscillating at a high frequency. This creates friction that heats the metals to a temperature at which they are able to join together. When the oscillation stops, the parts cool to form a forged-quality weld.

Linear friction welding material having a many advantages. It is a very consistent and fast process, taking only few seconds to create a weld. Very little preparation of the surfaces to be joined is required: any imperfections and impurities are removed along with a layer of surface metal as requires specific parameters of mass/weight, speed, andpressure to meet the requirements of the weld union. When the desired rotational speed is achieved, kinetic energy istransferred into the freely rotating part. Constant forge pressure is applied until a plastic state is reached. Rotation stops due to controlled pressure as the desired total displacement length of material (upset) are met. Rotational speedsare normally higher than direct drive friction welding. The majority of the total displacement comes at the very end of the weld cycle as compared to being spread out over the middle to end of the cycle. Following (fig.4) shows the Inertia welding Phases and the results shows on a graph. The end result is the same but the major difference betweenthe two techniques is the energy source, rpm, timing and distance as pressure is applied flash. It requires no consumables, produces no harmful fumes, and because of a solid-state welding process, no potential issues occurs with solidification e.g. segregation or porosity. There are some

other potential applications of linear friction welding has established itself as the primary method of fabrication of bladed disk assemblies for aircraft turbine engines. It hasgreat potential for other aerospace applications like manufacturing of aircraft structural components. Linear friction welding has the potential applications are automotive, shipbuilding, rail, oil and gas, energy and construction etc.

Inertia friction welding: Inertia friction welding or direct drive rotary friction welding, the part of rotation under pressure to heat the faying surfaces. A flywheel to generate the rotational motion in the part holding chuck. The flywheel driven chuck rotates and stops when the weld zone seizes. This inertia method is also sometimes known as a spin welding. Energy is provided by the machine's kinetic energy that is stored in a rotating system or mass. This requires specific parameters of mass/weight, speed, and pressure to meet the requirements of the weld union. When the desired rotational speed is achieved, kinetic energy is transferred into the freely rotating component. Continuousforge pressure is applied until a plastic state is reached. Rotation stops due to controlled pressure as the desired total displacement length of material (upset) are met. Rotational speeds are normally higher than direct drive friction welding. The majority of the total displacement comes at the very end of the weld cycle as compared to being spreadout over the middle to end of the cycle. RPMs, and timing/distance as pressure is applied.

Stage 1: One component is inserted into a rotating chuck and the other component is inserted into a fixed tail clamp. The head is then accelerated to a preset speed.

Stage 2: The rotating component or the fixed tailpiece is then forced against the remaining component.

Stage 3: Rotation stops under its own kinetic mass and then a forge pressure completes the welding cycle. Energy isprovided by the machine's kinetic energy that is stored in a rotating system or mass. In this instance the energy available in a stored energy system is finite.

Frictions stir welding: Friction stir welding is also produces a required plasticized state of material and a non- consumable rotating tool is held under the pressure against the materials to be joined. This tool is like a pin at the center also known probe or shoulder as shows in Fig. 5. FSW is a solid-state joining process with many advantages, such as sound mechanical and metallurgical properties and a narrow heat-affected zone compared with conventional fusion welding. This joining technique is energy efficient, environment friendly, and versatile. It can be used to join high-strength aerospace aluminum alloys and other metallic alloys that are hard to weld. A plastic state material is generated the heat resulted from friction between tool and materials when it comes in contact with. As the tool movesalong the joint line, material from the front of the tool is cleaned around this plasticized circular region to the rear, so reducing

II. MANUFACTURING PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production processprior to manufacturing.

A. Metal Cutting : Metal cutting or machining is the process of by removing unwanted material from a block of metalin the form of chips. Cutting processes work by causing fracture of the material that is processed. Usually, the portionthat is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling. Although the actual machines, tools and processes for cutting look very different from each other, the basic mechanism for the fracture can be understood by just a simple model called for orthogonal cutting**.**

III. COMPONENTS AN ROTARY FRICTION WELDING BY USING STEEL PIPES

A. Steel Square pipe

Stainless Steel Square Pipe is made up of various sBytainless steel grades. The square pipes are useful in structural applications as the geometric shape provides extra strength to the pipe. Navstar Steel is a leading manufacturer and supplier of the Stainless Steel Square Pipe products in various scales and dimensions.

B. Chuck

A chuck is a specialized type of Clamp used to hold an object with radical symmetry, especially a Cylinder In a drilla Mill and a transmission, a chuck holds the rotating tool in a lathe, it holds the rotating workpiece.

C. AC motor

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings.

D. Belt

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped overpulleys and may have a twist between the pulleys, and the shafts need not be parallel.

IV. WORKING PRINCIPLE

Traditionally, friction welding is carried out by moving one component relative to the other along a common interface,while applying a compressive force across the joint. The friction heating generated at the interface softens both components, and when they become plasticised the interface material is extruded out of the edges of the joint so that clean material from each component is left along the original interface. The relative motion is then stopped, and a higher final compressive force may be applied before the joint is allowed to cool. The key to friction welding is that no molten material is generated, the weld being formed in the solid state.

The principle of this process is the changing of mechanical energy into heat energy. One component is gripped and rotated about its axis while the other component to be welded to it is gripped and does not rotate but can be moved axially to make contact with the rotating component. At a point fusion temperature is reached, then rotation is stoppedand forging pressure is applied. Then heat is generated due to friction and is concentrated and localized at the interface,grain structure is refined by hot work.Then welding is done, but there will not occur the melting of parent metal.

Briefly the friction-welding process consists in bringing into contact two elements to be welded while one of the twois static and the other is rotated rapidly on its axis.As the soon as the heat generated by attrition at the interface is sufficient for solid state welding without melting,the rotation is stopped and the elements are forced together under pressure producing local forging which concludes the intimate joining and also expels at the joint all surface contamination and some of the upset material called flash.

In friction welding one component is rotated and one component is held stationary. The part that is rotated is broughtinto contact with the stationary component and when enough heat has been generated to bring the components to a plastic state and the desired burnoff has been achieved, rotation is stopped. More axial force is then applied between the two components resulting in a solid state bond at the interface forming a friction welded joint.

V. CAD MODEL

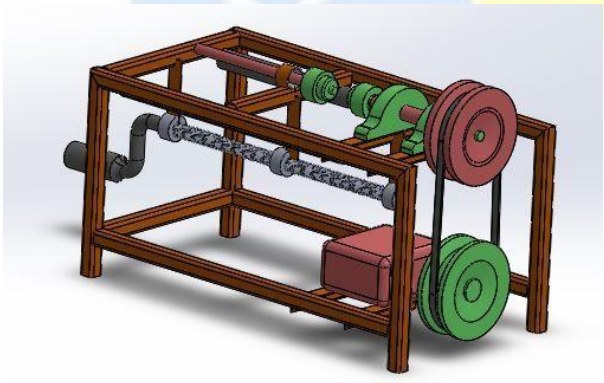

Fig.1. 3D Model Of Rotary Friction Welding By Using Steel Pipes

VI. APPENDIX

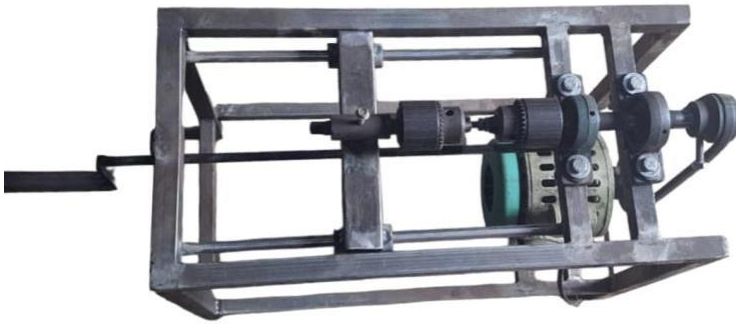

Fig.3 Rotary Friction Welding By Using Steel Pipes

Fig.2 Rotary Friction Welding By Using Steel Pipes

VII. CONCLUSION

In general terms, the present invention is dependent on relative motion where both faces of the weld joint are in motionduring the heating phase of the operation, which motions are brought into phase when the conditions of the joint are appropriate. While both will continue in motion, at least for a brief period, the relative motion between the parts is stopped by virtue of synchronizing the motions so they are in phase and identical. The change of phase of the motionsof the mating parts can be accomplished with far greater precision and speed than are possible when alignment of theparts is dependent on stopping the motion of one or both the parts.

In general terms, the present invention is applicable to all weldable materials, and includes a few materials not ordinarily joined by welding techniques. These materials include aluminum and a broad variety of aluminum alloys, brass, bronze, metallic carbides, such as tungsten and titanium carbides, cobalt based alloys, columbium, copper, cupronickel alloys,

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