NATIONAL CONFERENCE ON INNOVATIVE TRENDS IN ENGINEERING & TECHNOLOGY – NITET-19
15-16th March 2019
NOVATEUR PUBLICATIONS
International Journal Of Innovations in Engineering Research And Technology [IJIERT]
ISSN: 2394-3696

MODULAR DESIGN OF PORTABLE PLASTIC SPIN WELDING MACHINE

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Abstract: Plastics are used in day to day life right from simple children toys, utensils up to complicated parts such as heart valve for medical use. In the manufacturing of such components there is frequent need of joining/welding the plastic parts. In this work, a portable plastic spin welding machine is developed using modular design concept This welding machine can be utilised in laboratory for demonstration purpose or in small scale industry for welding the plastic components below 20mm diameter.

Keywords: plastic welding, spin welding, friction welding

INTRODUCTION

Plastics are used in day to day life right from simple children toys, utensils up to complicated parts such as heart valve for medical use etc. Plastics have ability to take good finish, excellent strength to weight ratio and good corrosion resistance. Hence plastic parts are frequently used in many industries.

Mechanical fasteners, adhesives, and welding processes can also be employed to form joints plastic components. Mechanical fasteners can join two components quickly, but they do not provide leak tight joint, and the localized stresses may cause them to separate again.

Adhesives can provide good properties and fully sound joints, but they are difficult to handle and slow to cure. Also joint preparation & surface cleanliness need to be given importance in adhesive bonding.

Welding can be used to produce bonded joints with mechanical properties that approach those of parent material. Welding offers superior strength, and often drastically reduced cycle times, to mechanical joining (snap fits, screws) and chemical bonding (adhesives).

There are two types of plastics, thermosets and thermoplastics.

The plastic welding is confined to thermoplastic polymers because these materials can be softened by heat. Thermosetting polymers once hardened cannot be softened again on heating. The heat required for welding thermoplastic polymers is less than that required for metals. Plastic welding is the process of creating a molecular bond between two compatible thermoplastics.

There are many types of plastic welding.

Hot gas welding uses a welding gun which has electric heating elements. They produce heat of hot gas.

Hot plastic welding uses a hot plate place between the two surfaces which are to be joined. In order to weld two pieces, ultrasonic welding uses a high frequency acoustic vibration. After subjecting them to high pressure, they are exposed to the vibrations until the weld is completed.

Vibration welding exposes the pieces to a frequency called amplitude. The two pieces are subjected to pressure due to which a friction is created which generates heat.

Spin welding, where friction is employed to weld two cylindrical parts. These parts are rotated. The rotation stops at a particular point and the weld is completed.

In this paper a focus is on spin welding process and the spin welding machine due to its easier and quick method of welding as well as it is economic.

PRINCIPLE OF SPIN WELDING,

Spin welding is based on principle of friction. In this heat is generated via internal friction generated between two parts when rotating and subjected to a load normal to the weld joint. This frictional heat causes the plastic to melt and create the bond between two components.

OBJECTIVES

1. To develop a low cost plastic spin welding machine for small scale industry.
2. To simplify the design of Spin welding machine.
3. To make the plastic welding process easy.
4. To design machine which can be operated by unskilled person also.
5. To provide leak proof joints and superior strength for plastic components.
6. To use standard parts as far as possible (Modular Design) in the construction of spin

welding machine for sustainable design concept.

LITERATURE SURVEY

Many researchers worked on plastic spin welding process revealing various aspects like effect of process parameters, heat generated in friction welding, flow of material, preparation of bond etc. Some researchers compared various plastic welding process explaining their advantages and disadvantages for easy selection of method of welding in a particular process.

Troughton M. J. in his book [1] Describes, Spin welding is a process where thermoplastic parts with rotationally symmetrical joining surfaces are rubbed together under pressure in a unidirectional circular motion. Normally, one part is held stationary while the other is rotated. The heat that is generated during this process melts the plastic at the interface, forming a weld upon cooling. Spin welding is a simple and highly energy efficient process; there is little excess heat generated, which means that cooling times are short. This makes the process well suited to automated assembly line applications. Strong, hermetic joints can be produced, which are frequently stronger than the parent parts. No foreign materials are introduced into the weld and no environmental considerations are necessary, as in solvent welding or adhesive bonding. The first reported application for spin welding was in the manufacture of fluid-filled compasses, where welding was carried out beneath the surface of the liquid. The process can therefore be used for sealing a liquid in a container. Other applications include fuel filters, check valves, truck lights, aerosol cylinders, and floats. Spin welding is also used for assembling structural components, connecting ventilation pipes to blow-moulded fuel tanks, and welding tops and bottoms on containers. Almost all thermoplastics can be joined using spin welding.

Stokes [2] says that, the friction (spin)-welding process for thermoplastics is known to consist of four phases: (a) initial heating of the interface to the melting temperature by Coulomb friction, (b) unsteady melting and flow in the transverse direction, (c) steady-state flow, and (d) unsteady flow and solidification after the spin motion is stopped. Simple analytical models, which are based on an analysis of the vibration welding process, have been developed for the first three phases. These models have been used for analysing spin-welding data for poly (methyl methacrylate), poly (vinyl chloride), acetal and nylon 66. Estimates have been obtained for the film thickness, the film viscosity and the film temperature as functions of the weld process parameters. In particular, it has been shown that an increase in the weld velocity can result in a significant reduction of the film viscosity. The film viscosity is shown to be less sensitive to the weld pressure.

Md Shakibul Haque [3] selected few Welding processes like hot gas welding, friction welding, hot plate welding, and compared them and concluded that although there are several methods that are reported to join two plastic pieces but hot air gun technique is most reliable and techno commercially beneficial from research as well as production point of view.

D Grewell [4] provides general introduction of welding fundamentals followed by section on few selected welding processes that have had significant developments over the last few years. The processes that are discussed are friction welding , Hot plate welding, ultrasonic welding, Laser/ IR welding, RF welding and hot gas/extrusion welding

Now a day's spin welding is mostly preferred welding process instead of riveting, bolting (mechanical fasteners) etc. or adhesives for joining purpose because welding provides high strength joints.

However, such welding process is mostly used in automation industries.

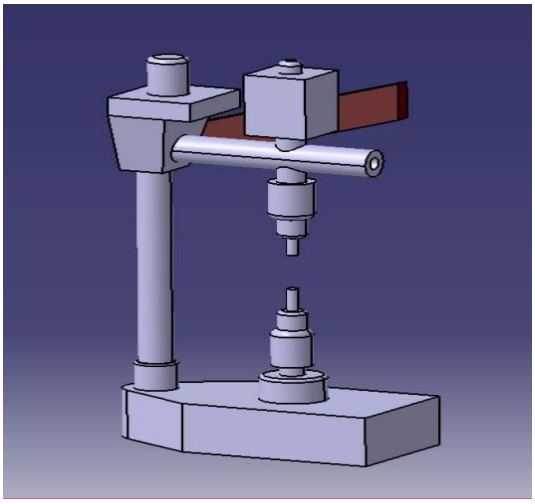
MODULAR DESIGN

Modular Design or "Modularity in Design", is an approach that subdivides a system into smaller parts called modules or skids, that can be independently created and then used in different systems.

Modularity offers benefits such as reduction in cost (due to less customization), shorter learning time, flexibility in design, augmentation, (adding new solution) by merely plugging in new module and exclusion

In this work, modular design concept is used. The readymade standard parts available in market are assembled to solve the purpose. A 3D model is initially developed

CATIA MODEL



PARTS AND SPECIFICATION

Motor

A variable speed sewing machine motor is used for rotating one of the work pieces. The variable speed facility is intentionally provided to check the welding strength for various speeds. A 120Watt/220V/0.6A clutch motor having 7000R.P.M. is used.

PCB drilling machine stand

A vertical axis spinning mechanism was to be developed hence a light weight aluminium body PCB drilling machine stand is used for holding the motor. A hand drill chuck is attached to the spindle of the motor and this assembly is fit in the upper movable attachment of this drilling machine stand. \ The height of PCB drill stand is 510mm and vertical travel for upper chuck is also possible for 60mm & upto 43mm diameter of part can be can be accommodated on both chucks.

Chuck

Two hand drilling machine chucks are used to hold the plastic work pieces. One chuck is attached to motor spindle and the other chuck is mounted on a free to rotate bearing attached to worktable. The upper chuck rotates at the speed of the motor. A special attachment is provided for lower chuck which will initially be stagnant and hold the work piece rigidly against upper rotating work piece. When the weld joint is completed, the lower chuck starts rotating with the speed of the upper chuck. Drill Chuck are made from special alloy steel with precision bored and reamed taper jaw holes. Its sleeve, jaws and gear-rings are hardened and ground for long life

Ball Bearing

Two ball bearings (6203, OD 40mm & ID 17mm) are used in the upper movable attachment of PCB drilling stand and the worktable. The use of bearings reduces the friction and improves the rotary motion with minimum motion loss.

Non contact type Tachometer

To measure the speed of rotating work piece, a digital laser RPM tachometer non contact measurement tachometer is used.

ASSEMBLY

CONCLUSION

A portable plastic spin welding machine is developed using modular design concept. This modular design concept saved much of expenditure for fabricating special parts of this equipment. The readymade standard parts available in market are used to solve the purpose. The total costing of this spin welding machine went up to Rs 8500/- only. This welding machine can be utilised in laboratory for demonstration purpose or in small scale industry for welding the plastic components below 20mm diameter.

The commercial machines available in market are fully automatic with control systems for every parameter. But these machines are not suitable for small scale industries because they are so expensive and they require skilled operator. The spin welding machine suitable for small scale industries is developed in this work.

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