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Design and Fabrication of Portable Friction Welding Machine for the Application of Thermosetting Plastic Materials

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ABSTRACT

This work is a model and a simplified version of friction welding on a mini Centre Lathe Machine and has been made under the constraints of space, time and resources available. The friction welding has been fused onto a cylindrical workpiece. The two cylindrical work pieces are joined to each other, when the two faces of the work pieces remain in contact with the two round faces. The friction welding method is one of the most simple, economical and highly productive methods in joining similar and dissimilar metals. It is widely used in the automotive, aircraft, aerospace, maritime and heavy industrial applications. In the present work, a cylindrical work piece is friction welded to another cylindrical workpiece. On the other hand, cylindrical work pieces were machined down using a lathe machine to the required dimensions. The diameters of the cylindrical work pieces were both 15 mm respectively. It is the strength of welded joints, which is a fundamental property to the service reliability of the welded work pieces. Rotational speed and axial pressure are the two major parameters which can influence the strength. Thus the axial pressure and rotational speed were taken as welding parameters, which reflect the mechanical properties. Rotational speeds for friction welding were around 700 rpm. A friction pressure was manually applied.

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INTRODUCTION

The term welding is used to cover a wide range of bonding techniques. Now-a-days many processes of welding have been developed and probably there is no industry which is not using a welding process in fabrication in its products in some form or other. One such welding process is Friction welding. Friction welding is considered as a solid state welding process that generates heat through mechanical friction between a moving work piece and a stationary component, with the addition of lateral force called "upset" to plastically displace and fuse the materials (Fuji, 1997). Technically, because no melt occurs, friction welding is not actually a welding processing the traditional sense, but a forging technique. However, due to the similarities between these techniques and traditional welding, the term has become common. Even metal combinations not normally considered compatible can be joined by friction welding, such as aluminum to steel, copper to aluminum, titanium to copper and nickel alloys to steel. As a rule, all metallic engineering materials which are forgeable can be friction welded, including automotive valve alloys, steel, tool steel, alloy steels and tantalum. In addition, many castings, powder metals and metal matrix composites can also be welded (Kiran Kumar).

Friction welding is a recent technique that utilizes a non-consumable welding tool to generate frictional heat and plastic deformation, thereby resulting in the formation of weld joint. The principle advantages of friction welding being a solid state process are less defects, low distortion, no filler, and cost. Friction welding is most rapid and easiest way of fabrication and assembly of metal parts (Ihsan Kirik). The research carried in this field has given various ways and methods to weld practically all metals. Means have also been found out to weld dissimilar metals. In comparison with other processes, friction welding gives better strength of joints and it is relatively easy and quick process. This process is being used in Automobile industry; aircraft machine frames, structural works, sports goods, etc. The recent applications of friction welding are welded for submarine rescue, aerospace, Production of micro cutting tools like drills, taps etc. Many of cost products are now-a –days being fabricated by welding various parts together (Imran Bhamji). A portable friction welding machine is given a trial of ram mechanisms which offer the required axial pressure throughout a fastening operation and

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additionally operate to maneuver a spindle of the fastening machine to a footing wherever the spindle is also pivoted outside the most machine body so flywheels is also simply hooked up or off from the spindle. The machine is additionally given associate automatic disconnect mechanism between the drive motor and also the spindle that disconnects the motor from the spindle upon the appliance of fastening pressure through the rams.

Direct Drive Friction Welding otherwise called as Conventional friction welding is a variation of friction welding in which the energy required to make the weld is supplied by the welding machine through a direct motor connection for a preset period of the welding cycle (Mumin Sahin). In Direct Drive Friction Welding, one of the work pieces is attached to a motor-driven unit while the other is restrained from rotation. The workpiece to be rotated is clamped in the spindle is brought predetermined speed. The motor-driven workpiece is rotated at a predetermined constant speed. The non rotating component is clamped in a chuck attached to hydraulically actuated tailstock slide. The work pieces to be welded are forced together and then a friction welding force is applied. To heat the work piece to welding temperature, the tailstock is gradually advanced to bring the work piece in contact by increasing axial pressure when the work piece is at or slightly above welding temperature. Heat is generated as the faying surfaces or weld interfaces rub together. This continues for a predetermined time, or until a preset amount of axial shortening called upset takes place. Spindle brake is applied simultaneously. Axial pressure is increased to complete weld. The rotational driving force is discontinued and the rotating work piece is stopped by the application of a braking force or by the weld itself. The friction welding force is maintained, or increased, for a predetermined time after rotation ceases (forge force).

Experimental work:

The Portable Friction Welding Machine was constructed with the basic idea of lathe is shown in Fig. 1. In this experiment, the friction welding machine has been fabricated over a mini lathe setup. The headstock assembly and tailstock were mounted over a base channel considering the centre distance. A single phase electric motor was mounted on to the base channel and was coupled to pulley in the headstock assembly through a V-belt. The centering of the headstock and tailstock was done by adjusting their heights accordingly. Firstly two cylindrical work pieces were taken. After machining the work pieces accordingly to the required dimensions, the work pieces are centered on a mini lathe setup. One end of the cylindrical work piece is fixed with the help of jaw chuck and the other work-piece is fixed through the chuck of tail stock. The machine is powered by an electric motor.

All attachment strategies are often investigated in one in all the two main categories; soften and pressure attachment. Friction welding could be a kind of controlled attachment methodology. Friction attachment could be a solid state method, wherever no electrical or other power sources area unit used, energy made by friction within the interface of components to be welded area unit utilized. victimisation heat expeditiously within the attachment region is merely potential by expeditiously distributing heat on surfaces, to that attachment are applied. throughout the attachment method, surfaces area unit fraught and this era known as the heating section continues till plastic forming temperature is achieved. The temperature within the attachment region for steels is between 900 and 1300 oC. Heated metal at the interface accumulates by incerasing pressure once heating section. Thus, a sort of thermo mechanical treatment happens within the attachment region and this region has stable particle structure. Metals and alloys, that can't be welded by different attachment strategies, are often welded using friction attachment. so as to get attachment affiliation between components, untreated surfaces have to be compelled to be contacted to at least one another. This contact is economical as a result of friction corrects contacting issues. The melting process doesn't normaly occur on contacted surfaces. albeit, alittle quantity of melting could occur, accumulation caused by post-welding method makes it invisible. Fig. 1 provides the stages of friction attachment used in tis experiment. One of the components is stationary whereas the opposite one rotates. once the roational speed rises to an exact value, axial pressure is applied and locational heating happens in components at the interface. Then, the rotation is stopped, heated material at the interface accumulates (Welding Handbook, 1980; Nicholas, 1983). The stages of friction attachment throughout the attachment process area unit given in Fig. 2 (Uzkut, Mehmet, 2010).

- Centering of the workpiece on the Friction welding machine.
- Facing of each work piece.
- The Work pieces are then fitted with chuck and through chuck.
- The Friction welding process starts by rotation of the chuck that is powered by an electric motor.
- The power supply to the electric motor is cut off at red hot conditions for immediate stopping of chuck to make joint.

The centre lathe machine is started, the cylindrical work piece attached to the chuck is rotated and the other work piece is pushed towards it by applying pressure manually. At a point fusion temperature is reached, then rotation is stopped with the help of braking device and welding is done. In friction welding one component is rotated and one component is held stationary (Anık, 1983). The part that is rotated is brought into contact with the

stationary component and when enough heat has been generated to bring the components to a plastic state and the desired burn off 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.

Fig. 1: Photograph of Portable Friction welding machine.

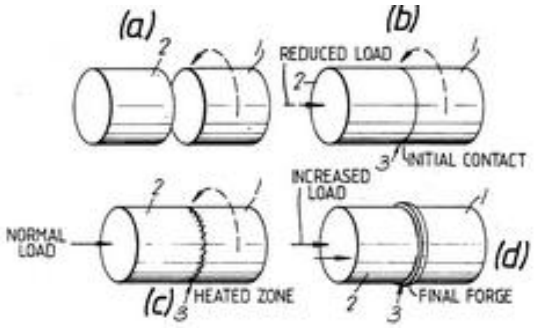

Fig. 2: Fabrication process of Friction welding.

Fig. 3: Friction welded thermo-setting plastic materials.

RESULTS AND DISCUSSIONS

In general terms, the present invention is dependent on continuous drive where one piece is in rotation & other in linear motion, where both faces of the weld joint are in motion during the heating phase of the operation; the motions are brought into rest when the conditions of the joint are appropriate. Friction welding technology brings substantial advantage to the area of joining of similar and dissimilar materials. It is safe on this machine to perform the friction welding up to bar diameter of 13mm with good mechanical properties. For light loads and soft work pieces, the Portable Friction Welding Machine on a mini lathe setup is much better and less expensive for welding moderate sized work pieces when compared to CNC controlled Friction Welding Machine. The two cylindrical work pieces were friction welded together successfully is shown in Fig. 3.

Optimum welding parameters should be properly selected in the friction welding of parts. Availability of data required for design of Friction Welding technology processes in open literature is limited but provides sufficient base to estimate roughly possible benefits of the usage of the technology. Information about basic welding parameters is sufficient to be used as starting values for optimization process on

materials and tools. Friction welding is indispensable tool for welding dissimilar metals. With the increase in rpm, the torque and coefficient of friction increases. This causes higher financial requirements for new adopters of the technology. This basic experimental study of friction welding leads us to a variety of scopes in future like microscopic study of weld, testing of weld, welding of dissimilar materials. The Effect of welding power on diameter of the specimen. The Diameter of the specimen increases the power required is also increases is shown in Fig.4. The process has uncommon high yield and lower energy demand and power offer. Moreover, power requirement of friction attachment is regarding one tenth of ohmic resistance attachment. Friction attachment causes triphase within the engine and therefore the power issue is Cos ϕ = 0.80 to0.85. However, ohmic resistance attachment is one part method and therefore the power issue is Cos ϕ = 0.40 to0.60.

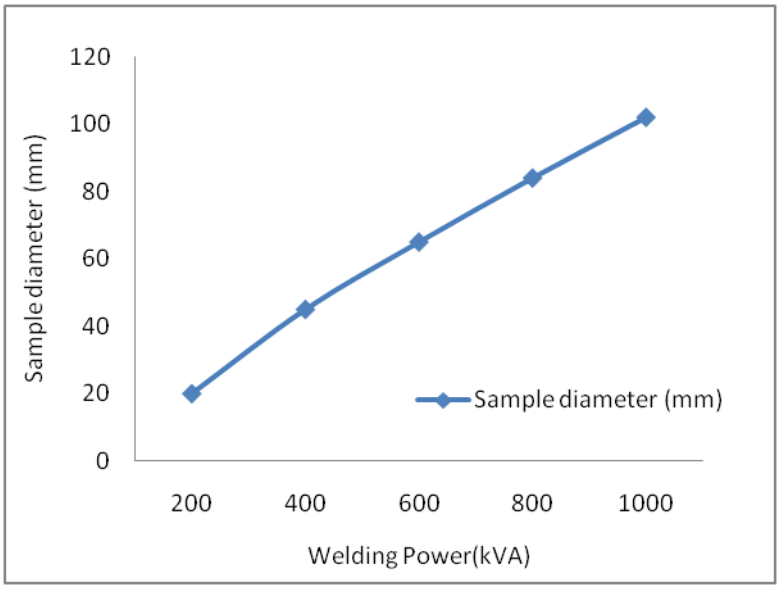

Fig. 4: Effect of welding power on diameter of the specimen.

Conclusions:

- It is safe & less expensive on the portable lathe machine to perform the friction welding up to work pieces of diameter 13mm.
- With the increase in rpm, the machine would be suitable for welding materials of higher melting points.
- The two cylindrical work pieces of thermosetting plastic were friction welded together successfully is plotted.
- Friction attachment causes trips within the engine and therefore the power issue is Cos ϕ = 0.80 to 0.85. However, ohmic resistance attachment is one part method and therefore the power issue is Cos ϕ =0. 40 to 0.60.

Scope for future work:

Friction welding technology brings substantial advantage to the area of joining of similar and dissimilar materials. Metal combinations not normally considered compatible can be joined by friction welding, such as aluminum to steel, copper to aluminum, etc. As a rule, all metallic engineering materials which are forgeable can be friction welded, including automotive valve alloys, maraging steel, tool steel, alloy steels and tantalum. In addition, many castings, powder metals and metal matrix composites are weldable.

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