Recent advances in Joining Process

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Abstract: Joining is a course in which mechanical members can be fastened by method of bolt and nut, riveting arrangement or by welding process. Joint preserve be a temporary or permanent depending ahead the usage and user specific requirement. In a manufacturing process energy efficient, cost effective, environment conscious plays essential role for the operative or the factory organization due to stringent environment laws. Several advances taken position in this way in current times particularly welding process. In this document, we are highlighting the advances in welding procedure and what are their merits and demerits are discussed.

1. Introduction

In a manufacturing process today challenge is to design and manufacture light weight materials, safe environment manufacturing practices, cost effective products and development of fusion of unlike metals. Welding is one of the important processes to join similar or dissimilar metals. Several advances in use place in new times viz. Solid state welding course, Laser Welding process and Resistance welding process. Several organizations working viz CEWAC, KU LEUVEN, BELGIUM WELDING INSTITUTE, LWF AND GSI SLV and several research works are taking place to develop defect free joining of the materials, validation of mechanical property, metallurgical properties and hardness of the combination materials. For the history three decades several alloying materials are developed and wide series of fusion process has been taken place and an amount of the materials such as Aluminum, Titanium alloys which are firm to weld are now easily joined by Laser welding and Friction stir welding. With reasonable cost producing a weld a milestone activity. In this paper we are highlighting the following joining process, merits and demerits, cost advantages.

1. Resistance welding with process tape
2. Resistance element welding
3. Friction spot welding
4. Friction Stir welding vs friction spot welding
5. Friction element welding
6. Electromagnetic pulse sheet welding
7. Laser beam welding (continuous or pulsed)
8. Arc element welding with an auxiliary joining part.

2. Resistance spot welding with process tape:
Resistance spot welding is a joining course in which thin sheets of materials are joining by using non consumable welding electrodes. In this process no filler rod or fluxes are necessary. The disadvantage of this process is lifetime of welding electrodes in automotive industry. This can be enhanced by way of new innovative method called Delta Spot by using the special method tape between welding electrodes and joining materials. The total of heat formation is depending on the welding current and weld time. The essential equation to create heat $H$ is depending upon on Current and Resistance of the electrode and time

$$H=I^2Rt$$

Where, $H$ is heat generated in Joules, $I$ is the current in Amps & $R$ is the resistance of the electrodes in ohms and $t$ is the time takes in sec

![Figure 1: Basic principle of resistance spot welding](image1)

The electrical resistance of metals increases with temperature. A process tape that will run between electrodes and sheets being joined. Fig (2) shows the principle of Resistance spot welding with tape. The continuous forward movement of the method tape results in an uninterpreted process producing consistent quality of welds results in increase in service life of the electrodes.

![Figure 2: Resistance spot welding process tape](image2)

3. Resistance Element Welding:
This course is extension of spot welding. In this course together thermal and mechanical process are combined. Fig (3) show the essential principle of Resistance Element Welding. A metal tie is created between auxiliary fusion element and bottom plate. After create pre-hole, the supplementary element called weld rivet is slot into the hole. The apex electrode is inferior in to the rivet. Electric current with Pressure is applied at a time so that weld nugget is created due to heat generation by electrodes.
Aluminum-steel, aluminum carbon reinforced plastics tin be welded by this process. A typical application of resistance spot welding adopted by M/s Volkswagen as shown in the Fig (4).

**Figure 3:** Process method for resistance element welding

**Figure 4:** Resistance element welding in Volkswagen passat B8

4. **Friction Spot Welding:**
In this course a three module tool called pin, sleeve and clamp ring which is worn link the plates. Initially a fixing ring the sheet adjacent to backing plate, a rotating pin and sleeve are stirred in reverse way a cavity will be formed due to friction. After plunge depth pin and sleeve returned to their unusual position. Figure (5) shoes the basic principle of Friction spot welding

**Figure 5:** Working principle of spot welding
5. Friction stir welding vs friction stir spot welding

Friction stir welding is a solid state fusion process. The basic principle is that a high speed revolving tool is plunged into the workpiece, creating friction between tool and workpiece, resulting in the development of high energy heat. This energy can be transformed to plasticize the parent metal and join. The major benefit is no filler rods, no fumes, and an environmentally friendly joining process. Friction stir spot welding is a variation of friction stir welding and involves no longitudinal movement but rotation of the tool up and down movement of the tool.
6. Friction Element Welding:

In this process, friction factor welding too combine mechanical and thermal welding, assisting joining welding, create a rigid metal bond, force and form-lock of the materials to be attached. The major variation with resistance element welding is the production of the essential course high temperature, which is through by friction.

![Process series for friction element welding](image1)

Figure 10: Process series for friction element welding

A rotationally symmetrical fusion portion called as friction element, step up to a high rotary motion speed and it is pressed adjacent to the surface of the upper fusion associate. The frictional heat up cause a plasticization, face sheet and allow penetrating the matter with no any pre-hole process or melting. The contact a face of the primary base sheet, the friction and so the temperature increase radically, form the attribute called upset. The sliding shell of the upset clears and activates the shell of the lower sheet following an exact limitation of the friction part, the rotary motion is congested, and the axial force is improved. Through dispersion, the clean untainted metal surface connects in a stiff metal tie. Declining heat as well causes an axial reduction; create a force-lock among the constituent and the face sheet. Relocate material from the face sheet fill the below head channel of the friction element cause a solid positive lock. The alike matter combination as for resistance element welding is investigated.

![Welding of Al alloy with steel thickness is 1,2 and 1,5](image2)

Figure 11: Welding of Al alloy with steel thickness is 1,2 and 1,5

7. Electromagnetic pulse sheet welding (EPSW):

The electromagnetic forces use fusion of work pieces and deformation. Electromagnetic pulse welding is an mechanical welding course, damaged for tubular and sheet metal application, located in overlie pattern. EPSW belong to group of pressure weld process. Power provides is use to accuse a capacitor bank, essential quantity of power is store in the capacitors; it is instantly sent into a coil, through a
extremely tiny era of time (usually 10-15 μs). The discharge current induce a burly momentary magnetic field inside the coil, which generate a magnetic pressure and cause one work piece to impact with another work piece. The deformation takes place on a extremely lofty velocity, similar to explosive welding. The explosive deformation force is produced a secure way, via use electromagnetic forces generate through an induction coil. It also called as solid state welding, which means to the material do not melt during the formation of bond, which provide the occasion to bond dissimilar materials

7.1 Advantages:

This tool doesn’t employ high temperature, but it uses pressure to form the bond, it offer chief compensation evaluate toward the conventional thermal welding process:

- Manufacturing of complex work pieces or novel products, which be before not likely with conventional fusion process.
- Magnetic pulse welding be a "cold" fusion course. High temperature raise is very limited (50 μm), consequently the work pieces achieve not additional than 30-50°C at the outer surfaces. It means that after welding the parts can directly be unloaded and they send to further process with other equipment.
- Increasing repeatability; steady joint eminence.
- More manufacture rate potential.
- Here is veto, radiation, smoke or gas, heat shielding gas, less hurtful for worker
- Less energy will be consumed by magnetic pulse welding course

8. Laser beam welding (pulsed or continuous)-LBW:-

LBW be stand lying on the contact amid a light beam through a specific composition plus the work piece substance. The beam be intense extremely in the vicinity, creation in welding technique a lofty power density path. Diverse laser source exist because carbon dio-oxide, fiber, YAGetc. The fiber laser produces a beam of exceptional optical worth for accurate cutting plus weld events. Owing to heat input, deep welds be able to be created at high heat and cool charge. This method character creates feasible to create accuracy joints by a thin heat affected zone (HAZ) and partial work piece deformation later than welding. The lofty high temperature change rates with positive effect on fusion dissimilar metals.
The application of heterogeneous welding includes associations of bronze to stainless steel, Cu to Al and Cu to steel. There are some other combinations like titanium to Al etc. have been tried with changeable degree and it is succeed.

Figure 15: a) Laser welding cabin b) Typical Weldment

The procedure being take place in a closed chamber, due to this the worker can be sheltered from some injurious emission, as use a shielding gas for the defense of the welding region. Welding tackle with this robust laser equipment is characteristically robot or CNC base, thus that vital welding speed and correct actions are joint with a lofty and steady course eminence.

The different parameter, tin be place and forbidden during the welding course for optimizing the heat effort and therefore the diffusion and weld value for a specific function are:

- Welding speed and laser beam power
- Pulse laser welding also the duration and form, beam pulse frequency
- Type and flow of shielding gas

9. Arc element welding with an auxiliary joining part:

In arc element welding, a short auxiliary fusion part is use. The top sheet should be perforate. The top sheet and the bottom sheet will not be directly joined together, but by using a auxiliary fusion part, compulsorily the top sheet will be fixed on the carter sheet in a mostly form fitting and limited force fitting joint. welding is created only among the bottom sheet and auxiliary

Figure 16: Arc element welding (AEW) with an auxiliary part
10. Conclusions
In recent years various joining process are developed. The joining of materials not only limited to similar metals but also extended to dissimilar metals. In this paper, We are highlighting the various methods of joining processes which is particularly suitable for Automobile, aircraft and aerospace industry.

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