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Overview of Orbital Welding Technology

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Abstract

There are different welding technologies on welding in the market. The orbital welding technology is the main topic of this paper. In this paper the history of the orbital welding, the basic concepts of the orbital welding, the problems related to the orbital welding are described. With that the solutions for the problems where suggested in the paper. The orbital welding technique is changing from last decade but still there are requirement of improvement in this technique related to the quality of weld, efficiency, the productivity, simplicity. The overview of this technology considering all above factors is considered in this paper.

1.Introduction

Orbital welding is the technology to weld the pipes or tubes. In case of pipelines this technology is used at a large scale as the pipeline having number of pipes joined together. These pipelines may have chances of leakages at their joints. These leakages may be harmful if the pipelines are used for gas supply or any harmful liquid supply like acid etc. through it. Also the leakage may cause loss in the productivity. To overcome these problems the welding technology is required to improve. As the use of pipeline is increasing day by day hence the requirement of orbital welding is also increases.

Like the pipe welding the tube welding is also become primary requirement of the industries now days. In some industries there is mass production of these tubes or pipes hence the increase I productivity is need of the industries. For that the improvement in the orbital welding is required now.

From last ten years orbital welding has gaining popularity steadily; this is mainly found due to semiconductor industry's requirements for better gas distribution systems. These systems encompassed all the requirements of a critical system. Orbital welding did not get its start in the semiconductor industry but found its growth there. The time has come to apply orbital welding technology to a broad range of industries.

For orbital welding in many precision or high purity applications, the base material, tube diameter(s), weld joint and part fit-up requirements, shielding-gas type and purity, arc length, and tungsten electrode type, tip geometry, and surface condition may already be written into a specification covering the specific application. In addition, orbital-welding equipment suppliers can offer recommendations on equipment setup and use. For those applications where no specification exists, the engineer responsible for welding must create the welding setup and develop the welding procedures.

Orbital welding uses the gas-tungsten arc-welding (GTAW) process as the source of the electric arc that melts the base material and forms the weld. During GTAW an electric arc forms between a tungsten electrode and the work piece. To initiate the arc, an RF or high-voltage signal will ionize the shielding gas to generate a path for the weld current. A capacitor dumps current into the arc to reduce arc voltage to a point where the power supply can regulate. The power supply responds to the demand and provides current to maintain the arc.

2.History of Orbital Welding

Orbital welding first found use in the 1960's when the aerospace industry recognized the need for a superior joining technique for aircraft hydraulic lines. The solution: a mechanism to rotate a welding arc from a tungsten electrode around a tube-weld joint. Regulating weld current with a control system automated the entire process. The result was a more precise, reliable method than manual welding. Orbital welding became practical for many industries in the early 1980's with the development of portable

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combination power supply/control systems that operated from 110-V AC. Currently, typical industries using orbital welding include aerospace; food, dairy, and beverage; nuclear; offshore; pharmaceutical; and semiconductor. Other applications include boiler tubing and tube and pipe fittings, valves, and regulators. Modern orbital welding systems offer computer controls that store welding schedules in memory. The skills of a certified welder are thus built into the system, enabling the production of enormous numbers of identical welds and leaving little room for error or defects

3.General Problem in Manual Welding

By considering manual metal arc welding process, electric arc welding is based on providing an electric circuit comprising the Electric current source the feed and return path, the electrode and the work piece. The arc welding process involves the creation of a suitable small gap between the electrode and the work piece. When the circuit is made a large current flows and an arc is formed between the electrode and the work piece. The resulting high temperatures causing the work piece and the electrode to melt, the electrode is consumable. It includes metal for the weld, a coating which burns off to form gases which shield the weld from the air and flux which combines with the nitrides and oxide generated at the weld. When the weld solidifies a crust is formed from the impurities created in the weld process (Slag). This is easily chipped away.

The blue area results from oxidation at a corresponding temperature of 600 °F (316 °C). This is an accurate way to identify temperature, but does not represent the HAZ width. The HAZ is the narrow area that immediately surrounds the welded base metal.

The effects of welding on the material surrounding the weld can be detrimental—depending on the materials used and the heat input of the welding process used, the HAZ can be of varying size and strength. The thermal diffusivity of the base material plays a large role—if the diffusivity is high, the material cooling rate is high and the HAZ is relatively small. Conversely, a low diffusivity leads to slower cooling and a larger HAZ. The amount of heat injected by the welding process plays an important role as well, as processes like oxyacetylene welding have an concentrated heat input and increase the size of the HAZ. Processes like laser beam welding give a highly concentrated, limited amount of heat, resulting in a small HAZ. Arc welding falls between these two extremes, with the individual processes varying somewhat in heat input. To calculate the heat input for arc welding procedures, the following formula can be used: where Q = heat

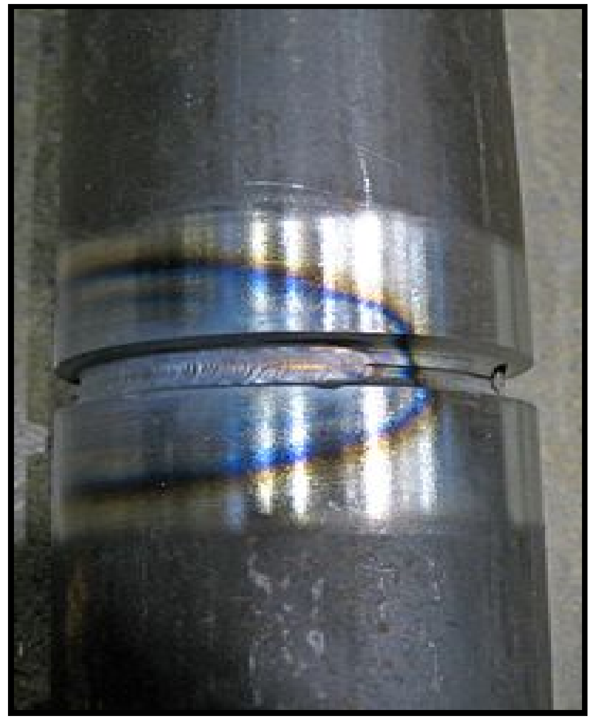

Fig.1. Heat-affected zone in Manual welding

input (kJ/mm), V = voltage (V), I = current (A), and S = welding speed (mm/min). The efficiency is dependent on the welding process used, with shielded metal arc welding having a value of 0.75, gas metal arc welding and submerged arc welding, 0.9, and gas tungsten arc welding, 0.8.

3.1.Distortion and cracking

Welding methods that involve the melting of metal at the site of the joint necessarily are prone to shrinkage as the heated metal cools. Shrinkage, in turn, can introduce residual stresses and both longitudinal and rotational distortion. Distortion can pose a major problem, since the final product is not the desired shape. To alleviate rotational distortion, the work pieces can be offset, so that the welding results in a correctly shaped piece. Other methods of limiting distortion, such as clamping the work pieces in place, cause the buildup of residual stress in the heat-affected zone of the base material. These stresses can reduce the strength of the base material, and can lead to catastrophic failure through cold cracking, as in the case of several of the Liberty ships. Cold cracking is limited to steels, and is associated with the formation of martensite as the weld cools. The cracking occurs in the heat-affected zone of the base material. To reduce the amount of distortion and residual stresses, the amount of heat input should be limited, and the welding sequence used should not be from one end directly to the other, but rather in segments. The other type of cracking, hot cracking or solidification cracking, can occur with all metals, and happens in the fusion zone of a weld. To diminish the probability of this type of cracking, excess material restraint should be avoided, and a proper filler material should be utilized.

4.Orbital Welding Process

The orbital welding was initially used to done by manually. In manual welding welder either used to weld the tube or pipe by rotating weld head or by rotating tube and keeping weld head as it is. In this process the time required to weld was more and also that weld was not continuous. This process was the process at the start but then the orbital welding techniques where introduced.

For the orbital welding the process was introduced where the weld head was steady and the pipes where rotating. The positioners were made which were used to hold the tubes together and to weld them. In this technique the positioner hold the job and rotate in 360^0 rotation with the speed controlled by feed control unit. These positioners were semi-automatic positioners.

Fig.2. Positioner for orbital welding

In modern techniques the computers were used for orbital welding. In the orbital welding process the tubes or pipes are clamped in place and an orbital weld heads rotates an electrode and electric arc around the weld joint to make the required weld. An orbital welding system consists of a power supply and an orbital weld head.

The power supply/control system supplies and controls the welding parameters according to the specific weld program created or recalled from memory. This supply provides the control parameters, the arc welding current, the power to drive the motor in the weld head, and switches the shield gas on/off as necessary.

Orbital weld heads are normally of the enclosed type, and provide an inert atmosphere chamber that surrounds the weld joint. Standard enclosed orbital weld heads are practical I welding tube sizes from 1/16inch to 6 inches with wall thicknesses of up to 154 inches. Larger diameters and wall thicknesses can be accommodated with open style weld heads.

Fig.3. Modern Orbital Welding

5. The Importance of Orbital Welding

There is very much impotence of orbital welding technology in the welding field. There are many reasons for using orbital welding equipment. The ability to make high quality, consistent welds repeatedly, at a speed close to the maximum weld speed, offer many benefits to the user:

5.1. Productivity.

An orbital welding system will drastically outperform manual welders, many times paying for the cost of the orbital equipment in a single job.

5.2. Quality.

The quality of a weld created by an orbital welding system (with the correct weld program) will be superior to that of manual welding. In applications such as semiconductor or pharmaceutical tube welding, orbital welding is the only means to reach the weld quality requirements.

5.3. Consistency.

Once a weld program has been established, an orbital welding system can repeatedly perform the same weld hundreds of times, eliminating the normal variability, inconsistencies, errors, and defects of manual welding.

5.4. Skill level.

Certified welders are increasingly hard to find. With orbital welding equipment, you don't need a certified welding operator. All it takes is a skilled mechanic with some weld training.

5.5. Versatility.

Orbital welding may be used in applications where a tube or pipe to be welded cannot be rotated or where rotation of the part is not practical. In addition, orbital welding may be used in applications where access space restrictions limit the physical size of the welding device. Weld heads may be used in rows of boiler tubing, where it would be difficult for a manual welder to use a welding torch or view the weld joint.

Many other reasons exist for the use of orbital equipment over manual welding. For example, applications where inspection of the internal weld is not practical for each weld created. By making a sample weld coupon that passes certification, the logic holds that if the sample weld is acceptable, that successive welds created by an automatic machine with the same input parameters should also be sound.

6. Basic Requirements in Orbital Welding

Orbital welding uses the gas tungsten arc welding (GTAW) process as the source of the electric arc that melts the base material and forms the weld. In the GTAW process, an electric arc in established between a tungsten electrode and the part to be welded.

6.1 Material Weldability

The material selected varies according to the application and environment the tubing must survive. The mechanical, thermal, stability, and corrosion resistance requirements of the application dictate the material chosen. For complex applications, a significant amount of testing is necessary to ensure the long-term suitability of the chosen material from a functionality and cost standpoint.

6.2. Weld Joint Fit-up

Weld joint fit-up depends on the weld specification requirements for tube straightness, weld concavity, reinforcement, and drop-through. If no specification exists, the molten material must flow and compensate for tube mismatch and any gap in the weld joint.

6.3. Shield Gases

An inert gas is required on the tube OD and ID during welding to prevent the molten material from combining with the oxygen in the ambient atmosphere. The objective of the welder should be to create a weld that has zero heat tint at the weld zone.

6.4. Tungsten Electrodes

The tungsten welding electrode the source of the welding arc is one of the most important elements of the welding system that is commonly ignored by welding system users. While no one would refute the importance of the ignition device on an automobile air bag, the rip cord for a parachute, or quality tires for automobiles, the importance of tungsten electrodes for quality welding is often overlooked.

7. Application of Orbital Welding

Orbital welding is having number of applications in different fields. Their applications are increases day by day now. Some of their applications are listed below.

7.1. Aerospace

The aerospace industry was the first to recognize the advantages of automated orbital welding. The high pressure systems of a single aircraft can contain more than 1,500 welded joints, all automatically created with orbital equipment.

7.2. Boiler tube

Boiler-tube installation and repair offer perfect applications for orbital welding. Compact orbital weld heads can be clamped in place between rows of heat-exchanger tubing.

7.3. Food, dairy and beverage industries

These industries require consistent full penetration welds on all weld jonts. For maximum piping-system efficiency, the tubing and tube welds must be as smooth as possible. Any pit, crevice, crack, or incomplete weld joint can trap the fluid flowing inside the tubing, becoming a harbor for bacteria.

7.4. Nuclear piping

The nuclear industry, with its severe operating environment and associated specifications for high quality welds, has long been an advocate of orbital welding.

7.5. Offshore applications

Sub-sea hydraulic lines use materials whose properties can be altered during the thermal changes that accompany a typical weld cycle. Hydraulic joints welded with orbital equipment offer superior corrosion resistance and mechanical properties.

7.6. Pharmaceutical industry

Pharmaceutical process lines and piping systems deliver high-quality water to their processes. This requires high quality welds to ensure a source of water from the tubes uncontaminated by bacteria, rust, or other contaminant. Orbital welding ensures full-penetration welds with no overheating that could undermine the corrosion resistance of the final weld zone.

7.7. Semiconductor industry

The semiconductor industry requires piping systems with extremely smooth internal surface finish to prevent contaminant buildup on the tubing wall or weld joints. Once large enough, a build-up of particulate, moisture, or contaminant could release and ruin the batch process.

7.8. Tube/pipe fittings, valves, and regulators

Hydraulic lines, liquid- and gas delivery systems, and medical systems all require tubing with termination fittings. Orbital systems provide a means to ensure high productivity of welding and optimum weld quality.

8. Conclusion

Now a day's competition in the production industries is increases. The customers are demanding the products having good/high quality. There are no chances for defects now in the product. To sustain in this competitive life there is a need of the change in the production.

Optimizing the welding process improves weld quality; increases weld speed, and reduce scrap and rework costs. By achieving these goals the companies can realize the lower cost per product with a good quality and minimum delivery time. Using the orbital welding technique with computer programming the control on the use of electrode, input material, shield can etc. can be achieved easily.

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