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DESIGN, MANUFACTURE THE SEMI-AUTOMATIC PIPE WELDING EQUIPMENT

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ABSTRACT

Pipe welding is one of the difficult welding techniques in the field of welding technology. This technique is widely applied in industries and construction such as welding the oil pipelines, gas pipelines, rollers of conveyor belts, etc. However, the pipe welding technique has not received much attention from scientists. In addition, the pipe welding equipment has not been invested in the equipment system for training in Machine manufacturing technology major at the Thainguyen University of Technology (TNUT). Therefore, the students have not been able to practice the pipe welding techniques during the vocational training. The article will refer to the research and design of semi-automatic pipe welding equipment to contribute to the training process and production practice.

KEYWORDS: Pipe welding, semi-automatic pipe welding equipment, welding technology, Machine manufacturing technology.

INTRODUCTION

The welding technology is widely applied in the industrial production process. it allows the fabrication of reasonable structures with a variety of materials, sizes and in different regions (such as in industry of oil, gas, shipbuilding, household, aircraft, food, hydropower, thermal-power, cement, bridge, tunnel, high-speed railway, factory manufacturing, truss, girder, agriculture ... Therefore, besides the basic professional knowledge and skills, the accumulation of knowledge and training of welding skills are important contents to train Mechanical engineers in general and Machine manufacturing technology engineers in particular who are able to meet the needs of mechanical engineering human resources in the current period.

With the importance of welding technology, there have been many domestic and foreign authors interested in research in this field. All studies [1], [2], [3] agree that the concept of welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure, or both forming a join as the parts cool and the completed welded joint may be referred to as a weldment.

The classification of welding methods is very diverse. Some of the main ways to classify welding methods include: (1) Molten welding and pressure welding (according to the state of the weld metal when they are heated), (2) Electric welding, chemical welding, mechanical welding, combined welding (according to the types of supplied energy) [2] and (3) welding position by, horizontal welding position, standing position welding, ceiling welding position or 1G, 2G, 3G, 4G, 5G, 5G/1F, 2F, 3F,

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4F (according to space weld, 1 - welding position by; 2 - Horizontal welding position; 3 - standing position welding; 4 - ceiling welding position and G - groove weld, F - fillet weld) [1], [2], [4], [5].

Beside the above studies, many authors focus mainly on the study of technological parameters of welding process, such as the effect of cooling speed on the structure of the two-way pipe weld by the automatic welding method using the drug layer [9], the three-wire Submerged Arc Welding (SAW) process for welding high-strength steel plates [9], the Welding drug consumption with constant heat input [8], the effect of additional metal particles on productivity and quality of welds [6,7,10,11].

Although there have been many studies on welding and pipe welding, however, pipe welding equipment has not received much attention from scientists. Moreover, in the equipment system for training of Machine manufacturing technology major at TNUT, this equipment has not been invested in, so students have not been able to practice pipe welding and semi-automatic welding techniques during the training process to perfect the professional skills. Therefore, the study and design of semi-automatic pipe welding equipment to contribute to production practice and training process is an necessary issue.

2. CONTENT

2.1 Overview of welding technology

2.1.1 Welding concept

Welding is a machining process that joins two or more metal parts together into a non-removable block by using a heat source to heat the metal in the contact area to a molten state, then the liquid metal is crystallized (freezing and solidifying) or by heating the metal in the contact area to a plastic state and applying an external force large enough to force them together to form a weld [2].

In other words, welding is a technological method to join two or more elements into a non-removable bond, which is performed by a "Q" heat source (or by a heat and pressure source) to heat the contact metal area to a welded state, then the metal self-crystallizes (corresponding to the welding state is molten) or using pressure (corresponding to the welding state is plastic) to connect the metal elements together for a weld [3].

2.1.2 Characteristics

Today's welding technology is strongly developed and widely used because of the following characteristics: (1) The welding joint is continuity and monolith city, (2) Saving metal, (3) The strength and tightness of the weld is great, (4) It is possible to process complex, super-long, and super-heavy parts, from materials of the same type or from materials with very different properties that the other processing methods cannot do, (5) The time used to prepare and manufacture the workpiece is short, the cost of the workpiece is low, the processing capacity is high (because the number of operations can be reduced and the labor intensity is reduced); (6) Welding equipment is simple, neat, light, easy to manufacture. However, this method also has some disadvantages: the processed material is affected

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by a large, concentrated heat source in short time, which adversely affects the organization and properties of the metal of weld zone. In addition, the welds are prone to defects such as pitting, cracking, etc., making reduce the bearing capacity of the structure; the welded structure had a large residual stress and deformation that will significantly affect the shape, size, aesthetics and workability of the product [2, 3].

Although there are certain limitations, the welding technology is increasingly interested in research, development and completion and is widely applied in most industrial fields because of the high economic and technical characteristics. In particular, the welding method is widely used to process and manufacture workpieces in the field of mechanical engineering, such as frame structures, trusses, beams, tanks ... in the field of construction industry, bridges, shipbuilding, etc. Therefore, it is necessary for students of Mechanical Engineering department in general and Machine Manufacturing Technology major in particular to have knowledge and practice skills in welding to quickly adapt to the professional environment in practice.

2.1.3 The pipe welding and requirements

a. The pipe welding

The pipe welding is a processing technique used a lot in the mechanical and civil industries. There are many types of them. According to the type of pipe welding product, it can be divided into the following types.

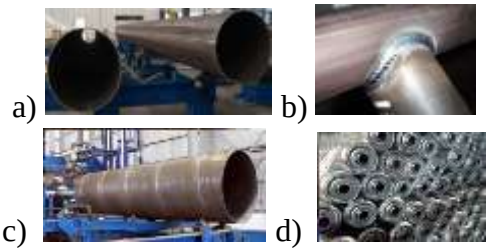

Figure 1. Some types of pipe welding

a) Welding pipelines; b) Welding of T-pipes; c) Continuous pipe welding; d) Pipe cage welding

According to the position and type of weld, the pipe welding is usually divided into 1F, 1G, 2F, 2G, 2FR, 3F, 4F, 5G, 6G where the first digit represents the welding position: 1 (the horizontal pipe position, the welder works in the flat welding position when the pipe rotates), 2 (the vertical pipe position, the welder perform the horizontal welding position), 5 (the horizontal pipe position, the welder perform the bare weld, flat weld and horizontal weld) and 6 (The pipe is be at 45° position, the welder perform in the flat, horizontal, ceiling and vertical welding position), and G is for groove welding, F is for angle welding, R is the restricted welding position [1], [2], [4], [5].

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Figure 2. Some types of pipe welds

b. The requirements of pipe welding

In order to ensure the good quality of the product after welding, some basic requirements for pipe welds include: have no convex defects on the welded pipe, no cracks on the surface, no porosity, wholesale and the welding process does not cause the steel pipe to be deformed.

2.2 The reality of the pipe welding equipment and the training process of Machine Manufacturing Technology major at the TNUT

2.2.1 The reality of demand for pipe welding technology and the pipe welding equipment

a. Demand for pipe welding

All pipe welding products are very commonly used in practice. However, at present, the conveyor roller is one of the important and indispensable equipment in the industrial conveyor system because it helps to support and transport products with a hard flat bottom, from light to, moderate to heavy weight. Therefore, the improvement of productivity and quality of roller pipe welding is also a problem for the process of equipment research and mechanical manufacturing processing.

Figure 3. Products of pipe welding technology

Thai Nguyen is a province where have diverse types of production and processing, so the demand for automatic lines using conveyor systems to transport coal, ore, wood, tea, garment products, etc. is very high. Therefore, the study of the pipe welding equipment in general and the pipe welding method to manufacture conveyor rollers has high practical significance.

2.2.2 The reality of the training process of Machine Manufacturing Technology major at TNUT

The Machine Manufacturing Technology major has been trained at TNUT since 2013. In order to meet the needs of high-quality technical human resources for businesses, the engineers need to ensure the

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outcome standard of the training program, in which the outcome standard of technical skills is one of the key tasks. To meet this outcome, the training has been equipped with relatively assured machinery and equipment for cutting machining (traditional/advanced turning, milling, grinding machines). However, the equipping of welding equipment for training is still very limited while the practical demand for welding is very high. Currently, there are two manual arc welding machines, one TIG welding machine at the Experimental Center for training. The welding practice module, 02 credits, mainly focus on the safety in mechanical processing, the concepts of technology, tools and jigs in metal welding; equipment, materials of manual arc welding techniques, semi-automatic MIG-MAG, TIG welding. However, the trained techniques are mainly welding basic welds such as butt joints, angle welding, and hardly interested in pipe welding training.

With the current training time and content, the students are mainly developed in machining skills on traditional machine tools (turning, milling, grinding,...) or digital machines. They have not been interested in training in welding techniques, especially pipe welding, to perfect the capacity of engineers of Machine Manufacturing Technology major according to the requirements of practice. Therefore, it is really necessary to research, design and manufacture pipe welding equipment for the practical process of students of Machine Manufacturing Technology.

2.3 Design, manufacture and test semi-automatic welding equipment

2.3.1 Selection of experimental processing products

To design, manufacture and test semi-automatic welding equipment, we choose the work piece as the conveyor roller (Figure 4).

Figure 4. Conveyor roller

The conveyor roller has a fairly simple structure, but it is necessary to ensure high durability to be able to work in environments with many corrosive chemicals, dust, and humidity…. Therefore, the welding of conveyor rollers requires good technique. Although there are differences in requirements and standards, the conveyor roller structure usually includes basic parts such as ball bearings, roller surface, shaft and some attached components. The roller is fitted to the shaft with a ball bearing, the outer ring is fixed to the roller, and the inner ring is attached to the shaft (Figure 5).

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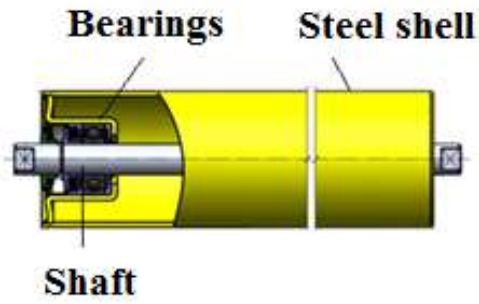

Figure 5. Structure of the roller

The fabrication of conveyor rollers should follow the following process: - Manufacturing roller shell: + The inner and outer sides of the roller shell must always ensure the concentricity, shape and thickness of the shell;

+ The inner surface of the steel pipe must be smooth, without leaving burrs (if there is a burr, it will create a counterweight and cause centrifugal force, causing the roller to vibrate strongly broken).

+ When machining the inner surface of the roller (where it is in contact with the outer ring of the bearing) when it is installed on the shaft, it is required to process it very smoothly and accurately so that the conveyor roller operates stably and has a long life, not affect the structure of the entire conveyor system.

- The joint between the outer ring of the ball bearing and the roller shell tube is a synchronous weld at both ends to form a unified block, ensuring that the roller stands firmly when carrying heavy loads or running at high speeds.

- The surface of the roller must always ensure a certain gloss. This paper only studies a device that can perform the pipe welding process to create a welded connection between the outer ring of the ball bearing (ball cup) and the shell tube of the roller.

Figure 6. Steel tube, bearing cup and conveyor roller

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Thus, to manufacture conveyor rollers, one of the important things is that we have to weld two pipes including conveyor cover and bearing housing together. The roller mainly works on the outer surface, so besides other processing methods, the welding process needs to ensure that the roller has high bearing capacity, roundness, good dynamic balance, smooth operation, long service life in the working process, and ensure high machining productivity.

2.3.2 Design and products of welding equipment

The welding device is powered by 380v through the transfer system (3) to adjust the rotational speed of the motor. The motor is connected to the sprocket drive system (2) which transmits to the active shaft (5) which helps the workpiece rotate during welding practice. After mounting and positioning the workpiece on the device, the device will be controlled through the button screen system (7) to automatically weld the required stroke.

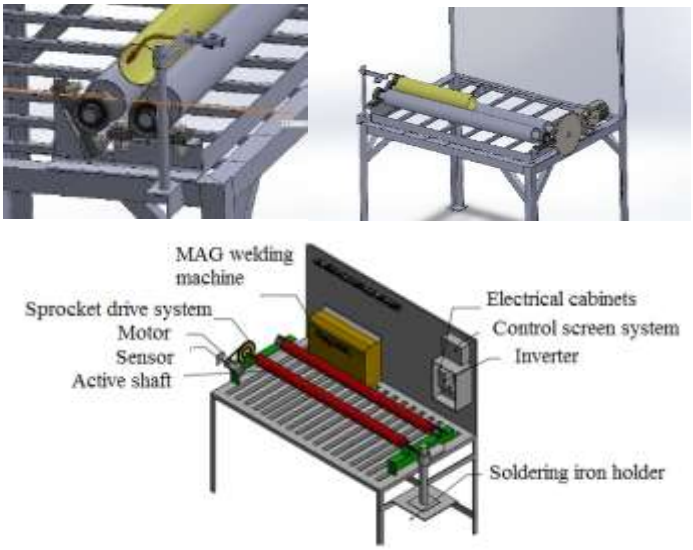

Figure 7. Working model of semi-automatic pipe welding equipment

Products of welding equipment after being fabricated are shown in Figure 8.

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Figure 8. Manufactured semi-automatic welding equipment product

2.4 Experimental results

Welding of conveyor roller tubes with designed equipment shows a significant difference in productivity, quality and efficiency compared with conventional welding methods. The following are pictures of welding products when using conventional welding machines and when using designed welding equipment.

a)

b)

Figure 9. Weld quality

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a) Welding by conventional equipment b) Welding by semi-automatic welding equipment
It can be seen that, with conventional welding equipment, the weld is not continuous, the penetration is uneven, the welding process depends entirely on the welder's skill and the working condition is difficult. The important reason for this limitation is that the welding process is completely manual, so it is difficult to maintain a uniform arc over the length of the pipe diameter. However, when we use this semi-automatic pipe welding device, the workpiece is rotated automatically on a motor-driven holder, the torch is fixed in position relative to the workpiece or the torch handle of the soldering iron. the welder is fixed in a suitable position, so the weld ensures continuity, penetration, uniform tightness throughout the diameter of the welded pipe, the quality of the processed product is less dependent on the hand of the welder, manufacturing productivity increases, product costs decrease, and thus the processing efficiency is improved.

2.5 Conclusions

The semi-automatic welding equipment is designed and manufactured is a combination of a Mig/Mag welding machine with a motor and microprocessor (PLC) to control the welding stroke throughout the pipe diameter. With this equipment, the welder can perform welds in position 5G, 6G, 5F, 6F with a large diameter of weld pipe. In addition, the welding process is carried out continuously, the welding seam is not interrupted, the welding scales are evenly arranged, and it helps to reduce the labor force of workers, contributing to increase productivity and product quality compared to the traditional manual welding method.

The results of application research for the process of welding billet steel pipe by semi-automatic welding machine were tested on real products, which are conveyor roller welding at Nhan Duc Co., Ltd., giving good initial results. Currently, the company is applying to weld roller conveyor belts for wood processing companies in Thai Nguyen province, Vietnam. On the other hand, in the near future, the author will propose to put this device to be applied in professional practice for the training program for Machine manufacturing technology major of Thainguyen University of Technology, TNUT, Vietnam.

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