

Innovative Application of Friction Stir Welding in Practical Teaching

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Keywords: Practice Teaching, Friction Stir Welding, Special welding, Engineering Thinking

Abstract: The purpose of the course is to consolidate and improve the students'practical ability, to enhance their innovative consciousness, and to integrate the special welding technology into the traditional welding teaching, let students know how to raise, analyze and solve problems, make students participate in production practice, give full play to the problem-solving ability, improve students'practical ability, and stimulate students'creative thinking ability. To realize the ultimate aim of the practical course of industrial training.

At present, the welding practice teaching in the Engineering Training Center of university is relatively single and can not match with the modern factory intelligence, so it is urgent to integrate the new welding [1] method and cutting method into the traditional welding practice teaching, to provide real support for student employment, mobilize the enthusiasm of students to learn, train students to do your ability, increase students'innovative thinking. Friction stir welding refers to the use of high speed rotation of the welding tool and workpiece friction generated by the heat of partial melting of the material to be welded [2], when the welding tool along the welding interface forward, the plasticized material flows from the front part to the back part under the rotating friction force of the welding tool, and forms a compact weld under the extrusion of the welding tool. 1 the teaching goal welding practice has been mainly around the brazing, the CO₂ Gas metal arc welding, the Argon arc welding and so on several common welding methods to launch, the teaching process is too unitary, the welding technology is more traditional, therefore, in order to fully arouse students'study enthusiasm, enhance students'interest in engineering training, and fully improve students'practical and innovative ability [3], we introduce welding practice teaching as an example, in the past, welding teaching was mainly carried out around several methods such as brazing and Argon arc welding. The form was too single and the technology was relatively backward. In order to make up for the shortage of teaching, students'interest in engineering practice was fully mobilized, and students'innovative and practical ability was improved [4], we have introduced the friction stir welding (HWI-JBH-T-6 type) to integrate the friction stir welding welding technology into the welding training course, and added a part of special welding course on the basis of the traditional welding training course [5]. The successful implementation of the teaching reform has

greatly enhanced the students'initiative to practice, and the students'comprehensive ability of engineering practice has also been greatly improved. Friction stir welding technology is introduced into welding practice teaching, students can get the best welding parameters through parameter programming and repeated test parameters [6]. This series of coherent operation process has greatly improved students'ability to deal with engineering problems, it also plays an extremely important role in the formation of students'engineering consciousness.

1. Practice Teaching Design

1.1. Practice Course Document Preparation

(1) writing practice instruction. The main contents of the training instruction include the detailed operation steps of each training equipment, as well as the safety operation rules of the engineering training. The training guide acts as a teacher's guide around each student at any time, and also provides technical support for the smooth running of the friction stir welding training course.

(2) compiling teaching plan of special welding course. For the special welding teaching, the Special Welding Training Teaching Plan is compiled by the welding front-line instructor, especially the preparation of the friction stir welding training process and the friction stir welding training course teaching plan, which has many advantages, in addition to allowing all the welding instructors to follow a uniform teaching template, there will be no arbitrariness in the teaching process of different teachers, nor will all the contents of the training be left out, this enables the teaching process to achieve the best state, to achieve the best teaching effect.

(3) preparation of syllabuses. The syllabus includes the object of practical training, the process of practical training and the specific arrangement of practical training tasks. Welding Training Teaching module mainly aims at mechanical and near-machine class students set up 16 hours, with 8 operating stations, 8 people/groups to demonstrate the operation of the training teaching [6] , the friction stir welding takes up 4 teaching hours, and the friction stir welding is divided up as shown in the table below.

Table 1: Friction stir welding training target

number	training content	hours allocation/h
1	learn about the production process, features and application of friction stir welding and safety procedures	0.5
2	learn about the various machines used in the friction stir welding process and use	0.5
3	learn about the programming features, application areas and development trends methods	1

(4) practical teaching materials. In order to meet the new requirements of the state in the reform of practical teaching in colleges and universities, the Engineering Training Center of our university strictly requires itself to carry out the requirements of the National Demonstration Center at all times, the Engineering Training Center of our university has assembled a team of key teachers from all disciplines and the front-line supervisors with rich experience in production practice to compile the engineering training textbooks, we completed the modern engineering training, which is the most characteristic teaching material of our university, and revised it in 2019 to integrate the friction stir welding into the traditional welding teaching chapter. The compilation of the teaching material of modern engineering training aims to be both systematic and scientific, and is closely combined with practical teaching ideas, especially for the friction stir welding teaching.

(5) to prepare internship reports. The new edition of the traditional welding practice report adds special welding content, training teachers according to all the teaching content of each step of the friction stir welding, the types of problems vary, and for the teaching process of all the basic knowledge and the proficiency of the entire operating process of a comprehensive and systematic testing, but also for the review of students after class to provide sufficient reliable theoretical basis.

1.2. Preparation of Teaching Equipment

Required equipment HWI-JBH-T-6 friction stir welding according to the requirements of the friction stir welding training syllabus. HWI-JBH-T-6 type friction stir welding is suitable for flat linear weld and Flat Curve Friction Stir Welding Weld of 6mm thickness aluminum alloy, magnesium alloy and other Non-ferrous metal plates. The constant displacement control mode is adopted, the welding upset pressure is stable, and the CNC numerical control system is the core of the control system, which is easy to operate and accurate.

Friction Stir Welding Code:

M03-spindle positive rotation

M04-spindle reverse

M05-spindle stop

M30-program stop

G01G91-incremental linear motion

F15-feed speed 15mm/min

S800-spindle speed 800r/min

G91G28X0-return reference point to 6mm thick aluminum alloy plate welding program

example:

M03 S800

G01 G91 Z-6.0 F15

G01 G91 X100 F200

G01 G91 Z100 F200

M30

2. Friction Stir Welding Welding Parameters and Process

2.1. Welding Parameters

friction stir welding welding parameters mainly include spindle speed, stirring tool down speed, welding speed, down pressure, welding dip angle.

(1) spindle speed and welding speed: spindle speed and welding speed together determine welding heat production, friction Torque, welding material flow, etc. , the higher the heat production, the smaller the friction Torque, the more intense the material flow; on the contrary, the lower the heat production, the higher the friction Torque, the slower the material flow. In order to obtain high quality welded joint, it is necessary to match spindle speed and welding speed according to the material to be welded.

(2) down pressure: The amount of down pressure is closely related to the weld forming. According to different materials, plate thickness and stirring tools, the amount of down pressure is reasonable.

(3) down-fastening speed: in the initial stage of welding process, the stirring tool is used to preheat the workpiece at a slow down-fastening speed, and the down-fastening speed should be reasonably controlled.

(4) welding obliquity: The size of welding obliquity is closely related to the weld shape and welding quality. Too Large or too small will affect the welding quality.

2.2. Welding Process

(1) fixing the workpiece to be welded: fixing the X and y axes of the workpiece.

(2) knife setting.

(3) welding parameter setting: set the required welding parameters in the welding procedure.

(4) select the appropriate welding procedure and start the welding procedure.

3. Conclusion

The student completes all the friction stir welding training independently according to the

training instruction book, and the First Line instructor acts as an assistant to help guide the student to optimize the processing parameters, thus training the student independently, it can help students to improve their ability of creative thinking and solving problems independently, and the combination of traditional welding technology and special welding technology makes students master welding knowledge more comprehensively, bring into full play the enthusiasm of study.

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