Internal Welding Monitoring Device of Spiral Submerged Arc Welded Pipe Based On AT89C51 Single-Chip Microcomputer System

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Abstract. In order to make the spiral submerged arc welded pipe more accurate, a device for monitoring the internal welding of spiral submerged arc welded pipes is developed. The device uses the AT89C51 single-chip microcomputer as the processor, and the PR9350 sensor detects the distance between the sensor and the slider in the chute to achieve monitoring. The purpose is displayed to the staff by the display. In the design of the detection program, a verification function is added to make the program more accurately report the working status during the running process, so that the staff can solve the abnormal situation of the program in time. In the overall design, the electric push rod is used in cooperation with the welding device to achieve the pipeline running in the normal track direction. After experimental verification, this device can automatically adjust and correct the offset track, the system runs smoothly and has high use value.

Keywords: Spiral Submerged Arc Welded Pipe, Monitoring Device, AT89C51 SCM, PR9350 Sensor

1. Introduction

Oil and gas transportation is generally realized by pipeline transportation, and most of the transportation pipelines required are produced by spiral welded pipe technology\textsuperscript{[1]}. In order to ensure the safety of the transportation pipeline, qualified welded pipe quality is necessary, and the accuracy of the detection device is also necessary during the welding process\textsuperscript{[2]}. At present, most steel pipe factories have operation methods of manual monitoring and manual correction, but this strip deviation measurement and control method has a poor correction effect and is prone to large errors\textsuperscript{[3]}. Therefore, data acquisition systems and inspection systems are being established at home and abroad. The automation and informationization of spiral submerged arc welded pipes is a trend.

In view of the above background, we have developed a device for monitoring the internal welding of spiral submerged arc welded pipes. This device is based on the AT89C51 single-chip microcomputer system. According to the needs of the detection system, an overall detection control
scheme and a closed-loop monitoring system \cite{4} with displacement sensor PR9350\cite{5} as the main component are developed and verified by experiments.

2. Control system and hardware design choice

2.1. Control System

According to the needs of the spiral submerged arc welded pipe internal welding monitoring device, we choose the AT89C51 single-chip microcomputer as the processing chip of the controller, and add the inductive displacement sensor PR9350 and the display. The power supply, display and sensor are connected to the controller through wires. And the welding device is completed, the sensor detects the welding device and feedbacks the information to the controller, and then the single-chip microcomputer chip processes the data generation program to pass to the control program to form a closed-loop system. The overall design of the control system is shown in Figure 1.

![Figure 1: Control system design plan](image1)

**Figure 1** Control system design plan

![Figure 2: AT89C51 SCM](image2)

**Figure 2** AT89C51 SCM

2.2. Processor AT89C51 SCM

Because the spiral submerged arc welded pipe internal welding monitoring device requires a certain computing program, so instead of choosing a slightly larger and costly PLC, a relatively cheap AT89C51 SCM is selected, as shown in Figure 2. This single-chip microcomputer has a service life of up to 10 years, which meets the service life of the testing device. It has strong data processing capabilities and can execute a series of algorithm programs to meet the computing needs of the device. Core processor of arc welding pipe internal welding monitoring device.

2.3. Displacement sensor PR9350

In order to prevent the welding seam from shifting during the welding process, a displacement sensor is required to detect the feedback and then perform an adjustment operation. This device selects the PR9350 inductive displacement sensor as the detection element. As shown in Figure 3, the distance between the slider and the sensor connected to the welding bracket is detected, and then fed back to the processor AT89C51 SCM to monitor the weld offset. The purpose of the situation.

![Figure 3: PR9350 inductive displacement sensor](image3)

**Figure 3** PR9350 inductive displacement sensor

![Figure 4: Control device diagram](image4)

**Figure 4** Control device diagram
2.4. Control device

The regulating device is shown in Figure 4. Two sides of the chute 1 are welded with two fixing blocks, and the electric push rod 2 is mounted on the fixed block by screws. The clamping block 4 is welded at the other end of the slider so that the clamping blocks are located on both sides of the slider 5. When the slider is displaced during the movement, the sensors located on both sides of the slider will detect and perform adjustment processing.

3. Design of monitoring procedures

The inductive displacement sensors PR9350 on both sides of the slider are used to detect whether the slider is offset during the movement, and then the data is transmitted back to the controller by the wire to process the information. The normal track is displayed to the staff through the display for manual operation when needed.

First assume that the distance between the inductive displacement sensor PR9350 and the slider is $L$, The distance from the left side of the slider to the left sensor is $L_1$, The distance from the right side of the slider to the right sensor is $L_2$, Offset on the left is $\Delta L_1$, Offset on the right is $\Delta L_2$.[6].

Then it can be calculated by calculation:

Left offset is:

$$\Delta L_1 = L - L_1$$

When $\Delta L_1$ is timing, Shift left, When $\Delta L_1$ is negative, Shift right.

Right offset is:

$$\Delta L_2 = L - L_2$$

When $\Delta L_2$ is timing, Shift right, When $\Delta L_2$ is negative, Shift left.

When $\Delta L_1 = -\Delta L_2$, it means the test program runs normally. The offset is now:

$$\Delta L = \frac{L_2 - L_1}{2}$$

When $\Delta L_1 \neq -\Delta L_2$, indicates that the detection program is running abnormally, and an alarm occurs at this time, so that the staff can deal with the problem as soon as possible.

The processor processes the detected program data, and the controller generates a control program to correct the offset that occurs during the movement, so that the device can detect and adjust the problem at all times during the production process to protect the normal operation of the welded pipe.

4. Overall design

The spiral submerged arc welding pipe internal welding monitoring device directly contacts the ground is the bracket of the entire machine, and a monitor and a controller are installed directly in front of the bracket. The right side of the bracket is connected with the fixed telescopic rod and the first electric push rod by screws, the telescopic rod is above, and the other end is connected with a welding device, which includes a wire feeding mechanism, a welding wire and a conductive arm. The first electric push rod is below, and the other end is connected with a slider. The top of the slider is welded with a connection plate. The connection plate has a clamp for positioning the welded pipe, and the welded pipe is firmly fixed in the middle of the clamp. The slider is placed in a chute on the ground. The outer wall of the slider is slidingly connected to the side wall of the chute. A roller is
installed at the bottom end. The roller and the bottom wall of the chute are in a rolling connection [7]. The overall design is shown in Figure 5.

![Figure 5 Design master plan](image1)

![Figure 6 Chute parts drawing](image2)

5. Test and Debug

Turn on the power and start the program. The control device starts to work. The first electric push rod drives the slider to move at a constant speed in the chute. The welded pipe is fixed on the connecting plate connected to the slider so that the welded pipe moves along with the slider at a uniform speed. The welding device starts to work. The welding device is inserted into the welding pipe through the telescopic rod, and the welding wire is started to melt. At this time, the sensor detects, and the data detected by the sensor will be transmitted to the controller in the form of electrical signals. When the data is normal, the device will continue to work. When the data exceeds the preset safety range, the controller will turn off the first electric fader and the welding device, and the controller will start the second electric fader. Drive the arc-shaped rod upward, the arc-shaped rod drives the clamping block to clamp the slider to correct the position of the slider, so that the offset of the slider is within the safe range. At this time, the controller makes the second electric push rod retract. The restoration stopped, and then the controller started the first electric push rod and the welding device to continue welding. Finally show it to the staff through the monitor and record the abnormal situation.

![Figure 7 Procedure diagram](image3)

The following set of data was obtained through experiments. The experiments show that the spiral submerged arc welded pipe internal welding monitoring device can detect and process abnormal data, and correct the welded pipe to the correct track to continue welding.
6. In conclusion
In this paper, a spiral submerged arc welded pipe internal welding monitoring device is designed. The AT89C51 single-chip microcomputer is selected as the processing chip. A PR9350 inductive displacement sensor and other necessary components are used to form a detection device. The experiment proves that the device can complete the abnormal data detection and processing. Complete the task of internal welding of spiral submerged arc welded pipes.

In the future, we will improve the spiral submerged arc welded pipe internal welding monitoring device, so that the device data processing ability is stronger, the detection effect is better, the spiral submerged arc welded pipe internal welding monitoring device will be smaller, and finally the spiral submerged arc welded pipe internal welding monitoring device will enter Perfect, it can also provide reference and reference for the application researchers who study the internal welding monitoring device of spiral submerged arc welding pipe.

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