SLUDGE AUTOMATIC RECOVERY SYSTEM IN THE STEEL SEDIMENTATION POND

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ARTICLE DETAILS

ABSTRACT

A lot of sludge will be produced in steel and other industrial production. The precipitation of iron sludge will be recycled again after treatment. In order to make a voluntary recall at a certain depth. According to Tangshan Iron and Steel Group Co., Ltd, developed ultrasonic testing automatic recovery system. Most of the recovery system usually use a timer, the recovery is in a specified period of time, because of the uncertainty of the production process, the recovery is not ideal. This system uses ultrasonic waves to detect echo time by Atmega16 and determine whether or not the thickness of the slurry reaches the discharge position, give prompts to the operators or automatic control motor recovery. In the actual test, the effect is good.

KEYWORDS

1. INTRODUCTION

In many industrial production, such as oil processing, steel iron, sewage treatment, etc., we need treat precipitated sludge, some need to be recycled, some required environmental treatment before discharge. Therefore, recovering sludge of industrial production becomes an indispensable work [1,2]. Here we describe the sludge treatment in the steelmaking as an example. In steelmaking process generates CO after the reaction between carbon and oxygen, the gas is exhausted, the furnace gas is converter gas. Converter gas through the scrubber, remove dust and cooling, discharged by dehydration, the converter dust is wastewater. Converter dust contains 70% iron, it has a high value in use, hence the sludge need to be dehydrated and recovered [3-5]. At present, use of a timing method to purify the sludge and get a lot of clarified water. When the sludge accumulated to a certain height, the surface of the floating debris and impurities will have some impact on the purity of the water clarification, it is necessary to control the depth of the pool of accumulated sludge and promptly pulled out [6]. To solve this problem, according to the ultrasonic wave propagation characteristics, designed this sludge recovery system.

2. Detection Principle

Ultrasonic is a sound wave, its frequency is higher than the human auditory limit (about 20 kHz). Ultrasonic sensor is using the characteristics of ultrasonic. Ultrasonic vibration frequency is above 20 kHz, the chip vibrates under the voltage, it has high frequency, wavelength is short, the diffraction is small, especially good direction, can become the rays and directional spread etc [7]. Ultrasonic spreads faster in liquid and solid than in the air, in liquid that can spreads tens of meters. Ultrasonic will produce significant reflection form echo when they suffer impurity or countercheck.

At present, the ultrasonic inspection equipment used the ultrasonic sensor and take it above the sediment basins water about 1 meter tall. Ultrasonic emit from top to down, and detect echo after the emission, when the ultrasonic contact level it can reflective pait,the other well refract into the sludge, through the water layer will form a secondary reflection after encountering sludge [8]. This ultrasonic sensor only adapt to operate in

the air,because its working energy loss more in the water, so the echo reception is not ideal, easily lead to misuse.

Based on the above reasons, using underwater ultrasonic sensors detect become the effective method, it reduces power loss and avoid mistake. Principle of work is as follows: the ultrasound in object spread, basically have the following parameters: one is the speed V, two is frequency F, three is wavelength λ, four is the transmission distance L, five is spread time t [9]. The relationship between the five as follows: $V = f \cdot \lambda$, $t = L/V$. According to the same distance conditions, ultrasound in water and sludge spread in different time, can judge whether the sludge to emissions in the process of position or discharge whether to terminate discharge position [10,11]. The ultrasonic sensor need be placed in the liquid, therefore need to use waterproof sensors. Sensor operating frequency is different from air sensor operating frequency, the operating frequency of the ultrasonic sensor in the air mostly 40KHz, in this system, the liquid sensor chooses 1 MHz in order to prolong and improve the detection accuracy of ultrasonic propagation distance.

Ultrasonic have the attenuator when they wave in the substance, the distance is farther, the energy attenuation is greater, the transmission and reception of the distance between the two ultrasonic probe is not too far away, typically between 20cm-50cm. Detection schematic diagram shown in Figure 1.2.
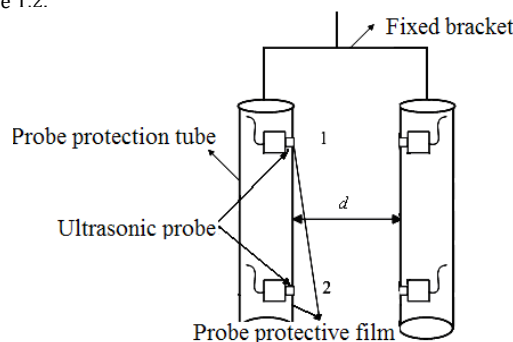

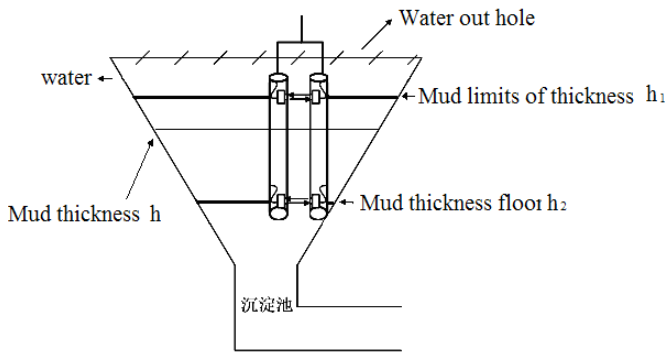**Figure 1:** Ultrasonic sensor structure chart inside the deposited pond

Figure 2: Ultrasonic sensor installation sketch map

3. SYSTEM

System includes hardware and software.

3.1 System Hardware

Control system hardware includes an ultrasonic transmission / reception circuit, MCU processing circuit, power supply circuit, a serial interface circuit, JTAG interface circuit, LCD interface circuit, LED tips and alarm circuit. Ultrasonic transmission / reception circuit include the ultrasonic sensor 1MHZ TCF1M-21T / R1, MCU Atmega16, ultrasonic processing chip CX20106.

TCF1M-21 T/R1 is liquid ultrasonic sensors, can work in liquid for a long time, the real figure as shown in figure 3 below. MCU Atmega16 has an internal oscillator, it can be programmed to produce 1MHz sasser, and then transmits from the ultrasonic sensor, thereby forming an ultrasonic transmission circuit. the other side of the ultrasonic sensor receives the ultrasonic wave through the CX20106 processing circuit amplification, shaping, and passes the information to the microcontroller Atmega16, constitute the ultrasonic receiver circuit, specific device connected to the circuit shown in Figure 4.

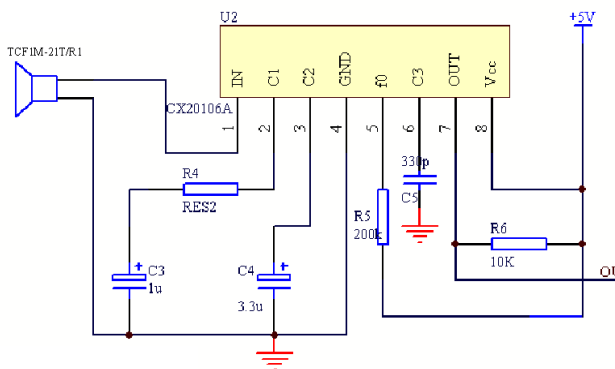**Figure 3**: Ultrasonic sensor TCF1M-21T/R1

Figure 4: Ultrasonic receiving and disposal circuit

Microcontroller program refers to the processing circuit Atmega16 microcontroller as the core device, other peripheral circuits connected it, upon detection of the sludge reaches the discharge position, the microcontroller instructs the motor control their own emissions, emissions can be controlled after the end of the motor termination

emissions. (Due to the limited format diagram, the motor control circuit not shown.) With reference to the specific case of figure 5, figure 7

Power supply circuit has the external transformer interface, the indicator light, and the switch, the switch can control circuit board whether to work even if it connects the external transformer. Serial interface circuit is the serial interface drawn from the microcontroller, and its main purpose is to calculate the microcontroller good ultrasonic transit time sent to the PC so that the PC has a visual display. JTAG interface circuit is the interface in the microcontroller Atmega16 simulation program.

LCD interface circuit is controlled by the microcontroller, the information transmitted by the pin will be displayed to nokia5110 LCD module and display the working status of the current system, such as in detecting, emission start, emissions, discharge end, etc. LED prompt and alarm circuit is also work the state display a form, LED lamp and alarm circuit for staff view he current system working state in far distance.
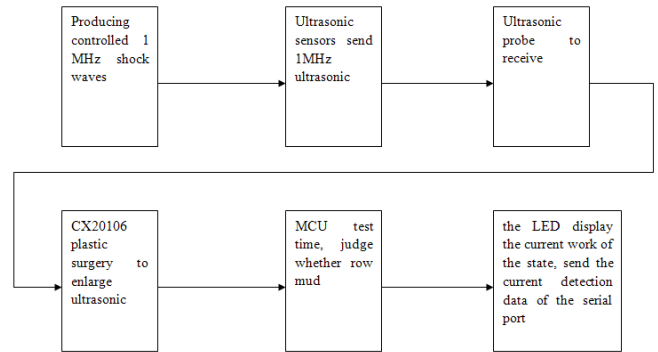

Figure 5: Slurry discharge char

3.2 System Software

Software operating environment: Windows XP operating system, programming software AVR Studio 4. Software features include generating 1MHz pulse waveform , ultrasonic echo time, display the current status, control relays open sludge discharge apparatus. Among them, the ultrasonic timing and display program is more important.

Generating 1MHz pulse waveform: Atmega16 theoretically have an internal 1MHz oscillator, but the actual effect is often less than the theoretical value. Therefore, the use of an external crystal, 1MHz pulsed wave generated by the timing counter, sent to the ultrasonic sensor. Control program flow shown as shown in figure 6.
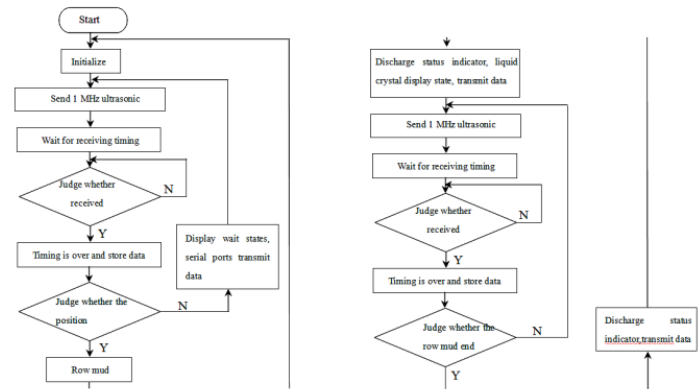

Figure 6: Control program map of MCU

4. EFFECT AND CONCLUSION

The distance test of transmission and reception of ultrasonic sensor set L= 20cm, temperature 27 ℃ (due to the converter dust waste water is in the steel deposited pond, substantially year-round temperature is between 27 ℃ to 28 ℃, the sensor in the water, so the outside temperature effect little on the propagation velocity of the ultrasonic wave). From the test in the water timer value is 00001101, the ultrasonic wave propagation time in water t=13us, ultrasonic wave propagation velocity in water of V = L / t = 1538m / s, the slurry timing is 00010011, the ultrasonic wave propagation in the sludge time t = 19us, ultrasonic wave propagation velocity in the slurry is V = L / t = 1052m / s. As listed in Table 1.

Table 1: Ultrasonic Measurements in the Water and Sludge

number	in the water		in the sludge	
	timing（binary）	speed（m/s）	tining（binary）	speed（m/s）
1	1101	1538	10011	1052
2	1101	1538	10011	1052
3	1110	1428	10101	952
4	1101	1538	10100	1000
5	1110	1428	10011	1052
6	1110	1428	10011	1052
7	1101	1538	10011	1052
8	1101	1538	10100	1000

According to the error analysis of the measured value table is shown in figure 7:
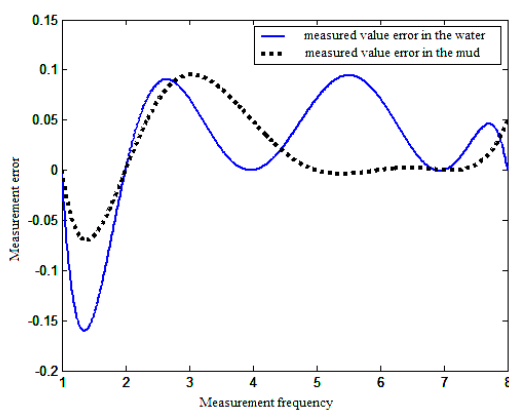
Figure 7: Measurement error chart

According to table 1 and figure 7 analysis, ultrasonic wave in the water spread faster, energy loss is small; The sludge density is big, ultrasonic in the sludge have the larger energy loss, which affects the transmission speed. In the measurement due to the presence of disturbance, water or sludge flow, causing the measured value of data fluctuation. From the error analysis reveals that that enables will appear peak fluctuation but does not affect the measuring accuracy of the whole.

Staff can observe tank sludge change situation through three ways, first is from serial port to send a PC display, second is the different colors highlighted light emitting diode display, third is the LCD screen display. When the count value exceeds 00010011 (19us), PC machine gives the instruction, control relays open sludge discharge apparatus, the system will automatically discharge sludge in the sedimentation pond. The system in April 2010 passed the laboratory experiment, second month gone to the field test data, through the present test and analysis the result, sedimentation pond without manual operation basic can realize automatic discharge sludge.

5.   RESULTS AND SUMMARY

The system based on the ultrasonic in water and sludge propagation speed is different, calculate the time of ultrasonic transmission in a fixed distance, and through the receive time length to judge sludge accumulation degree, when it reaches the discharge position, the system automatically discharge sludge, after the discharge will automatically stop. This system reduces the inspection, opening and closing of the tedious work of numerous equipment before discharge the sludge, basically avoided staffs give bad operation and have maintenance equipment difficult in harsh environments.

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