Positioning Management System of Oil and Gas Pipeline Detection Device Based on Mobile Phone APP

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Abstract. Aiming at the problem of low efficiency and high cost in the current oil and gas pipeline detection equipment location system, a location management system of oil and gas pipeline detection equipment based on APP is proposed. The system can automatically real-time detect the whether the equipment has passed the set point in real time and passes the location map of equipment and related information to the sever of project management side. At the same time the information is passed to the engineering staff in order to let them know the equipment position. Therefore this system can greatly reduce the labor intensity and cost, improve work efficiency, facilitate the management and have a good value of promotion.

Induction

The oil and gas pipeline has a very important position in the energy transportation. With the increase of energy demand in China, the exchange between China and energy producing countries is becoming more and more frequent, therefore the construction quantity and demand of long distance oil and gas pipeline are increasing gradually [1-4]. To the end of 2015 the total mileage of China's onshore oil and gas pipeline is up to 120 thousand km [5, 6]. In order to ensure the normal operation of oil and gas pipelines, the detection equipment is needed to detect and clean the pipeline regularly [7]. Pipeline inspection equipment needs real-time positioning in the process of operation. When the equipment fails, pipeline defects and other conditions needs to be positioned timely and accurately in order to take measures to eliminate the trouble [8-10].

The existing positioning system of oil and gas pipeline detection device is still backward in engineering practice. Because oil and gas pipeline detection device is always running, its position needs to be determined in time to avoid device failure. Traditionally, workers use cars to carry many receivers and lay the receiver along the pipeline at a certain distance. Once the oil and gas pipeline detection device through a certain receiver, the receiver will alarm and notice staff the device has passed this point. Then the receiver is taken back. This method is repeated until the end of the test. Another way it to set and shallowly bury the receiver along the pipeline at a certain distance. The marker for staff identification is inserted at the location of buried receiver. According to the operation speed of the device, the staff can estimate about what time to reach which receiver and then go to see whether it has passed. If a receiver is not passed within a predetermined time, blocking phenomenon may occur. This requires staff to take the receiver to find the specific location of oil and gas pipeline detection device in the blocking distance. In this way the workload is still small in short distance, but it will be unimaginable when the pipeline distance is less than tens of kilometers, more than a few hundred kilometers and even thousands of kilometers.

A positioning management system of oil and gas pipeline detection device based on mobile
phone APP is proposed to solve the above problems. This system can use mobile phone APP software to get the alarm signal of the receiver to achieve the purpose of remote detection. It greatly improves the on-site work efficiency and provides great convenience for the management of engineering company.

System Working Principle

As it is shown in Figure 1, for the improved positioning method, Oil and gas pipeline detection device is equipped with a transmitter which continues to issue 22Hz low frequency sinusoidal electromagnetic signals when the device is advancing in the pipeline. The receiver picks up 22Hz electromagnetic signal through coil. The received signals are amplified and filtered, then converted from analog signal to digital signal. The amplitude of 22Hz low frequency sinusoidal signal can be calculated through cross correlation algorithm. When the transmitter is close to the receiver on the ground, the received signal is gradually enhanced and reaches the maximum when the transmitter is just below the receiver and then quickly weakened. According to the strength of the received signal and the change process, it can be judged whether the device has passed the receiver on the ground. Once the information is confirmed the receiver will send the alarm information to the positioning system management control center. The positioning system management control center converts the receiving information into location, speed and other related one and sends it to the specific mobile phone with APP so that the staff can view the real time updated positioning information map. All information can be displayed in real-time through the screen and also be saved in time in order to achieve the purpose of remote detection and management. Compared with the traditional way, the positioning system will greatly improve the field work efficiency and provide great convenience for the management of engineering companies.

System Design

Transmitter

Transmitter Parameters

The transmitter parameters are shown in table 1.
Table 1. Transmitter parameters.

| Parameter                  | Value               |
|----------------------------|---------------------|
| excitation voltage         | 60V                 |
| working voltage            | 6V                  |
| magnetic core material     | Cold rolled silicon steel 800 |
| Exciting current          | 0.8mA               |
| circuit operating current | 10mA                |
| transmitting power        | 232mw               |
| transmitting distance     | >12m                |
| work hours                | >120h               |

**Transmitter Circuit Design**

Transmitter circuit design frame Figure is shown as Figure 2. It mainly includes 5 parts, namely power circuit, MCU, clock circuit, reset circuit, power amplifier circuit and transmitter coil. The power supply circuit of the device generates the voltage needed for normal operation of each part. MCU circuit control produces stable frequency and beat signals. Clock circuit, reset circuit is to ensure the normal operation of MCU circuit. Amplifier circuit amplifies power. The amplified signal is finally emitted by the transmitting coil, picked up and identified by the receiver in order to judge the location of detection device of oil and gas pipeline.

![Transmitter circuit design framework](image)

**Receiver**

**Receiver Parameters**

The receiver parameters are shown in table 2.

Table 2. Receiver parameters.

| Parameter                  | Value               |
|----------------------------|---------------------|
| working voltage            | +9V,—9V             |
| Enamel covered wire diameter | 0.13mm          |
| coil length                | 200mm               |
| Gain resistance            | 20k                 |
| receive distance           | >12m                |
| Signal amplification factor | 10~+∞             |
| interference immunity      | good                |
| positioning error          | ±0.05m              |
| Effective detection depth  | ≤5m                 |
Receiver Circuit Design

Receiver circuit mainly includes 2 parts, namely power supply circuit, information processing module, SIM card SMS module, storage circuit. Here only lists information processing module and SIM card SMS module circuit diagram. It can be seen from the Figure 3-4.

Figure 3. Information processing module.
Experiment Condition

The experimental site is located in Tianjin, a pipeline testing equipment traction experimental site. Pipeline to be tested is a steel pipe with Ø25cm and length of 50m. It is placed on the round. The experimental equipment is one pipeline pig with transmitter. There are 9 receivers which are placed every 5 meters outside the pipeline 0.5-3 meters as shown in Figure 5. The front end of the pipeline pig is provided with a traction ring which is connected with the motor through a steel wire rope. The pipeline pig can be driven by the rotation of motor. There are also a computer and a mobile phone.

Experiment Procedure

(1) Connect the transmitter and receiver to the power supply. The transmitter is in the signal transmitting state, and the receiver is in the signal receiving state.
(2) Load the pipeline pig into the pipeline to be inspected.  
(3) Start positioning control system server and mobile phone, 9 receivers were numbered.  
(4) Start motor, pull the pipeline pig one time at speed of 0.5, 1.5m/s, 3m/s respectively. Stop motor in midway randomly to observe whether the alarm and the stay position is consistent.

### Experiment Data

The experimental data are shown in Table 2. V—pipeline pig movement speed, unit:m/s;d—distance from receiver to pipe top wall, unit: m; The stop position indicates the distance from the tractor leaving the initial position, unit: m; “T” indicates that the pipeline pig has passed through the receiver and the indicator lights and alarm message is sent successfully, “F” indicates that the pipeline pig has not passed through the receiver and the indicator doesn’t light.

| Experimental parameters | Stop position | NO.1 | NO.2 | NO.3 | NO.4 | NO.6 | NO.7 | NO.8 | NO.9 |
|-------------------------|---------------|------|------|------|------|------|------|------|------|
| V=0.5, d=1             | 3.2           | F    | F    | F    | F    | F    | F    | F    |
| V=1.5, d=1             | 28            | T    | T    | T    | T    | F    | F    | F    | F    |
| V=3, d=1               | 14            | T    | T    | T    | F    | F    | F    | F    | F    |
| V=0.5, d=2             | 43            | T    | T    | T    | T    | T    | T    | F    |
| V=1.5, d=2             | 37            | T    | T    | T    | T    | T    | T    | F    |
| V=3, d=2               | 9             | T    | F    | F    | F    | F    | F    | F    | F    |
| V=0.5, d=3             | 47            | T    | T    | T    | T    | T    | T    | T    |
| V=1.5, d=3             | 31            | T    | T    | T    | T    | F    | F    | F    |
| V=3, d=1               | 22            | T    | T    | T    | T    | F    | F    | F    |

The positioning diagram of the pipeline pig is shown in Figure 6 (when V=1.5m/s, d=1m). Green means “pass” while red means “no pass”. The number in circle means the ID of receiver. Time is the absolute time that the pipeline pig has passed the receiver. Speed is the average speed between the receiver which has been pass just now and the previous receiver.

**Figure 6. Positioning diagram of the pipeline pig.**

### Summary

It can be seen from the experimental data that the method is stable, reliable, convenient and intuitive and can greatly improve the construction efficiency of pipeline detection. But because the method is still in the experimental stage, whether it is adapt to different site environment, need to be further verified.

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