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Research on Deceleration Method of Pipe Cleaner Based on Electromagnetic Brake

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Abstract

As a tool for cleaning pipelines, the pipe cleaner is one of the current research hotspots, and it has very important engineering significance. In view of the problems existing in the current pipe cleaner collection, this paper proposes a method of slowing the ball collection of electromagnetic brake. The method mainly includes the following points: firstly, an electromagnet, a motor, a signal transceiver and a control system are arranged on the pipe cleaner, and then a weak magnetic detector is installed at a front end of the pipeline deceleration area at 100 m, and a pass ball indicator is arranged at the front and rear ends of the deceleration region. The pressure sensor and the rubber tire are arranged in the receiving cylinder, and finally the valves are turned on and off and the electromagnet is operated by the upper computer. Through theoretical analysis and experiments, it is proved that the method can realize the stepless speed change when the pipe cleaner is decelerating, eliminating the physical impact of the pipe cleaner on the receiving cylinder, and protecting the pipe cleaner and the collecting cylinder. The method is simple in operation and realizes the automatic collection of the pipe cleaner.

Keywords

Pipeline cleaner; magnetic; deceleration Method.

1. Introduction

Before the pipeline is put into use, it needs to carry out a series of processes such as pipe cleaner and pressure test. In order to ensure the safe operation of the pipeline, the pipeline needs to be cleaned and tested frequently during the daily operation of the pipeline. These operations involve the use of the pipeline receiving and receiving ball device [1,2].The traditional ball collecting device is to install 1~2 used tires or other objects in advance in the collecting cylinder as a buffer for the pipe cleaner, and the compressor station stops the compressor before the ball enters the station. The device, but this will impact the pipe cleaner, which will damage the pipe cleaner [3, 4].At present, the commonly used receiving ball process in China can avoid the impact on the pipe cleaner, but the process is more complicated, and it is necessary to manually switch each valve. It relies heavily on the experience of the operator, and it is easy to cause the pipe cleaner with insufficient oil thrust to stagnate and thrust. Big speeding and high cost. Therefore, it is of great significance to find a device that is economical, efficient, safe, and capable of automatically detecting the pits of the pipe cleaner and decelerating it in time for the operation and maintenance of large-scale buried oil and gas pipelines.

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2. Method Principle

As shown in the model of Fig. 1, the electromagnetic brake-based pipe cleaner slow-return ball collecting method is realized by the following technical solution: when the field weakening detector detects the magnetic field fluctuation, the upper computer 3 transmits a signal to the pipe cleaner 7 to make the pipe cleaner The electromagnet 8 on the device 7 operates; the electromagnet 8 moving on the pipe cleaner causes the tube 2 to generate an induced current, and the induced current interacts with the varying magnetic flux to generate a Lorentz force, thereby achieving a deceleration effect.

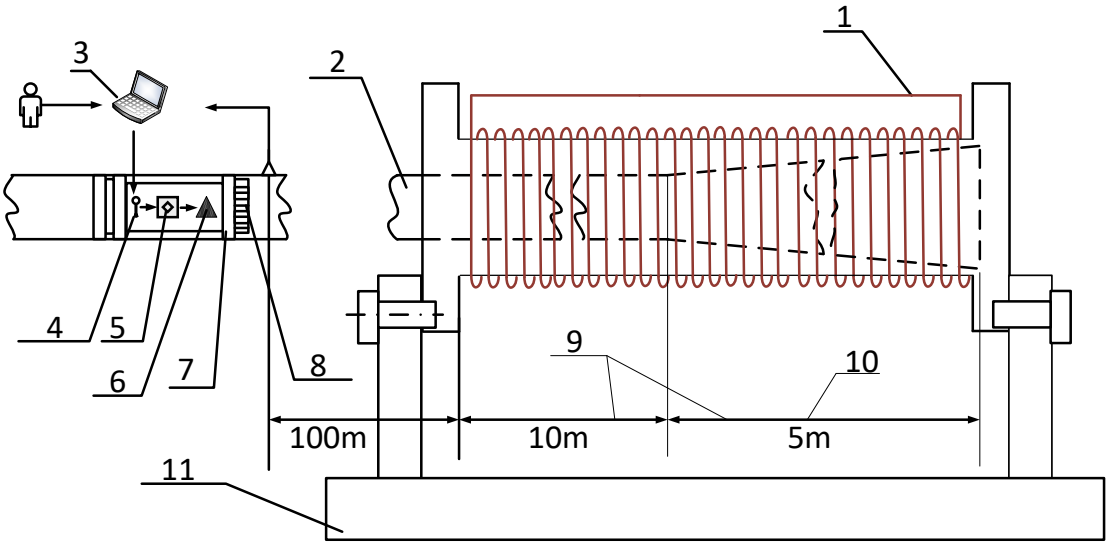

Fig 1. Deceleration area device design

In Figure 1, the codes represent: 1 coil, 2 oil pipeline, 3 upper computer, 4 signal receiver, 5 control system, 6 motor, 7 pipe cleaner, 8 electromagnet, 9 deceleration zone, 10 transition zone, 11 Fixed base.

3. Implementation Method

As shown in the model of Fig. 2, in order to achieve the effect of the method, the specific implementation details are as follows: the field weakening detector 17 is installed at the front end of the deceleration region 100m to facilitate detection of the real-time magnetic field signal. The deceleration zone 9 comprises a section of the oil pipeline 2 and a transition zone 10, said deceleration zone having a length of 15 m, said transition zone 5 m. When the upper computer 3 sets no clearer to pass, the calm magnetic field detected by the weak magnetic detector is used as the detection threshold, and the magnetic field fluctuation higher than the calm magnetic field 100nT is used as the detected effective signal to determine whether the pipe cleaner is about to enter the deceleration region. .The pipe in the deceleration zone shall be a conductive material, and the pipe made of non-conductive material shall be wound around a fixed copper coil.

In Figure 2, the codes represent: 12 valves, 13 valves, 14 inbound valves, 15 pass ball indicators, 16 vent valves, 17 weak magnetic detectors, 18 ball inlet valves, 19 ball cylinders, 20 Rubber tires, 21 blind plates, 22 over station valves, 23 blowdown valves, 24 valves.

The process of the ball collecting process is as follows: firstly, the over-station valve 22 and the in-station valve 18 are respectively closed and opened, and then reported to the upper computer, and the upper computer issues an instruction to tell the first station to serve. When the field weakening detector at 100m at the front end of the deceleration zone detects that the magnetic abnormality is greater than 100nT, it indicates that the pipe cleaner is about to enter the deceleration zone. At this time, the host computer transmits a signal to the signal receiver on the pipe cleaner, and the signal receiver transmits a signal to the control system, so that the electromagnet starts to work.

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The oil pipeline itself is made of ferromagnetic material, so after the electromagnet works, the pipe cleaner will have a certain deceleration before entering the deceleration zone; when the pipe cleaner enters the deceleration zone with greater conductivity of the pipeline material, The speed will be suddenly reduced to a safe low speed uniform speed, referred to as safe speed.

The ball receiving cylinder 19 is connected to the deceleration zone 9 as a transition zone 10, and the transition zone is still in the deceleration zone, and its diameter is gradually increased. During the passage of the pipe cleaner through the transition zone, oil will flow from the side of the pipe cleaner to the ball collecting cylinder, thereby balancing the pressure difference between the pipe cleaner and the front. Therefore, when the pipe cleaner leaves the deceleration zone and enters the ball collecting cylinder, the pressure difference between the pipe and the front is substantially zero. At the same time, the oil that flows into the ball collecting cylinder also acts as a buffer for the pipe cleaner.

When the pass ball indicator 15 at the end of the deceleration zone detects the passage of the pipe cleaner, the host computer transmits a signal to the signal receiver on the pipe cleaner, and the signal receiver transmits a signal to the control system, thereby stopping the electromagnet. At the same time, the inbound valve 14 is closed, the vent valve is opened, and when the pressure is 1 MPa, the vent valve 16 is closed. The drain valve 23 is opened, and after the drain valve is fully opened, the valve 24 is opened for draining. The venting valve 16 is opened to release pressure. When the pressure is zero, the blind plate 21 is opened to complete the ball collecting operation.

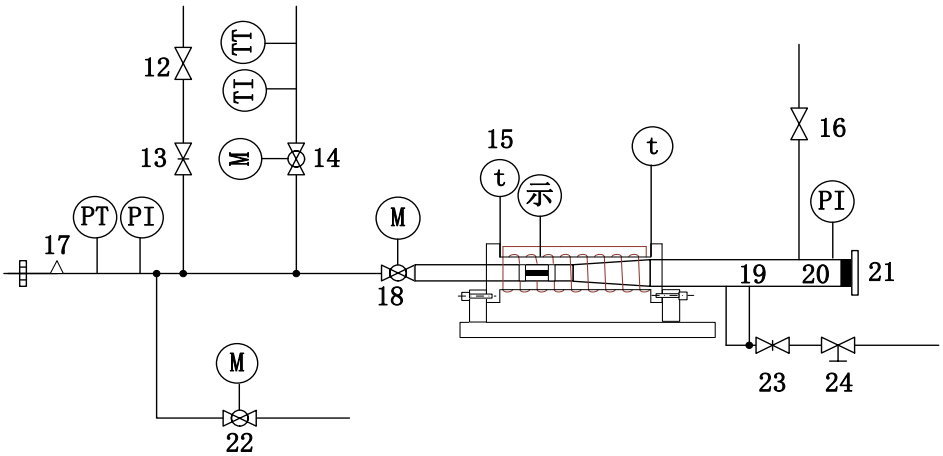

Fig 2. Flow chart of the ball collection process

4. Experimental Simulation

According to the method described in Fig. 1 and Fig. 2, it is assumed that the pipe cleaner is in the oil pipeline with a diameter of 1 m, a wall thickness of 0.01 m, a relative magnetic permeability of 300, a hydraulic pressure of 1 MPa in the pipeline, and a specific resistance of 1.786×10^{-7}. When the initial speed is 10m/s and the residual magnetic flux density is 0.4~2T (numbered from 1~5), the deceleration law is shown in Figure 3.

For different actual working conditions, the pipe cleaner deceleration can also be controlled by changing the residual flux density of the electromagnet, the conductivity of the deceleration zone, the wall thickness of the deceleration zone, and the number of coil turns. The core technology of this method is based on electricity. The Lorentz force generated by magnetic induction is used to achieve deceleration.

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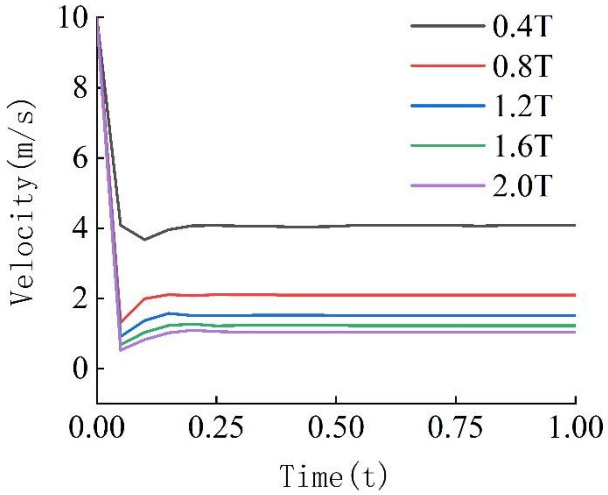

Fig 3. Speed curve of pipe

5. Summary

Aiming at the problems of the pipe cleaners in collecting the ball, this paper proposes a method of decelerating and collecting the ball of the electromagnetic brake. The specific implementation method is as follows: when the weak magnetic detector detects the magnetic field fluctuation, the upper machine goes to the pipe cleaner The signal is emitted to operate the electromagnet on the pipe cleaner; the electromagnet moving on the pipe cleaner causes the pipeline to generate an induced current, and the induced current interacts with the varying magnetic flux to generate a Lorentz force, thereby achieving a deceleration effect. It mainly includes the following contents: (1) The weak magnetic detector is installed at the front end of the deceleration area at 100m to detect the real-time magnetic field signal; (2) the pipe in the deceleration area should be a conductive material, and the pipe made of non-conductive material should be wound around it. Fixed copper coil; (3) The upper computer setting program processes the data from the weak magnetic detector to determine whether the pipe cleaner enters the deceleration area; (4) the upper computer program judges that the pipe cleaner enters the deceleration area and passes The signal transmitter will send a signal to the signal receiver on the pipe cleaner; (5) After receiving the information from the signal receiver, the control system on the pipe cleaner turns on the motor power, so that the electromagnet works to produce a stable orientation. (6) The induced current interacts with the changing magnetic flux of the electromagnet to generate the Lorentz force to achieve the deceleration effect; (7) When the pass ball indicator at the end of the deceleration zone detects the passage of the pipe cleaner, the upper machine controls the electromagnetic disconnection The current of the iron makes it stop working; (8) After the pipe cleaner completely enters the collecting cylinder, close the inbound valve, open the vent valve, and then close the vent valve when the pressure is 1Mpa; (9) open the drain valve, Perform sewage discharge; (10) open the air release valve to relieve pressure when its pressure is zero, open the blind board and finish the ball collection. Through theoretical analysis and experiments, it is proved that the method can realize deceleration without adjusting the differential pressure before and after the pipe cleaner in real time, and avoids the accident of stagnation or deceleration of the pipe cleaner, which has important practical significance.

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