The design of the position detection system for drilling and stealing oil in oil pipeline

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Abstract. Oil theft by drilling refers to the theft of oil by drilling and installing branch pipes and valves on the oil pipeline, which can easily cause leakage and lead to the risk of pipeline failure. Drilling and oil theft is a problem that has troubled the oil pipeline enterprises for a long time, and it causes a series of serious consequences every year in China. This paper presents a design method of detecting system for locating the location of drilling and oil theft, which is accurate and reliable in performance. It can be operated under harsh conditions, and is very suitable for high pressure and harsh application environment. It has a good application prospect.

1. Introduction
Pipeline transportation has the characteristics of low cost, energy saving, safe and efficient and stable supply, which has been widely used in the transportation of oil and natural gas. Due to the long distance of pipeline transportation, the complex terrain, pipeline corrosion, man-made damage and pipeline defects and other reasons, will cause the media leakage in the pipeline. Especially in recent years, oil pipeline leakage accidents caused by illegal drilling, oil stealing and corrosion perforation occur frequently, which not only affect the normal production order, cause serious economic losses and environmental pollution, but also cause oil and gas explosion and casualties. Drilling oil theft refers to the theft of oil by drilling and installing branch pipes and valves on the oil pipeline. It is easy to cause leakage and lead to the risk of pipeline failure. It is a problem that has troubled the oil pipeline enterprises for a long time [1]. How to timely detect the drilling oil theft, determine the specific location, crack down on the arrogant of the oil theft criminals, maintain the normal production of oil and gas pipelines, all of these have put forward urgent requirements for us.

2. Identification and localization of oil theft by drilling
At present, the main methods to detect the drilling and stealing branches of oil pipelines include manual inspection, aerial inspection by unmanned aerial vehicle, online leakage detection, traditional external detection and internal magnetic leakage detection. Except for magnetic flux leakage internal detection, other technologies have disadvantages such as personnel can not enter the restricted area, high false alarm rate, and can not detect oil theft in small tube flow. Although the internal detection accuracy of magnetic flux leakage is the highest, the detection cycle is long, the cost is high, and the requirement for pipeline cleanliness is high, so it is not suitable for periodic monitoring of drilling and
oil theft. Therefore, it is necessary to develop an internal detector with low cost and convenient implementation to effectively solve the above problems.

3. Design of position detector for drilling and stealing oil

Most of the pipelines are buried, so the purpose of stealing the internal oil can only be realized by drilling holes in the pipelines. Through the drilling and oil theft detector, the penetration defect of the pipeline can be found, which can prevent and effectively reduce accidents and ensure the safe operation of the pipeline.

The perforated oil theft detector runs in the pipeline driven by the pipeline transport medium, uses the special sensor to detect and record the pipeline in real time, and accurately locates through the mileage wheel. The drilling oil theft detector transmits the relevant data acquisition information to the monitoring system[3]. When the leak is found, the monitoring system will send out sound and light alarm signals and automatically display the location of the leak point.

The structure of perforated oil theft detector is shown in the figure below. The drilling oil theft detector consists of the following parts: the carrier pig, the main sensor, the mileage wheel, and the electronic acquisition module. The 36 sensors are installed on the internal detector in a ring distribution, connected to the main body of the detector by the mechanical arm, and evenly distributed on the inner wall of the pipeline by the spring on the arm.

![Diagram](image)

Figure 1. Hardware structure of digital charger.

3.1. Carrier pig

Carrier pig is a special tool for cleaning the pipeline driven by the pipeline conveying medium. After the modification, it can carry the electronic acquisition module, the main sensor and the mileage wheel to complete the detection task of drilling and stealing oil in the pipeline. This pig can be a mechanical pig or a soft pig such as rubber or foam. The leather bowl or soft pig of the mechanical pig is elastically sealed with the inner wall of the pipeline, and the pressure difference generated by the pipeline transport medium is used as the power to push the pig to run along the pipeline.

3.2. Microcontroller control circuit

The main sensor is a passive sensor composed of a magnet and sensor coil, ideal for high pressure and harsh service environments. The sensor is encapsulated with epoxy resin and can operate in high pressure environments.

The sensor is mounted close to the inner wall of the pipe, the magnet N level is facing the pipe wall, and the coil is located between the magnet and the pipe wall. When the sensor passes through the penetration defect of drilling and stealing oil, the distribution of the magnetic field changes, and the millivolt voltage is induced at both ends of the coil, which enters the electronic acquisition module through the twisted pair. After amplification and filtering, it is collected into digital signals by the analog-digital converter and stored[2].
3.3 miles round
It consists of a retractable mechanical assembly and a magnetic pulse sensor, usually with 2-3 mileage wheels. The retractable structure enables it to adhere to the wall at all times. The magnetic pulse sensor triggers the pulse following the rotation of the mileage wheel, and the pulse signal enters the electronic acquisition module through the signal line, providing the distance label in the form of pulse count for the main sensor data. In the late data analysis, the accurate position of the defect point is determined by pulse counting of the mileage wheel.

3.4 Electronic acquisition module
The electronic acquisition module is the core of the detector, which is installed in the pressure chamber together with the power supply battery to complete debugging, collect and record the main sensor and mileage pulse, and provide the data communication interface, so that the data can be downloaded to the computer for subsequent data analysis[3].

4. Design of monitoring system for drilling oil theft

4.1 Composition of monitoring system
The monitoring sub-station is set up in the first station, the shunt valve room and the end station respectively. The terminal station not only serves as the control and dispatching center of the whole system, but also serves as the monitoring sub-station of field detection[4]. The software monitoring system is located in the terminal control center and consists of data server, network communication equipment, GPS timing system, monitoring system software, etc.

4.2 Functions of monitoring software
The main functions of the drilling oil theft monitoring software are as follows: receiving the data uploaded by the monitoring client of each monitoring point, conducting comprehensive analysis, processing and calculation, displaying and recording real-time production status (pressure, flow, location of leakage point, etc.), alarm of accidents, formation and printing of production operation and management data reports; Provide pictures of oil pipeline operation dynamic, trend, alarm, etc., centrally monitor and deploy the running state of the pipeline, judge and locate the occurrence of leakage.

4.3 Monitoring software workflow
Each monitoring sub-station transmits data to the control center server in real time through the existing fiber-optic LAN, and the central server receives the data in real time[5]. Once there is any abnormality, the system immediately calls the drilling and stealing oil location module. If the leak is found, the system will send out acousto-optic alarm signal and automatically display the location of the leak point.

5. Conclusions
The drilling and oil theft position detector is accurate and reliable, and can quickly form accurate analysis data and provide reports through monitoring software. It can operate in quite harsh conditions without the need for pigging operations before detection. The main sensor is passive sensor, which is very suitable for high pressure and harsh application environments. The operation cost is comparable to that of ordinary pig, so it is suitable for quarterly or monthly inspection.

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