OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Research and Application of Submarine Pipeline Outer Anticorrosion Detection Technology -Based On Underwater Robot

Su bi huang[1,2], Huang gui bai[1,2],Wang zhi tao[1,2], liu ran[1,2] ,Zhang yan jun[1,2],
(1.CNPC engineering technology research co., LTD., tianjin 300451, China;
2.Coating material and insulation structure laboratory, key laboratory of CNPC petroleum pipeline engineering, tianjin 300451, China)

ABSTRACT *objective to introduce the research and application of submarine pipeline external anticorrosion detection technology -based on underwater robot,And investigate the feasibility of dc potential gradient detection method in the detection of submarine pipeline external anticorrosion layer damage. The system composition and realization process ofThe testing device is introduced. Conclusion the method based on dc potential gradient is feasible to detect the corrosion of pipeline. The developed measurement system of pipelinePipeline detection device can be used to measure the potential gradient along the pipeline,Judge the damage of the corrosion coating outside the pipeline and the position of the sacrificial anode block,And realize the non-contact detection of the damage of the corrosion coating outside the pipeline. By the root and tail line of the test pile at the shore end with the detection device,The ROV is 2 run along the pipeline to measure the cathodic protection potential along the pipeline, so as to judge the cathodic protection situation of the pipeline.*

KEY WORDS *pipeline; The cathodic protection potential; Potential gradient; Words; The ROV;*

Date of Submission: 15-09-2020 Date of acceptance: 30-09-2020

I. INTRODUCTION

Submarine pipeline is a pipeline that continuously transports a large amount of oil (gas) on the seabed through a closed pipeline. It is the main component of the offshore oil (gas) field development and production system, and it is also the fastest, safest, economical and reliable offshore oil and gas transportation mode at present.With the development and utilization of oil and gas resources, submarine pipeline will face the challenges of the service condition deteriorated, maintenance costs, combined with the increasingly stringent environmental requirements, to ensure the integrity of the whole life cycle of submarine pipeline becomes an important prerequisite for smooth implementation of the strategy for the development of oil and gas resources, pipeline operation unit is an urgent need to gain in the operation of the pipeline of the anticorrosive layer outside the effectiveness and Yin bao, the sea pipe pipeline anticorrosive detection implementation is difficult, but also the lack of effective detection methods.The detection of the external anticorrosive layer of the buried pipeline on land is mainly to judge the situation of the external anticorrosive layer of the pipeline by measuring the potential gradient along the line based on the principle of dc potential gradient method, and to judge the effectiveness of negative protection by measuring the ground potential along the pipeline. The offshore anti-corrosion detection system of submarine pipeline described in this paper is officially based on the principle of direct current potential gradient method, and it realizes the detection of buried submarine pipeline by developing an underwater robot (hereinafter referred to as ROV) equipped with a detection system, so as to provide data support for the management and decision-making of submarine pipeline by the operating unit.

1. Principle of dc potential gradient method

During the process of applying cathodic protection, underwater pipelines release electric current into the soil and water. After the electric current flows through the medium, it flows into the pipeline and forms a conductive path. During the flow of negative current, a relatively stable electric field will be formed in water and soil. If the pipe is well protected, an electric field distribution in the medium surrounding the pipe will decay

exponentially as it moves away from the anode, as shown by the dotted line in the figure above. If the protective layer of the pipeline is damaged, the local resistance of the pipe body in contact with the medium will be reduced, and the cathodic protection current can flow back through the exposed point of the damaged protective layer of the pipeline in large quantities. Thus, the voltage degree around the damaged protective layer and the nearby medium will change sharply, and an approximate spherical electric field and potential distribution will be formed there. The closer you get to the point of failure, the greater the voltage gradient and the greater the current density around the pipe. Generally speaking, the larger the damage area of the protective layer of the pipeline is, the larger the current density nearby is, and the larger the voltage gradient in the medium is. Therefore, the size and changing trend of the potential gradient can be used to determine whether there is a damage point in the outer anticorrosive layer of the pipeline.

The potential gradient detection process for underwater pipelines can be approximately understood as the use of a sensitive millivoltmeter with two measuring electrodes connected at both ends. When the electrode is placed in the field generated by cathodic protection, the voltage at both ends of the electrode will be different. Measuring the horizontal voltage gradient generated by the two electrodes in the electric field can reflect the location of the corrosion coating damage on the pipeline. The underwater pipeline detection system is equipped with a device with potential gradient measurement function, which can detect the distribution of potential gradient of the underwater pipeline according to the measured potential gradient. According to the existing testing standards, the position of the defect in the pipeline protection layer can be detected by the change of potential gradient.

II. RESEARCH AND DEVELOPMENT OF TESTING DEVICE

The whole device is divided into the ROV control system and measurement system, the ROV control system is mainly to ensure the ROV can stable operation, underwater measurement system design for plugins in underwater pipeline detection system in the framework of the ROV, can realize independent measurement, display and storage system, reduce the ROV systems may influence and interference in the measuring system, ensure the accuracy of testing data by measuring subsystem, stability and security, at the same time reduce the failure rate of the system, the system maintenance and maintenance more convenient and quick.

2.1 ROV control system

The control system is composed of water control unit, handheld controller, cable and underwater detection robot.

2.1.1 water control unit

The water unit is an integrated u-shaped chassis, including the following parts:

1) display

The display is a U - fold display, which can be integrated into U - shaped cabinet.

2) sonar receiver

The unit is specialized in processing sonar acquisition signals.

3) control board

The unit is integrated with the main control board of the underwater detection robot, which is responsible for collecting the number of sensors of the underwater detection robot

Data and generate motion instructions.

4) programmable power supply system

The programmable power supply system, or PSU, can generate the following two voltages used by underwater detection robots:

(1) 250 VDC ~ 350 VDC: this voltage is used to supply power to the propeller system of the underwater detection robot. The output voltage is automatically regulated according to the voltage drop generated by the line impedance and the line current. This circuit voltage is continuously monitored by LIM (insulation monitor).

(2) 48VDC: this voltage is used to supply power to the logic control circuit of the underwater detection robot.

2.1.2 underwater robot

The vehicle is equipped with a variety of underwater sensors and is designed to be supported by a central support column, so that the side panels on both sides can expand outwards. With ROV of this structure, the overall robot load capacity can be increased by 30% to 40% compared with the traditional structure. Contains the following parts:

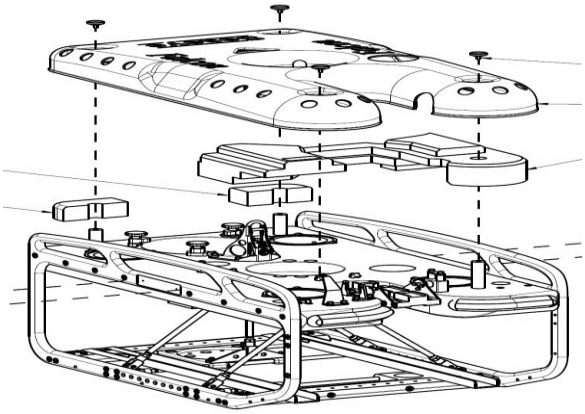


Fig. 1 the Open composition

1) main electric cabin

The main power module includes control module, dc-dc change module, propeller interface switch plate and other components. The main electrical compartment contains various connector interfaces for connecting various devices.

2) propeller

Thrusters are the core components of the auv's power, with built-in drive circuits. 250VDC working voltage.

3) camera and lighting

Cameras and lights are used to provide underwater video and illumination.

4) compass and depth gauge

The compass provides the auv with a yaw Angle relative to the magnetic north, and the depth meter can detect the auv's dive depth.

5) image sonar

Image sonar is a kind of shielding sonar, which can transmit multi-beam and real-time the contour of objects and terrain

Surveying and mapping.

6) USBL

The USBL is an ultra-short baseline positioning system consisting of transducers and beacons. It can locate the target of underwater robot in real time.

2.2 measurement system

According to the functions, working environment and carrying conditions of the underwater pipeline detection system, the subsystem can meet the requirements of waterproofing and sealing for underwater detection, resist the strong current interference in the underwater pipeline detection system, and accurately measure the potential and potential gradient parameters.

The measurement system is composed of 5 modules, shore measurement system, underwater central processing unit, potential measurement unit, magnetic pipeline positioning unit and intelligent power management.Underwater intelligent central processing unit module and intelligent power management module. The addition of these two groups of modules has a minimum impact on the real-time performance of pipeline information and the instability of external power supply voltage. The central processing unit adopts high-speed circuit and large amount of computation embedded technology to directly calculate and process the measurement results and correct the errors, which improves the efficiency and reduces the dependence on the engineers' measurement experience compared with the original measurement uploaded to the shore and processed through the measurement engineer's interpretation and analysis.

(1) sealed capsule

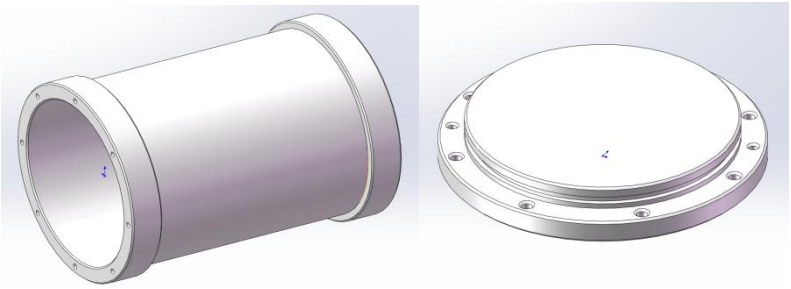
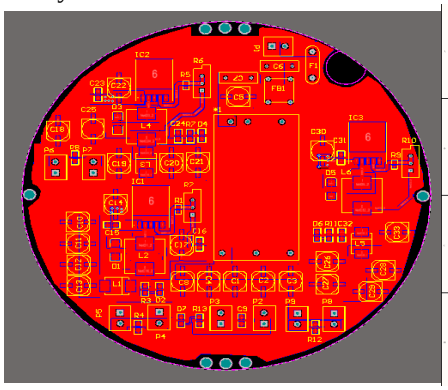


Fig. 2 Measurement module

The sealing chamber is made of corrosion-resistant aluminum alloy, and the surface of the aluminum is treated with oxidation black to further increase the corrosion resistance of the sealing chamber. The size of the sealing chamber is according to the size of the internal circuit board to choose the corresponding thick-walled aluminum barrel, made of digital machining. The end cover of the sealing chamber is designed with a seal notch and a compression screw hole. After the screw is installed on the compression screw hole, the internal seal of the sealing chamber can be achieved to prevent the entry of external media. The sealed capsule can withstand the pressure of 100m water column, which is fully able to meet the current detection requirements of underwater pipeline field environment.

(2) detection system circuit



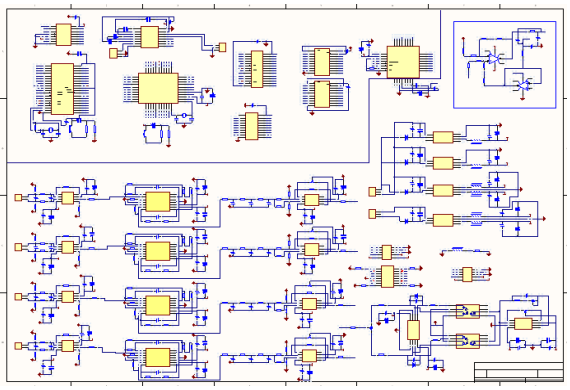


Fig.3 Power PCB Fig.4 simplified schematic of Potential Measurement circuit

According to the functional requirements of the measurement subsystem, design the circuit board in the sealed cabin. Since the sealed chamber is round, the circuit board is also round, which is convenient for the installation of circuit board in the sealed chamber. Each circular circuit board is connected to each other through 4 holes on the edge and copper column in a cage shape. There are circular holes on the side of the circuit board for the connection between the circuit boards. The design of the serial caged circuit board can reduce the interference between each circuit board, and is also conducive to the heat dissipation of the components between each circuit board, so as to maximize the use of the internal space of the sealed capsule.

III. FIELD TEST

In order to test the practical application effect of the developed subsea pipeline detection device, the subsea pipeline at the 1km offshore end of an oil field was selected as the detection object to test the outer anticorrosive layer and cathodic protection potential of the pipeline.

3.1 measurement of cathodic protection potential

The two sites measured on land were the test pile and pipeline excavation site, and the cathodic protection potential was -721mv (relative to saturated copper sulfate reference electrode CSE) and -677mv

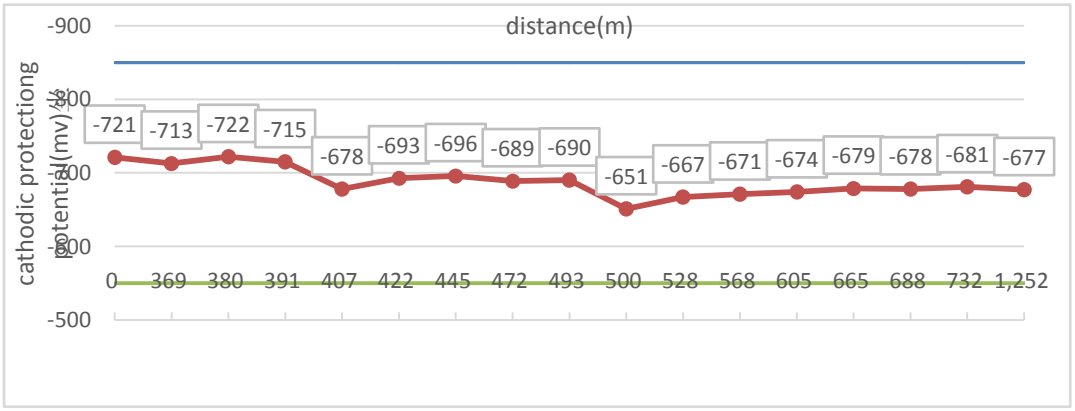


Fig. 5 The curve of Pipe cathode protection potential

respectively.The overwater cathodic protection potential was from -722mv (CSE) to -651mv (CSE).It can be seen from the graph that the cathodic protection effect of the pipeline crossing is poor, not up to -850mv (CSE) standard, and cannot effectively protect the pipeline from the impact of corrosion. Therefore, it is suggested to improve the cathodic protection effect of the pipeline.

3.2 potential gradient measurement

The potential gradient value of underwater pipeline crossing is between 27.2mv /m and 7.4mv /m. It can be seen from the curve that there are damage points in the pipeline anticorrosive layer at 406m and 499m, and the potential gradient increases significantly, indicating that the consumption of cathodic protection current at this point increases.

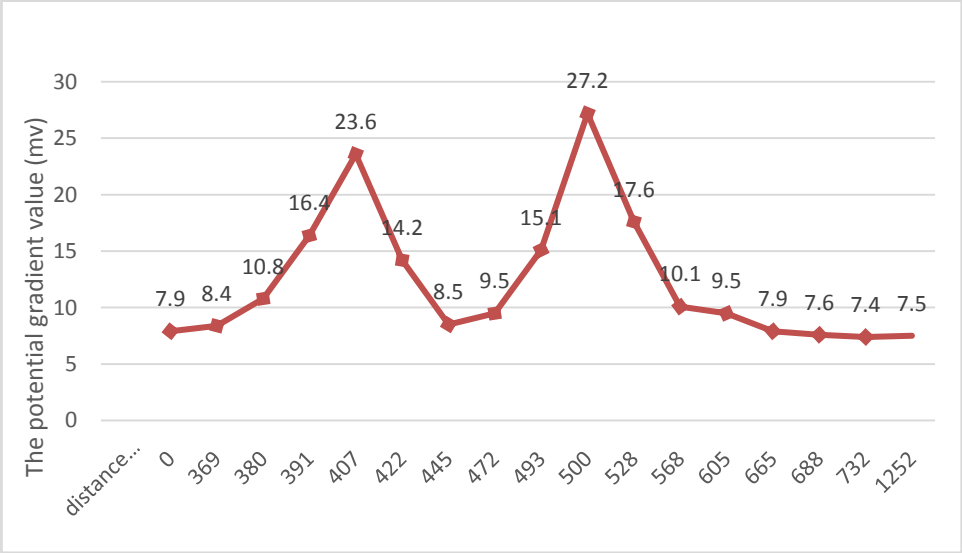


Fig.6 The curve of Pipeline potential gradient

IV. CONCLUSION

From the results of the study and the actual testing situation.

(1) the developed submarine pipeline detection device measurement system can be used to measure the potential gradient along the pipeline, judge the damage of the pipeline outer anticorrosive layer and the position of the sacrificial anode block, and realize the non-contact detection of the damage of the pipeline outer anticorrosive layer.

(2) by connecting the root and tail line of the test pile at the shore end with the detection device, the cathodic protection potential along the pipeline can be measured by ROV running along the pipeline, so as to judge the cathodic protection situation of the pipeline.

COWEN OFFER REFS

[1]. HU Ge. Study on Corrosion Pipeline Corrosion Detection and Corrosion Prediction[D]. Hangzhou: Zhejiang University, 2007.
Hu ge. Corrosion detection and prediction of submarine pipelines [D]. Hangzhou: zhejiang university,2007.
[2]. WangZhiTao.External Coating Damage Inspection Technology for Submarine Pipelinesin Paralic Zone Based on DC Potential Gradient Method.Tianjin:CNPC Research Institute of Engineering Technology, 2016.
[3]. Wang zhitao. Research on damage detection technology of outer anticorrosive coating of submarine pipelines in shallow and shoal seas based on direct current potential gradient method. Tianjin: engineering technology research institute of China petroleum corporation, 2016.
[4]. GB/T 19285, Inspection of Corrosion Protection for Buried Steel PipelinesfSJ.
[5]. GB/T 19285, corrosion protection engineering inspection for buried steel pipeline [S].
[6]. HOU bao-rrong. Theory of Marine Corrosion Environment and Its Application[M]. Beijing: Science Press, 1999.
[7]. Hou baorong. Marine corrosive environment theory and its application [M]. Beijing: science press,1999
[8]. HU Shi - xin. Faced of Cathodic Protection, [M]. Beijing, Chemical Industry Press, 2005.SAM W A.
[9]. Hu shixin. Cathodic protection manual [M]. Beijing: chemical industry press, 2005.

Su bi huang, et. al." Research and Application of Submarine Pipeline Outer Anticorrosion Detection Technology -Based On Underwater Robot." *International Journal of Modern Engineering Research (IJMER)*, vol. 10(09), 2020, pp 01-05.