Research on Detection and Quantitative Evaluation of the Anti-corrosion State of Submarine Pipeline

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ABSTRACT

There is natural correlation between the anti-corrosion state and the associated electric field (the ambient electric field) in Anti-corrosion system which combined coating protection with sacrificial anode. Based on analysis of the accurate mapping Relation between the anti-corrosion state and the ambient electric field, a method of quantitative evaluation of anti-corrosion state of submarine pipeline by measuring the ambient electric field is proposed. Through Artificial Neural Network (ANN) learning, the mapping Relation between characteristic parameters of the ambient electric field and the parameters which describe the anti-corrosion state of submarine pipeline is gotten. It is concluded that this method comes true. And then, the solution for the non-contacting detection and quantitative evaluation of the anti-corrosion state of submarine pipeline is proposed.

KEY WORDS: Submarine pipeline; non-contacting detection; quantitative evaluation; anti-corrosion; neural network; boundary elementary method; ambient electric field.

INTRODUCTION

Researches in the field of offshore oil and gas have gotten a great development in the past few years, and that brings the large usage of submarine pipeline. The corrosion damage is one of the main reasons to the accident of submarine pipeline. Therefore, it is very important to inspect the anti-corrosion state of submarine pipeline. In order to achieve this goal, there are three steps should be taken. First, find the target - submarine pipeline. Then, collect data from the target. Finally, use the data to evaluate the anti-corrosion state.

For the first step, the primary way of searching submarine pipeline used to be carried out by the diver. Recently, many advanced detection methods and equipments have been developed. For example, ac magnetic field techniques, imaging technique based on underwater inspection, detecting technique of submarine burying height and detecting technique based on remotely operated vehicle (ROV). These techniques and equipments show a new way of searching submarine pipeline, if they can be properly integrated together.

For the rest two steps, one of the key points is to find out a way to quantitatively evaluate the anti-corrosion state of submarine pipeline. In engineering practice, anti-corrosion measure which is composed of coating protection and sacrificial anode is generally adopted. In this compound anti-corrosion (CAC) system, basic factors such as average deflection of anti-corrosion coat, current of sacrificial anode and remaining weight of sacrificial anode are used to describe the anti-corrosion state of submarine pipeline. Meanwhile, there are some natural correlations between the anti-corrosion state and the associated electric field (the ambient electric field) in CAC system.

Based on analysis of the non-linear mapping Relation between the anti-corrosion state and the ambient electric field, a method of quantitative evaluation of anti-corrosion state of submarine pipeline by measuring the characteristic parameters of the ambient electric field is proposed in this paper.

Based on all the possible states of submarine pipeline, which would be described with diameter of pipeline, deflection ratio of anti-corrosion coats, spacing of sacrificial anodes, specific resistance of seawater, specific resistance of seabed mud, and buried depth of pipeline, a large number of numerical models to simulate submarine pipelines are build up, and the “Influencing Factors Database of the Submarine Pipeline under Compound Anti-corrosion System” is obtained by numerical simulating calculations on those models with boundary elementary method (BEM). This database contains the full data for analysis.

Based on this database, using the characteristic parameters of the ambient electric field as the input, and the parameters which describe the anti-corrosion state of submarine pipeline as the output, artificial neural network (ANN) mapping models between these two sets of parameters are designed. Through ANN learning by training algorithms, the ANN which reflects the non-linear mapping Relation is gotten. Through this ANN, the quantitative evaluation of the anti-corrosion state of submarine pipeline can be realized by measuring the characteristic parameters of the ambient electric field. Some data from laboratory experiments shows that this ANN has high prediction accuracy. It is concluded that the method comes true.

Based on all the mentioned above, a full solution for the non-contacting...