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Review of Life Evaluation of Oil and Gas Long - Term Pipelines

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Abstract: ***In recent years, China's oil and gas pipeline industry is booming, and the working life of oil and gas pipelines increases year by year, it will face problems in terms of pipeline corrosion, which requires a life evaluation of the pipeline to provide specific recommendations for the replacement and overhaul of the pipeline. This paper introduces the corrosion factors of pipelines: the environmental factors around the pipeline, the factors of pipeline corrosion protection, and the material factors of the pipeline itself. The current research status, research methods and shortcomings of the pipeline life evaluation, as well as the future direction of pipeline life evaluation methods to improve the outlook, and to complement the life evaluation technology of oil and gas pipelines.***

Keywords: oil and gas long - distance pipelines; life evaluation; current status of research; outlook

1. Introduction

The main way of oil and gas transportation is pipeline transportation, China's oil and gas pipeline industry is booming, more and more pipelines are laid underground, and many more pipelines are buried deep underground, despite some anti - corrosion measures, the anti - corrosion conditions of long - distance pipelines that have been buried deep underground for a long time are still severely challenged, if the pipeline is not accurately overhauled and replaced, it will cause great unpredictable accidents, which will not only pollute the environment, and even cause great economic losses to the oilfield. The life evaluation of long - distance pipeline will detect whether the pipeline needs to be overhauled and replaced, which will prevent the accident in time and bring economic benefits to the oilfield.

1 long - distance pipeline corrosion factors and evaluation steps

The life evaluation method of oil and gas pipelines is to determine the remaining strength of the pipeline based on the corrosion condition of the pipeline, such as corrosion appearance, remaining wall thickness and other aspects, and then discern the probability of failure of the pipeline, including the remaining life, and knowing this will provide a reference method for pipeline maintenance and replacement.

1.1 Pipeline corrosion factors

The corrosion of oil and gas pipelines in service is subject to many factors, but there are three main aspects:

(1) Soil corrosion

The soil contains gas, liquid and solid state solids, and also contains a lot of corrosive ions, which forms an electrochemical corrosion environment outside the pipeline, which in turn corrodes the pipeline and thus results in the shedding of the anti - corrosion layer on the outer wall of the long - distance pipeline. In addition, due to the special corrosive environment of the soil, resulting in uncertainty about the nature of corrosion of the soil.

(2) Anti - corrosion measures for pipelines

Corrosion measures for pipelines include: pipeline protection by coating the outer wall of the pipeline, and pipeline protection by sacrificial anode with the pipeline as the cathode. The outer coating protection of the pipeline will block the corrosive substances outside the coating from contacting the pipeline substrate, and then corrode, but because sometimes the laying of the pipeline will cause the rupture of the outer coating of the pipeline, which will reduce the protective effect of the coating, and also due to the long - term service of the pipeline, coupled with the limited service life of the coating, the coating will have different degrees of peeling, perforation and other phenomena, which will lead to corrosion of the pipeline. If the cathodic protection of the pipeline is improper, stray currents outside the pipeline will also be a threat to the corrosion protection of the pipeline.

(3) Pipe material

The material of the collector pipeline are metals, metal material is not easy to react with the material in the soil, this kind of pipeline is not easy to be corroded, so, often add some alloy elements to the metal material, which will enhance the stability of the metal, and then make the metal not easy to be corroded.

It is because the corrosion factors of the pipeline will affect each other, when the pipeline is corroded will play a different role, which will make the pipeline corrosion environment, corrosion mechanism, corrosion results in the appearance of diversity, combined is that these complex factors to the long - distance pipeline life evaluation has increased a lot of difficulty.

1.2 Pipeline life evaluation steps

1) Pipeline initial data collection
   The initial data of the pipeline, including the metal properties of the pipeline, the material, and the relevant parameters at the time of design are collected.
2) Pipeline field data collection
   Including the corrosion morphology of the pipe, corrosion after the wall thickness, corrosion defect type, corrosion defect size and other data.
3) Pipeline data analysis
   Analyze the measured wall thickness of the pipe after corrosion and other relevant data to derive the corresponding results.
4) Derive the remaining strength and remaining life evaluation of the pipeline
   Calculate the minimum yield limit of the pipe, the pipe tolerance size, according to the depth of erosion and erosion of the pipe wall thickness can be calculated to calculate the residual strength of the pipe, and then calculate the corrosion rate of the pipe, and then you can get the approximate probability of failure of the pipe.
5) Pipeline protection methods recommended
   Based on the calculated probability of pipe failure, we recommend protective measures for the pipes, such as: pipe repair or pipe replacement.

2. Research status of life evaluation methods for oil and gas long - distance pipelines

2.1 Status of foreign research on remaining life evaluation methods

The magnitude of residual strength of oil and gas long - distance pipeline represents the degree of pressure resistance of the pipeline under different pressure, and the residual life of oil and gas long - distance pipeline represents the standard of how long the pipeline can still be used, and the residual strength prediction of oil and gas long - distance pipeline is a way of pipeline life assessment, and because of the complex and various elements affecting the residual life of pipeline, foreign scholars have achieved more research achievements in the residual strength of pipeline than others more.

Foreign scholars on the pipeline life evaluation research is mainly the use of corrosion data measured in the field to calculate, and then come up with the desired results, or use in the pipeline to place the hanging piece, so that the hanging piece in the field under the corrosive environment, corrosion, and then come up with the corrosion rate to change to. However, in the field of the pipeline corrosion causes are too complex, resulting in the pipeline corrosion face is also different, which requires the use of gray principle, can calculate the erosion rate of the pipeline in a certain period, after the calculation can be analyzed the residual strength and residual life of the pipeline. Because of the erosion elements of the pipeline, corrosion elements of a variety of foreign experts have also established a variety of models to predict the life of the pipeline, such as the use of gray principles to establish the corrosion rate model, and corrosion life prediction model, etc. [1 - 4].

Current foreign measures of pipeline life assessment include the following:

1) Using the electrochemical erosion mechanism of buried pipelines, an approximate model can be simulated: the model is able to derive the life prediction measures of pipelines for the corrosion morphology of gas transmission pipelines and their development, however, the method has some limitations and is only applicable to the prediction of soil erosion of long - distance transmission pipelines.
2) In the room by simulating the field environment, do experiments on hanging sheet erosion, apply the measured hanging sheet corrosion rate data, simulate the relevant life prediction model: this model can be simulated by the field environment and the relevant data, but these data and the field of the real problem there is a big difference, so this model can not be measured to predict the actual remaining life of the pipe.
3) soil corrosive factors can lead to corrosion of the outer wall of the pipeline, the use of these corrosion - related data can be summarized in the pipeline corrosion morphology criteria, and then derived from the simulation of the pipeline erosion prediction model: the model is only applicable to the characteristics of the soil under, so this model is less applicable.
4) The use of periodic full - line inspection of long - distance pipelines and the detection of their erosion data can lead to a simulated pipeline residual life prediction model: this model is based on periodic inspection of full - line pipelines, so the cost of inspection can be very high, and this condition can be accompanied by a considerable range of restrictions on the application of the model.
5) After the erosion of the elements of the pipe and the relevant data after corrosion, a life prediction model can be established, but this corrosion model is based on experimental data and derived from the data has limitations and chance, so the accuracy of the prediction of this model is limited.
6) the application of the system analysis of gray theory, able to simulate the life prediction model, gray theory refers to the relationship between the corrosion factors is not clear, and it is not clear what these factors are specifically, the use of correlation method, so the model in the prediction accuracy is sometimes inaccurate, so the accuracy needs to be improved.
7) the corrosion depth of the pipeline detection, the maximum erosion depth determines the residual life of the pipeline, in accordance with the law of distribution of the poles, the value of the maximum corrosion depth in accordance with its law is satisfied, by calculating the distribution of its poles, it will be able to derive the maximum depth of erosion of the pipeline, and then you can predict the residual life of the pipeline, because the establishment of this model requires a lot of on -

site, various aspects of the test, so The operability of this model needs to be improved.

2.2 Domestic remaining life evaluation method research status

Although the current pipeline industry in China is booming, but China's pipeline industry related research time are not long, looking at the pipeline research at home and abroad, the initial research is based on the pipeline surface protection measures, such as corrosion inhibitors and external coating of the pipeline, slowly as foreign research gradually deepened, such as the life evaluation of oil and gas long - distance pipelines, so the domestic is also following its pace. Therefore, China is also following its pace and gradually carrying out a lot of exploration on pipeline life evaluation, but nevertheless, the remaining life prediction of oil and gas pipelines in China may have to be in the exploration period for a long time.

Chenghao Liang et al, used probabilistic statistics to assess the residual life of oil facilities, by proposing a method for predicting the remaining life of pipelines, and then inferred the residual life of eroding pipelines [5]. In the safety management of gas pipelines, Jiajia Xu applied theories and methods of safety engineering, while using artificial neural networks to establish a prediction model. Because of the limitations of the corrosion life evaluation measures of oil and gas pipelines, in order to obtain more accurate residual life probability results, the finite element approach was applied to think about the residual strength prediction of oil and gas pipelines, and the results obtained were compared with the results of the current analysis methods, and it was found that the residual life failure probability obtained by applying the finite element measures was more credible [6]. Wang just after the assessment of the erosion characteristics of the pipeline being worked, summarized the corrosion types of oil and gas pipeline corrosion, and also the evaluation and analysis of the current pipeline life evaluation methods, and established a model of pipeline corrosion patterns. Because the pipeline corrosion has uncertainty and the soil environment factors around the pipeline are too complex and diverse, Wang Gang used the probability statistics principle to find out the corrosion pattern of the pipeline. The electrochemical theory was applied to simulate the electrochemical model of different erosion conditions of oil and gas pipelines, and the erosion dimensions of pipelines were verified, so as to determine the residual life of pipelines with different erosion types [7].

3. Future Perspectives of Life Evaluation Methods

Many studies have been conducted by domestic and foreign experts on the remaining life of pipelines, and a lot of research results have been achieved. According to the current research results, the following aspects are advocated to further improve the remaining life assessment of oil and gas pipelines in China.

1) on the mechanism of pipeline corrosion, but also need to continue to strengthen research in order to more accurately determine the type of pipeline corrosion, determine the trend of pipe wall thinning, grasp the trend of corrosion changes, the establishment of an accurate corrosion rate model.
2) Oil and gas long - distance pipeline should establish a corrosion prediction database, and can be used in conjunction with the relevant software, so that ordinary managers can complete the remaining life prediction.
3) Further development of detection methods applicable to China's oil and gas pipelines, to improve the detection accuracy of the pipeline, not only to improve the detection accuracy, but also to have some savings in the cost of detection, so that the pipeline life prediction can be more fully guaranteed.
4) To take different prevention and control measures according to different places, study and develop external corrosion control programs suitable for different blocks and soil environments, and provide technical support for oilfield ground process simplification, pipeline corrosion overhaul, old area renovation, and planning investment control.
5) Unify the criteria for pipeline failure guidelines to provide an effective reference for pipeline failure or not.
6) Improve pipeline suitability evaluation techniques to facilitate more accurate determination of the probability of remaining pipeline life.

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