

Corrosion Perforation Failure Analysis of Inside Coating Sewage Pipeline

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ABSTRACT

The corrosion morphology, material properties and corrosion products of corroded perforated L290M sewage pipelines were analyzed, and the reasons for corroded and perforated were discussed in combination with the analysis of service environment and operation of pipeline. The results show that corrosion pits of L290M sewage pipelines are round, and there are corrosion pits at the side of the pipeline

segment. At the same time, the material performance of the failed pipeline conforms to the requirements of GB/T 9711-2011 standard for L290M steel. There are two reasons for pipeline failure. On the one hand, coating damage leads to contact between pipeline matrix and corrosive medium, which leads to pitting corrosion under the joint action of bacteria and dissolved oxygen in sewage. On the other hand, the undamaged parts and damaged parts form a "large cathode, small anode" corrosive electrochemical system, accelerating corrosion perforation.

Key words: Sewage pipeline; Inside coating; Bacterial corrosion; Failure analysis

INTRODUCTION

Corrosion exists in the whole process of oil exploitation. Pipeline failure caused by corrosion can cause serious economic losses and Security incidents. Due to corrosion factors such as ions and bacteria introduced by sewage, the service environment of the sewage transmission pipeline between the sewage station and the water injection pressurization station studied in this paper becomes more serious[1]. Pipeline corrosion prevention becomes more challenging. As the result, it is vital to analyze the causes of pipeline corrosion failure and master the response measures of pipeline corrosion [2]-[3].

The L290M steel pipeline studied in this paper was completed and put into production in May 2018, with a service time of about 1.2 years. The pipeline is 23km length, 7.1mm thickness and diameter of 400mm. Titanium nano inner coating is used to protect from internal corrosion. The operating pressure of the pipeline is 0.8MPa, and the operating temperature is 40-50 °C. The conveying medium is sewage with a salinity of 207976mg/L. The types and contents of ions in sewage are shown in Table 1. On June 14, 2019, a local leakage problem occurred on the water pipeline, and one month later, another leak occurred about 0.6km from the first one. Both perforation locations were located at about 9 o'clock of the pipeline clock position. In order to make clear the reason of the pipeline perforation, the failure reason of field pipe section was analyzed, in order to provide guarantee for oilfield water injection development.

Table 1: Type and content of ions in sewage water

Ions(mg/L)	K ⁺ +Na ⁺	Ca ²⁺	Mg ²⁺	Cl ⁻	SO ₄ ²⁻	HCO ₃ ⁻	Br ⁻	pH	Dissolved O ₂ (mg/L)
Content	66115	12169	1527	127563	350	185	150	6.7	0.31

PHYSICAL AND CHEMICAL TESTS AND RESULTS

Corrosion Profile Analysis

Corrosion according to the field investigation, there is no obvious corrosion outside the L290m pipeline, mainly manifested as the internal perforated corrosion of the pipeline (as shown in Figure 1). It can be seen from the field feedback pipeline perforation photos (as shown in Figure 2) that there are isolated corrosion pits inside the pipeline and the pits are circular. The shape of the external corrosion pits is basically the same as that of the internal corrosion pits. The difference is that area of pits is slightly larger than internal ones. There is no obvious corrosion in other parts. The corrosion perforation position of the coating is damaged, and there are wrinkles in and around the damaged part of the coating.



Figure 1: Corrosion morphology of field of the failure tubing

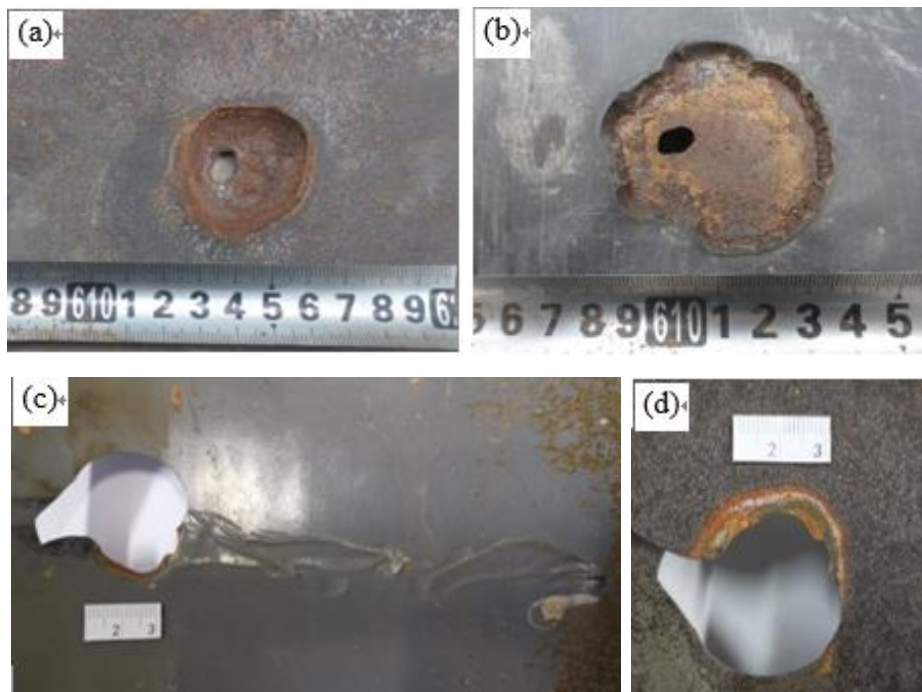


Figure 2: Morphology of the failure tubing

(a) The internal surface (b) The outside surface (c) The surface of coating (d) The back of coating

Chemical Composition Analysis

Metal scraps were taken from the metal matrix near the perforation part of the failed pipeline, and elements of C, Si, Mn, P, S, V, Nb, Ti were detected according to ASTM A751-2008 "Test Method for Chemical Analysis of Steel Products", and the results were shown in Table 2. According to the test results, the chemical composition of the failed pipeline meets the requirements of GB/T 9711 "Petroleum and natural gas industries-Steel pipe for pipeline transportation systems" for L290M.

Table 2: Chemical composition of the failure tubing (mass %)

Elements	C	Si	Mn	P	S	V	Nb	Ti
Failure of pipeline	0.064	0.13	1.13	0.008	0.005	≤0.01	≤0.01	≤0.01
GB/T 9711-2011	≤0.22	≤0.45	≤1.30	≤0.025	≤0.015	≤0.05	≤0.05	≤0.04