ISSN: 2664-9640

Analysis and Protection Technology of Corrosion Influencing Factors of Gathering and Transportation System

Feng Ma [1, 2], Xiaohong Ma [1], Fanyu Kong [1]

[1]Oil and Gas Engineering Research Institute of Jilin Oilfield Company, Songyuan 138000, China

[2]CO_2 flooding and storage test base, China

Abstract

The conditions of oilfields and mines are complex, and the produced fluids of oil wells often contain various corrosive media, which makes the gathering and transportation system corrosive. Based on the actual conditions of the gathering and transportation system of Jilin Oilfield, this paper analyzes the causes and influencing factors of the corrosion of the gathering and transportation system in detail according to the characteristics of the produced water quality of the oilfield, and proposes anti-corrosion methods. Important guiding role.

Keywords

Gathering and transportation system, pipeline corrosion, water quality, corrosion factors, protection technology.

1. Introduction

In the development and production of oilfields, the corrosion of the gathering and transportation system has always been an important issue that restricts the normal exploitation of the oilfield and affects the safe and stable production of the oilfield. With the deepening of water injection development in oilfields, most areas have entered a period of high water cut development. As the water contains corrosive media, corrosion of the pipelines and equipment of the gathering and transportation system will occur, which will bring great harm to production and cause huge economic losses. According to statistics, the annual loss of oil fields caused by corrosion is more than 20 million yuan. Therefore, in view of the actual situation of the oil field, a clear understanding of the corrosion mechanism of the gathering and transportation system and the adoption of targeted measures to protect it will play a huge role in ensuring the normal production of the oil field.

2. Analysis of Corrosion Influencing Factors

2.1. The influence of dissolved salts

The dissolved salts in the produced water of the oil field have a significant effect on the corrosivity of the water. Generally, there are a large amount of salt dissolved in oil field water, which has a high degree of salinity. The salinity of produced water in Jilin Oilfield is generally 5000-30000mg/l, so the conductivity of water is strong, which not only makes it farther from the metal surface Anions and cations can interact with each other and cannot form dense attachments on the metal surface, and the corrosion rate is increased. At the same time, it also affects the stability of the colloidal precipitate of Fe(OH)2, which makes the quality of the protective film worse and increases corrosion. However, increasing the salt content to a certain value will reduce the solubility of corrosive dissolved oxygen, weaken the cathodic process, and reduce the corrosion rate. The combined effect of the above factors generally increases the corrosion of steel. Chlorides, sulfates, and bicarbonates are common dissolved salts in oil field

ISSN: 2664-9640

water. Different anions and cations have different corrosion degrees to water at very low concentrations. Generally, chloride ion and sulfate ion are more corrosive. Cl- ions not only cause stress corrosion damage to stainless steel, but also easily damage the oxide film on the metal surface. Therefore, chloride ions are also the main cause of pitting corrosion of carbon steel. The pitting tendency increases with the increase of chloride ion concentration. Pitting corrosion is large cathode and small anode, which has autocatalytic properties. Corrosion in the small holes causes cathodic protection around the small holes. The smaller the hole, the larger the ratio of the anode to anode area, and the faster the perforation. Therefore, pitting corrosion is extremely destructive and has attracted more and more attention. The Cl- ion content in the produced water is above 7000 mg/l, and the corrosion is very serious.

2.2. The influence of corrosive gas

2.2.1. The impact of hydrogen sulfide (H_2S)

Hydrogen sulfide in oilfield water mainly comes from the dissolution of sulfur-containing oilfield associated gas in the water, as well as the decomposition of sulfate-reducing bacteria. The high content of hydrogen sulfide in produced water causes serious corrosion of pipelines. The content of hydrogen sulfide in produced water in typical blocks is as high as 120mg/L, and local corrosion such as pitting and pitting corrosion of oil production equipment is relatively serious. The solubility of hydrogen sulfide in water decreases with increasing temperature. Dry H2S has no corrosive and destructive effect on metal materials. It is corrosive only when dissolved in water. Once dissolved in water, it ionizes immediately. The released hydrogen ions are strong depolarizers, which can easily seize electrons at the cathode and promote anode iron. Dissolution reaction leads to general corrosion of steel.

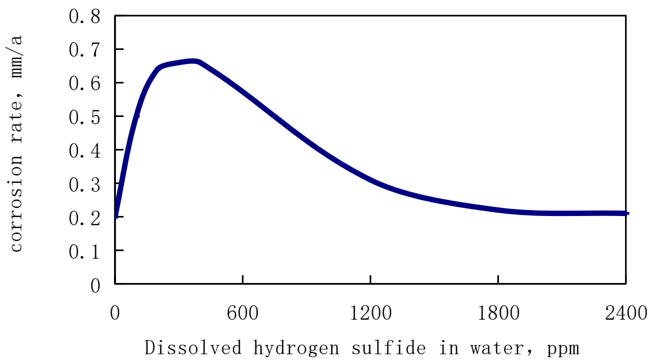

Figure 1: Corrosion rate of carbon steel in water with different concentrations of H2S

Hydrogen sulfide in water has another form of corrosion damage, H2S can make metal materials rupture. Hydrogen sulfide electrochemically corrodes steel to produce hydrogen, and promotes the penetration of hydrogen atoms into the steel, destroying the continuity of its matrix, resulting in hydrogen damage, and cracking may occur under very low tensile stress. Therefore, in areas with severe hydrogen sulfide corrosion , The sucker rod breaks more frequently.

2.2.2. The influence of dissolved oxygen

The oxygen contained in oilfield produced water is generally carried in by injected water. The only oxygen that can cause metal corrosion is dissolved oxygen. Dissolved oxygen has a great influence on corrosion. The concentration of about 0.1 can cause serious corrosion. From the morphological point of view, most of the corrosion caused by dissolved oxygen is more harmful local corrosion.

The electrochemical corrosion process of oxygen on steel can be expressed by a pair of conjugate reaction formulas:

Anodic reaction (corrosion of steel):$Fe \rightarrow Fe^{2+} + 2e$

ISSN: 2664-9640

Cathodic reaction (depolarization of oxygen):$O_2 + 2H_2O + 4e \rightarrow 4OH^-$

The total reaction formula is:$2Fe + O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4OH^-$

In addition, the special corrosion caused by dissolved oxygen is the oxygen concentration corrosion under the scale and corrosion products. It is the most common form of localized corrosion, which is more serious and more threatening than uniform corrosion.

2.2.3. The impact of carbon dioxide

The CO_2 in the produced water is mainly produced by the geochemical process of the earth. The solubility of CO_2 in water increases with increasing pressure and decreases with increasing temperature. If the oil field water contains excessive CO_2, it will cause serious corrosion to metal equipment.

CO_2 corrosion is mainly hydrogen depolarization corrosion. When free CO_2 exists in water, the following reactions will occur:

$$CO_2+H_2O \rightleftharpoons H^++HCO_3^-$$

The consumed hydrogen ions will be supplemented by the continued ionization of the weak acid. CO_2 makes the water acidic, destroying the protective film, and the corrosion products generated by the corrosion of the steel by CO_2 are all soluble. The corrosion feature is often that there are no corrosion products on the metal surface.

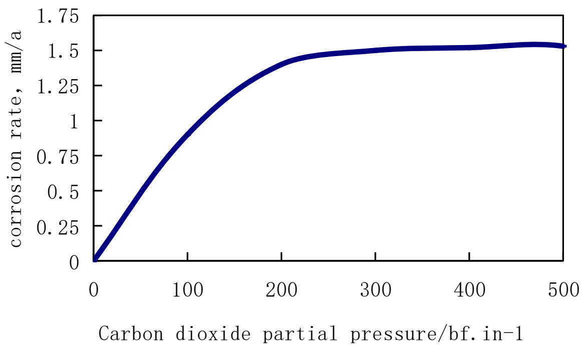

Figure 2: Corrosion of carbon steel in distilled water containing CO_2

2.3. The influence of bacteria

There are generally three types of bacteria that breed in the produced water of oil fields: sulfate-reducing bacteria (SRB), iron bacteria, and saprophytes. The most harmful to the gathering and transportation system is SRB. SRB removes inorganic sulfate in the water in an anaerobic environment. It is reduced to hydrogen sulfide, which causes corrosion to the system. There are black FeS in the corrosion products. The produced water is often black and odorous, causing serious corrosion to the equipment. The sulfate-reducing bacteria in the oil field gathering and transportation medium is as high as 105/ml, and the damage is quite serious, so it must be controlled.

2.4. The influence of pH

The pH value of oil field produced water is generally between 6-9. Within this range, the pH value generally has no significant effect on the corrosion of metal materials. Tests have confirmed that the surface corrosion rate of carbon steel does not change much when the pH value is between 4.3-10.

2.5. The influence of temperature

At present, the temperature of the gathering and transportation system is generally at 2050°C. The effect of water temperature on corrosion is the same as most chemical reactions, and temperature can accelerate the speed of electrochemical reactions, thus accelerating corrosion.

ISSN: 2664-9640

The corrosion rate increases proportionally with the increase of water temperature. Generally, for every 10°C increase in water temperature, the corrosion rate of steel increases by about 30%. Therefore, temperature is the main factor affecting corrosion.

2.6. The influence of flow rate

The flow speed and flow state of the gathering fluid have a great influence on the corrosion of tools and equipment. The increase of the flow rate will promote the diffusion contact of the corrosive medium to the surface of the equipment, promote the diffusion and exchange of the corrosion reactants to the surroundings, and will wash away the protective protective film formed on the metal surface, thus accelerating the corrosion. At the same time, the gathering and conveying fluid often contains solid particles such as mud, sand, scale, etc., which will cause impact and erosion on the surface of the equipment at higher fluid speeds, which will cause severe erosion and corrosion mainly mechanical damage.

3. Anti-corrosion measures of the gathering and transportation system

3.1. Corrosion resistant materials

According to the actual production conditions of the gathering and transportation system, corrosion-resistant materials can be selected economically and reasonably. Stainless steel, FRP, coatings and other materials have very good application effects in severely corroded gathering and transportation systems.

3.2. Chemical agents

The use of chemical agents for the corrosion control of the gathering and transportation system must be targeted. Therefore, the reasons for the corrosion of the gathering and transportation system and the actual production conditions must be clearly understood in order to economically and rationally choose the prevention and control agents. For example, for dissolved oxygen corrosion, you can add some reducing agent to remove the oxygen in the solution to slow down the corrosion; for hydrogen sulfide corrosion, you need to add a desulfurizer or a corrosion inhibitor for hydrogen sulfide corrosion; for bacterial corrosion, you can add a bactericide to inhibit corrosion. In short, different corrosion inhibitors should be selected for different gathering and transportation system corrosion.

4. Conclusion

Recognizing the characteristics and causes of corrosion of pipelines and equipment in the gathering and transportation system during the production process, and taking appropriate measures to prevent them, can prevent serious corrosion damage in the gathering and transportation system, extend the service life of pipelines, tools and equipment, and avoid corrosion Accidents such as breakage and leakage can prolong the service life of the pipe string and ensure the integrity of the station and pipeline. This is of great significance for the construction of green mines and economic and efficient development of oil fields.

Acknowledgements

Funded project: "Comprehensive Prevention and Control of Corrosion of Oilfield Gathering Pipelines", a scientific and technological project project of PetroChina Exploration and Production Branch Technical Research",kt2020-14-03-05.

ISSN: 2664-9640

References

[1] M. B. Kermany, L. M. Smith. CO_2 Corrosion Control in Oil and Gas Production--Design Considerations [M]. Beijing: Petroleum Industry Press, 2002.
[2] Zhang Xueyuan, Di Chao, Lei Liangcai. Carbon dioxide corrosion and control [M]. Beijing: Chemical Industry Press, 2000.
[3] Lin Guanfa, Bai Zhenquan, Zhao Xinwei, et al. The influence of temperature on the morphology of carbon dioxide corrosion product film[J]. Acta Petrolei Sinica, 2004, 25(3), 101-105.
[4] Lin Yongxue, Chen Lei, Wang Lizhi. Preliminary study on anti-corrosion technology of tubing in CO_2 corrosive environment[J]. Petroleum Drilling Technology, 1999, 27(3), 34-36.
[5] Tan Shihai, Zhang Wenzheng, Shi Jie. Corrosion mechanism and prevention of CO_2 production wells [J]. Petroleum Drilling and Production Technology, 2001, 23 (4), 72-75.
[6] Li Bo. Application research on internal corrosion and corrosion protection technology of gathering pipelines in Zhongyuan Oilfield[J]. Inner Mongolia Petrochemical Industry, 2005, 08: 170-161.
[7] Liu Bin, Qi Gongtai, Yao Jiexin, Guo Xingpeng. Cause analysis of corrosion perforation of Q235 water intake pipe[J]. Corrosion Science and Protection Technology, 2006, 18 (2) 141-143.
[8] Ma Lihua. Two new types of oil pipeline anti-corrosion technology experiments [J]. Oil and gas field surface engineering, 2015 (5) 16-17.

[Profile of the author]: Ma Feng, senior engineer, bachelor degree, graduated from Southwest Petroleum University with a major in applied chemistry, CO_2 flooding and storage laboratory of Jilin Oilfield Petroleum Engineering Research Institute, mainly engaged in oilfield corrosion protection technology research. Contact number 0438-6336175; E-mail: ma-feng@ petrochina.com.cn, Address: No. 618, Changning North Street, Ningjiang District, Songyuan City, Jilin Province, 138000;