Специфика борьбы с коррозией под изоляцией на предприятиях нефтяной отрасли Вьетнама

Specificity of Corrosion Control Under Insulation in Vietnam Oil Industry

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Аннотация: Коррозия под изоляцией является наиболее распространенной в нефтехимической промышленности. Если коррозия вовремя не обнаружена, это может привести к серьезным утечкам или взрывам, повреждению оборудования и длительным простоям из-за ремонта или замены. Таким образом, точное обнаружение участков, подверженных риску коррозии, предложение защитных мер, строительство и управление мерами защиты металла от коррозии под изоляцией; содействие предотвращению повреждений во времени, сокращение расходов на техническое обслуживание и ремонт, помогает предприятию стабильно, эффективно и безопасно функционировать; повышать экономическую эффективность, обеспечивать целостность нефтегазовых проектов во время эксплуатации. В статье рассматриваются проблемы с коррозией на предприятиях нефтегазового сектора Вьетнама.

Ключевые слова: коррозия под изоляцией, термография, импульсный вихревой ток, система управления коррозией, коррозионная инженерия

Abstract: Corrosion Under Insulation (CUI) is the most popular in the petrochemical industry. If not detected, the CUI could lead to serious leaks or explosions, equipment damage, and extended downtime due to repair or replacement. Therefore, accurately detecting the sites at risk of corrosion, proposing protective measures, constructing and guiding the management of metal corrosion protection measures under the insulation; help prevent damage in time, reduce maintenance and repair costs, help the plant operate stably, effectively and safely; improve economic efficiency, ensure integrity of oil and gas projects during operation. The article deals with the problems with corrosion at the enterprises of the oil and gas sector of Vietnam.

Keywords: Corrosion under insulation, Thermography, Pulsed Eddy Current, Corrosion management system, Corrosion engineering.

INTRODUCTION

According to the Vietnam Petroleum Institute (VPI), corrosion under insulation (CUI) is the most difficult corrosion to detect in the oil and gas industry (more than 40% of pipes and equipment are destroyed due to corrosion under insulation). Methods for detecting corrosion under insulation include the thermographic method (indirect) and the pulsed eddy current method, the visual inspection method (direct). Each method has its own advantages and disadvantages.

Vietnam is one of the countries in the region with high humidity, which accelerates the process of metal corrosion. To reduce corrosion of metal under insulation, it is necessary to apply measures to protect the metal from corrosion, such as: replacement of the corroded section of the pipe, coatings and insulating coatings. In particular, the CMP Fibalite method of corrosion protection under insulation is highly valued and effective today.

Next comes the construction of a corrosion management system that contributes to increasing equipment life, maintaining its continuous operation and minimizing management costs, maintenance and repair of equipment in the oil and gas processing industry. The corrosion management system for equipment works includes two main components: corrosion management (CM) and corrosion engineering (CE) [4]. Corrosion monitoring engineering includes in-line (in-line), online (online) and offline (offline) [5]. The choice of corrosion monitoring method depends on many factors: the composition and properties of the tissue substance, temperature, pressure and technical characteristics of the equipment ... The in-line monitoring device is installed directly in the controlled position and then removed for periodic analysis. For online monitoring, tracking devices are used that are fixed or removable from a monitored position (such as sensors for measuring resistance, polarization resistance meters, ultrasonic probes...). Offline monitoring is designed to determine the extent of the damage and often uses non-destructive testing (non-destructive — NDT) methods such as visual inspection, ultrasound... Corrosion protection measures in current oil and gas projects, in principle, are still based on traditional methods: inhibitors, electrochemical protection and coatings.

In a survey of some oil and gas refineries in Vietnam, it was found that these enterprises have established corrosion management systems; however, they focused only on the types of corrosion, corrosion protection measures, and did not pay attention to the management of corrosion protection measures, so the operational results of this system were not as effective as expected and may present more significant risks. In this article, provide specific examples of instructions for the construction and management of corrosion protection systems using coatings.

CORROSION UNDER INSULATION

According to the Vietnam Petroleum Institute (VPI), corrosion under insulation (CUI) is a form of severe damage (difficult to monitor and control) in the oil and gas industry. According to statistics, more than 40% of pipes and equipment are destroyed due to metal corrosion under insulation (Fig. 1).

Fig.1. CUI in insulated carbon steel tube

The main reason for this phenomenon is the presence of water and water vapor on the metal surface. The use of an outer aluminum sheath serves to protect the insulation, keep the insulation dry and insulate it from damp environments. However, during operation, over time, as a result of changes in ambient temperature and the influence of external forces, the seal decreases or ages, destroying the crust and insulation so that water can seep inside [1]. In the wet position, a metal surface in contact with water containing dissolved oxygen or other corrosive substance is corroded by an electrochemical mechanism (Fig. 2).

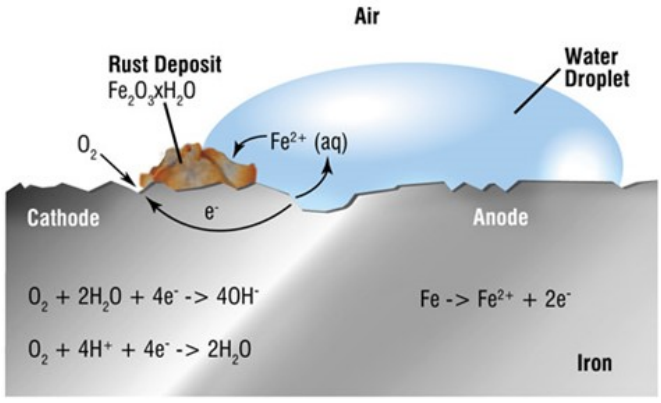

Fig.2. Corrosion reaction of metals in the presence of water and moisture

METHODS FOR DETECTING CORROSION UNDER INSULATION

There are many methods for testing corrosion of metals under insulation, such as the indirect moisture method, which is an infrared thermography (IR thermography). There are also methods for directly assessing the level of corrosion under insulation, determining the reduction in pipe wall thickness and equipment such as: pulsed eddy current (PEC), visual inspection (VT).

infrared thermography (IR thermography)

Thermography is widely used in the oil and gas industry to identify potential problems that the human eye simply cannot detect.

Thermography is a type of camera that uses sensors to take photographs. Infrared cameras use infrared beams that operate in the 9000–14000 m (9–14 μm) wavelength range. These infrared rays are able to detect changes in temperature, light. When encountering objects of different temperatures, the resulting reflected infrared waves amplify the light. The thermal signal through the sensory device forms an image [2].

An infrared camera (IR camera) allows you to shoot distant objects or objects that cannot measure their temperature directly. There are two main types of infrared cameras: cooled and uncooled.

The cooled camera consists of an image sensor (or detector), electronics for interfacing and onboard imaging, an optional zoom lens, and a cryocooler . They typically operate in the mid-infrared (3–5 microns) wavelengths (MWIR), but can be

designed to provide imaging in the long-wave infrared (LWIR) spectrum. It mainly operates in the range of 60-100 0 K, providing higher image quality, but high cost, consuming a lot of energy and cooling time.

An uncooled chamber does not use a cryogenically cooled detector. The design of the detector is based on a microbolometer , a tiny silicon element resistor with a large surface area, low heat capacity, and good thermal insulation. These uncooled bolometer-based sensors are typically designed to operate in the long-wavelength infrared (LWIR) range (7–14 μm). This allows these systems to better penetrate poor environmental conditions such as dust, fog and smoke. These sensors are cheaper to manufacture and also consume less power. Lower image quality and resolution.

The use of an infrared camera is an intuitive method to prevent potentially corrosive areas. In the position of defects in insulation, moisture condensation, heat transfer coefficient of dry insulation and moisture insulation are different, resulting in a difference in temperature

and is detected by an infrared camera image. An image of corroded pipes under insulation taken from an infrared temperature chamber is shown in Figure 3, where white bright areas indicate the presence of water [1].

The advantage of the infrared camera is that it can check while the device is running, and can quickly check a large area, no additional processing is required ... However, this device also has the disadvantage of material inhomogeneity, which leads to different heat reflection , affects high accuracy, may depend on the sources of thermal radiation of the environment [1-2].

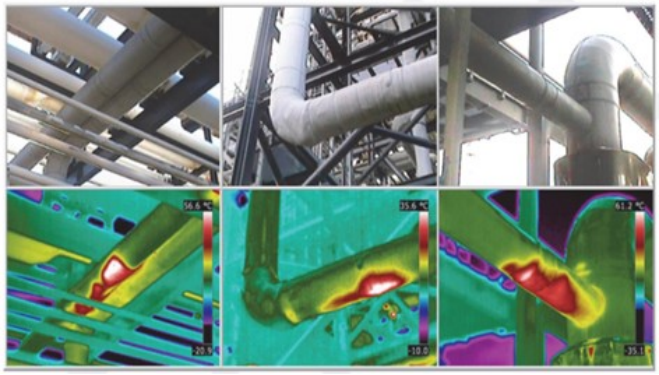

Fig.3. Image of corroded pipes under insulation taken from IR cameras [2]

Pulsed eddy current (PEC)

The pulsed eddy current (PEC) method uses repetitive short wavelength pulses instead of a simple frequency sinusoidal pulsed signal. Since the penetration is frequency dependent, the diffusion of the radiated pulsed current covers the entire thickness of the tube wall. A high frequency pulse will penetrate less than a low one. Penetration also depends on time. When intermittent positions occur, the pulse will be interrupted and displayed on the device at the time of interruption. From here, defects are detected on the surface and in the equipment case, as well as in insulated pipes [1-3].

Eddy current method is not required to remove insulation, used in a wide temperature range -110 0 C–550 0 C , but difficult to detect pitting corrosion, do not use for galvanized or aluminum coated steel.

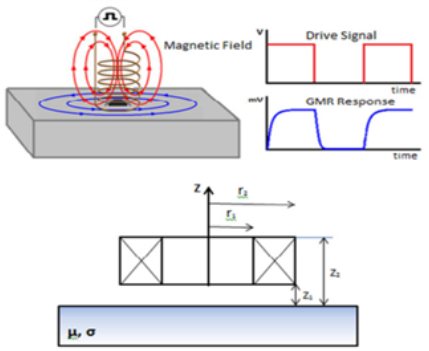

Fig.4. The principle of operation of the pulse method eddy current (PEC) [3]

Visual Inspection (VT)

Visual inspection is the easiest method to check for corrosion of metal under insulation. The method requires only the removal of insulation and a visual inspection of the condition of the surface of the pipe or insulation equipment. The visual inspection method can be divided into two types: partial removal of insulation or complete removal of insulation.

Fig.5. visual test method for corrosion under insulation

Only in this way can 100% corrosion damage to the outer surface be detected. However, the disadvantage is the high cost of implementation, due to the need to remove and reinstall the insulating layer (especially in the place where it is necessary to install building structures ...), which can affect the technological mode when removing insulation during the operation of the pipeline.

CORROSION PROTECTION MEASURES FOR METAL UNDER INSULATION

In Vietnam, metal corrosion under insulation is usually dealt with by metal compensation or replacement of the corroded section of pipe, surface treatment, coating and insulation. Insulation materials are mainly selected from fiberglass, less water permeable, chloride-free, durable AM coating. Check the location of the insulation for deformation, signs of damage or discoloration, signs of peeling/aging... in order to solve the problem as soon as possible. In fact, the corrugated iron shell is thin, difficult to process, install, easy to distort by mechanical impact; The sealing material is usually a flexible silicone sealant that can withstand high temperatures, but over time it is subject to aging, loss of adhesion and peeling...

To effectively resist corrosion under the insulating layer, VPI recommends solutions to completely isolate metals from the environment: the use of paint with high corrosion resistance on metal surfaces; replacement of the insulating material with a high-strength one; tightness to prevent water and moisture from the environment from entering the insulating layer. In which VPI introduced a CMP Fibalite under-insulated anti-corrosion solution using alucemp anti-corrosion coating (simple surface treatment; solvent-free paint, adhesion and durability, and corrosion protection at temperatures above

260 0 C); suitable insulating installation, insulating cover based on fibalite composite (reinforced with glass fiber FE, cured by sunlight, high strength, easy to apply, install, repair, does not require the use of sealants ...). Thanks to By applying this solution, the building has a long service life (15 years and 10 years warranty), effectively isolate the metal from the environment, helping to reduce the cost of surface treatment, construction and inspection, periodic maintenance and repair; increasing economic efficiency, ensuring the integrity of oil and gas installations during operation.

Management Guide for the Use of Corrosion Resistant Metal Under Insulation Protective Coatings

Coating is the primary corrosion protection solution often used for corrosion protection in seawater and oil and gas processing plants. Most coatings used as thin layers of organic resin materials contain inorganic colored substrates and organic solvents. Typically, the coating consists of three layers: a substrate to suppress corrosion, a second layer increases the thickness, and a top layer creates a sensory shell. Some coatings do not contain the solvents used in the form of a mist or " trowel ", which are widely used for internal corrosion protection. The thickness of the coating will be greater and usually only 1-2 coats. This type of coating is used in high temperature conditions. In the past, carbon coatings and fibrous bitumen have been used in pipes; currently, multi-layer paints, epoxy and plastic layers are used [6].

Some causes lead to damage to the coating, such as: water penetration through the paint film (due to osmosis), causing rust and paint rupture; UV rays in sunlight damage the organic plastic layer; solvents and chemicals will damage the coating. Thus, when using a coating, it is necessary to prepare the surface well before painting, this will help remove impurities and improve the quality of paint adhesion; design should avoid sharp edges or rough surfaces and hard to reach positions.

In addition, touch top coatings also play an important role in protecting the metal surface. Coatings can also be used in combination with cathodic protection. In this case, slight flaking is acceptable, but requires the use of a paint with a higher pH on the cathode area. Several thick coatings are used for fire protection [4-6] .

Policy and strategy

Maintenance costs for external coatings are relatively high, so an optimal measure of the quality of the initial coating and the cost of maintaining the coating in the future is required. coating maintenance method: maintenance based on the results of coating inspection and coating condition inspection ; develop a maintenance plan based on the study and prediction of the ability of the coating to peel; monitor the condition of the metal surface, then cure the coating only when the weight loss value approaches the allowable limit; repair, replace the equipment when the weight loss value has exceeded the limit and maintenance of the coating is not required.

When applying maintenance measures for coatings, take into account the stringent requirements for surface preparation and coating when choosing methods and materials; damage and envi-

ronmental pollution at the plant; difficulties when working in high temperature environments, risk of fire and explosion. Typically, if interior areas are difficult to access or submerged, long life coatings are often used and rarely need to be replaced. Surface preparation and coating application must be strictly controlled: cleanliness of the metal surface; coating film thickness; temperature and humidity conditions.

Organization

Related job subjects: specialist in corrosion and materials; supplier of coating materials; the contractor plans maintenance in the field of coating; equipment maintenance group; corrosion engineer; coating control technician . The information is needed to raise awareness of the factors affecting the destruction of coatings and the importance of implementing maintenance measures for coatings.

Corrosion risk assessment and implementation plan preparation

The coating corrosion control plan is based on: performance targets, usually in terms of the coating's ability to peel; the subsequent conduct of a sensory survey and a cycle of surveys; corrective actions in case of non-compliance; the organization's responsibility for monitoring, controlling and protecting against corrosion.

When developing a detailed implementation plan, it is necessary to complete: a risk-based coating maintenance program; a program of scheduled maintenance of the coating; corrosion control and monitoring services, including assignment of responsibility, coordination, process and scope of work.

Implementation and analysis

Maintenance and inspection of the coating must be carried out as planned. Collected data, including time and coverage, combined with a coating condition study to assess the degree of peeling of the coating. Data analysis is carried out in two stages: (1) analysis of the condition of the coating in relation to the target, determining the need for planning maintenance work on the coating and preventing corrosion; (2) analysis of all data normally performed by a corrosion engineer, ensuring that the goals set in the strategic plan are achieved, assessing the risk of corrosion and planning for the implementation of improvements, updating accordingly.

Track and check progress

Proactive metrics include: completeness of coating maintenance compared to plan; the number of failures exceeds the destruction limit; the completeness of the coating survey compared to the plan. Exposure indicators include coating failure earlier than expected service life.

Check work efficiency

Regularly review the results of corrosion monitoring, corrosion testing and corrosion protection measures and, if necessary, take corrective actions. Review of implementation measures, especially assessments of impact indicators and overall trends in initiative indicators. Analysis of the root causes of coating damage, using appropriate corrective measures. Make appropriate changes and improvements.

CONCLUSIONS

Metal under insulation corrosion is a form of localized corrosion that is difficult to detect, control and control, and can occur on operating equipment, shut down completely or temporarily. In order to increase economic and technical efficiency, plants often use a combination of methods for detecting the corrosive effects of metals in the insulating layer; identify and classify pipe and equipment types at high to low risk of corrosion, then periodically program metal under insulation corrosion testing for each pipe and equipment, with priority testing for major failures and selecting the most efficient and cost-effective testing methods.

A corrosion management system that is tailored to the nature of the oil and gas planta can operate at various managerial and technical levels within an organization. The degree of diversity and complexity of the system depends on the size of the enterprise, the number of employees, the roles and responsibilities of managers, engineers, technicians and contractors.

When the corrosion protection management system is regularly monitored and updated, in conjunction with plant management and the contractor helping the corrosion management system to achieve maximum efficiency, safety during the operation of the plant is improved.

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