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ANALYSIS OF MODERN ELECTROCHEMICAL PROTECTION DESIGN SYSTEMS

Abstract: Proceeding from the task of raising the level of training of energy specialists who deal with the design and development of electrochemical corrosion protection technologies, the need to familiarize with the systems of complex design and calculation of electrochemical protection of equipment logically follows [1,2].

Key words: corrosion is electrochemical, electrochemical protection systems, design systems.

Анотація: Виходячи із завдання підвищення рівня підготовки енергетиків, які займаються проектуванням і розробкою технологій електрохімічного захисту від корозії, логічно випливає необхідність ознайомлення із системами комплексного проектування та розрахунку електрохімічного захисту обладнання.

Ключові слова: корозія електрохімічна, системи електрохімічного захисту, системи проєктування

Presenting main material. Metal structures operated in various environments (in the atmosphere, water, soil) are exposed to the damaging effects of this environment. The destruction of a metal due to its interaction with the external environment is called corrosion. The essence of the corrosion process is the removal of atoms from the metal lattice, which can occur in two ways, so corrosion can be chemical and electrochemical.

Corrosion is electrochemical if, upon leaving the metal lattice, a positively charged metal ion, i.e. cation, enters into contact not with the oxidizing agent, but with other components of the corrosive environment, while the oxidizing agent is given electrons that are released during the formation of the cation. In electrochemical corrosion, the removal of atoms from a metal lattice is carried out as a result of not one, as in chemical corrosion, but two independent, but interconnected, electrochemical processes: anodic (transition of “captured” metal cations into solution) and cathodic (binding by the oxidizer of released electrons).

Oxidizing agents are hydrogen ions, which are everywhere where water is present, and oxygen molecules. Electrochemical corrosion is accompanied by the appearance of an electric current.

Two types of factors influence the rate of corrosion processes

- internal and external.

Internal factors affecting the rate of corrosion are determined by the type of metal and its condition. The internal factors of electrochemical corrosion of metals include: the nature of the metal, the condition of its surface, the crystal structure and the presence of structural defects, the presence of stresses, etc.

External factors affecting the rate of corrosion of metals are determined by the nature and properties of the corrosion environment and its parameters. External factors of electrochemical corrosion of metals include: activity of hydrogen ions (pH), composition and concentration of solutions, electrolyte movement speed, temperature, pressure, contact with other metals, external and stray currents, ultrasound, irradiation, etc.

A feature of most corrosion processes is that the stages of oxidation and reduction occur in different places of the metal. This is possible because metals are considered conductive, so electrons can flow through the metal from the anodic to the cathodic regions. The presence of water is necessary for the transfer of ions to and from the metal, but a thin film of adsorbed moisture may be sufficient.

Which parts of the metal serve as anodes and cathodes can depend on many factors, as can be seen from commonly observed non-uniform corrosion patterns. Atoms in stressed areas, which can be obtained by molding or machining, often have higher free energy and thus tend to become anodic.

In contrast to the anodic regions, which are usually localized in certain areas of the surface, the cathodic part of the process can occur almost anywhere. Because metal oxides are typically semiconductors, most oxide coatings do not interfere with the flow of electrons to the surface, so almost any area that is exposed to O_2 or some other electron acceptor can act as a cathode.

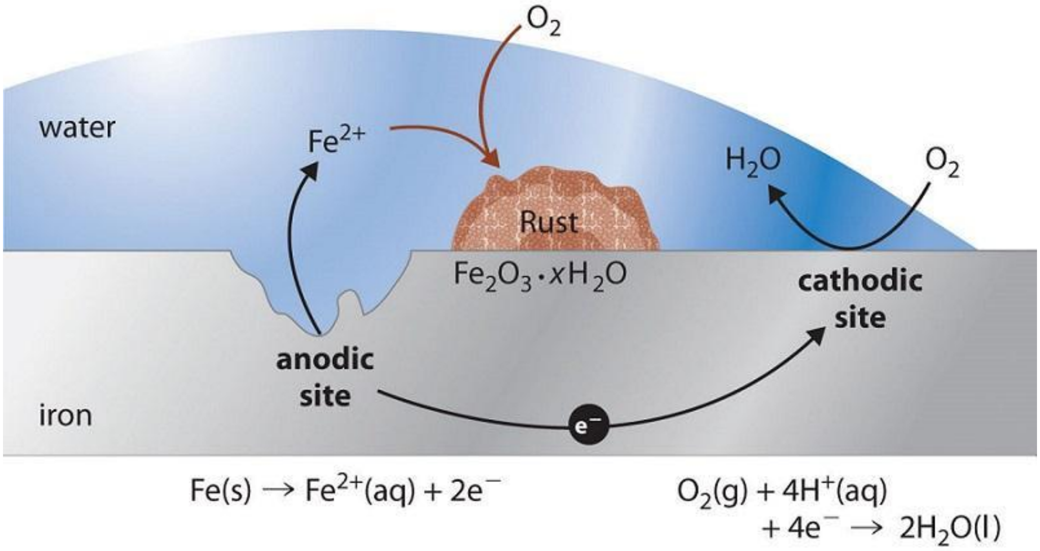

Fig. 1. Schematic diagram of corrosion cells on iron

The tendency for oxygen-deprived sites to anodize is the cause of many widely observed corrosion patterns. O_2 or some other electron acceptor can act as the cathode. The tendency for oxygen-deprived sites to anodize is the cause of many widely observed corrosion patterns [3].

If one part of a metal object is protected from the atmosphere so that there is not enough O_2 to create or maintain an oxide film, this "protected" area will often be where corrosion is most active. The fact that such places are usually hidden from view explains much of the difficulty in detecting and controlling corrosion.

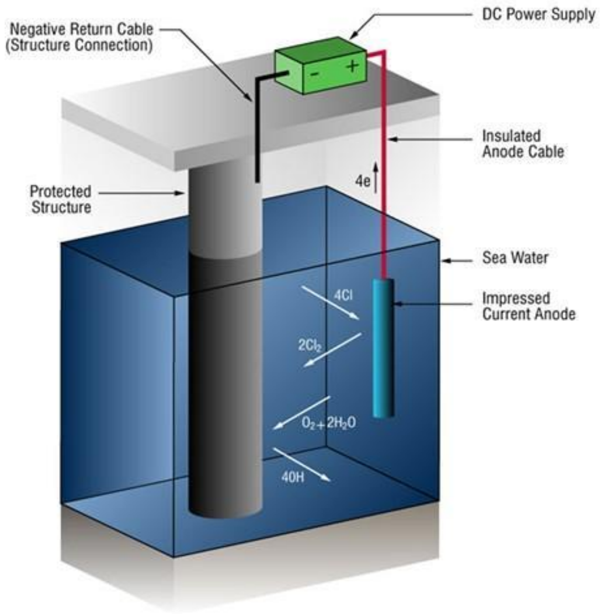

Fig. 2. Installation of cathodic protection

To reduce the rate of electrochemical corrosion, electrochemical protection (ECP) is called upon, which consists in cathodic or anodic polarization of a metal structure. Cathodic protection by external current is carried out using direct current from an external source: the protected metal is connected to the negative pole (cathode), and an additional electrode (grounding) polarized anode is connected to the positive pole. With tread protection, the structure is connected to a metal that has a more negative potential. In practice, cathodic protection is widely used [4].

Determining the corrosion state (diagnosis) of metal structures is important to ensure their reliable operation and timely prevention of emergency situations. At each current moment of time, the corrosion state of a metal structure can be determined by the corrosion effect. Corrosion effect is a set of indicators characterizing corrosion processes and their intensity.

At the same time, the complexity of solving these problems is complicated by the fact that the intensity of corrosion damage and the condition of the pipeline depends on a number of factors, including corrosion activity, soil characteristics at the installation site, the depth of the pipeline section at the intersections with power lines and transport infrastructure facilities (sources of stray currents), the quality of the insulating coating, the performance of protection installations, etc.

The complete integrated automation of the electrochemical protection (EChP) system is one of the most important areas for improving the durability and reliability of the pipeline system. Calculations can be significantly simplified, and design time reduced, by using software modules with a set of calculation formulas, technical reference documentation, databases of products and equipment, convenient input and output interfaces.

Often faced with the problem of choosing one or another computer-aided design system, because the right choice is a reliable condition for its effective use.

Modern automated electrochemical protection systems solve the task of monitoring protection parameters and their automatic regulation at cathodic protection stations, a large amount of data on changes in the corrosion state of protected objects is accumulated. The implementation of such systems potentially allows solving such problems as:

- control and management of operating modes of electrochemical protection means;
- control of corrosion processes in explosive zones; provision of emergency signaling in case of failure of elements and means of protection, as well as their power supply systems;
- analysis of the corrosion condition of equipment and structures.

Elsyca CPMaster is a revolutionary 3D software for cathodic protection design and optimization of complex structures: buried tanks, offshore platforms, ship hulls, etc. Elsyca CPMaster provides the corrosion engineer with an intelligent tool to manage operating costs, significantly reducing costly commissioning surveys. maintenance and costly repairs while making environmental benefits.

Elsyca CPMaster results include all data of interest to a corrosion engineer, such as potentials between structure and soil and current density distribution. This allows you to directly determine the levels of local protection in many practical situations [5].

The SESCPCalculator is a fast new tool that performs calculations to evaluate the appropriate cathodic protection design for specific target designs to be protected from corrosion. SESCPCalculator automatically analyzes the system to be protected and provides corrosion protection calculations according to various standards. The SESCPCalculator provides two simple calculators to evaluate the corresponding ICCP (Current Corrosion Protection) and GACP (SACP) (Galvanic/Sacrificial Anode Corrosion Protection), respectively, onshore and offshore [6].

Conclusions: Thus, the use of innovative technologies that enable the application of electrochemical corrosion protection design systems will allow future power engineers to evaluate adequate cathodic protection designs for specific target structures that require corrosion protection.

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