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EVENTS OF CORROSION OF MAIN PIPES AND METHODS OF THEIR PROTECTION

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Abstract

the article describes the classification of events with its destruction during the period of exploitation of the main pipelines, the impact of the environment due to the method of laying pipes, as well as methods of protection against corrosion meeting.

Keywords: corrosion, pipe, coating, anak, cathode, insulation, electrolyte.

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Introduction

External corrosion of main pipeline networks occurs in three phases of the metal coating-electrolyte boundary. According to traditional approaches, it is accepted to consider decay according to the following classification:

1. According to the nature of decay, decay is classified into two types: chemical and electrochemical.

Chemical corrosion is an involuntary oxidation of the metal of pipelines under the influence of the surrounding non-conductive environment. As a result of this process, corrosion products appear on the section of the metal surface exposed to corrosion. Chemical decay is classified into the following types: gaseous decay and decay in non-electrolytes.

Electrochemical corrosion is the corrosion of the metal of pipelines with the formation of an electric current in the electrolyte. It is classified according to the following types: soil corrosion, electrocorrosion, atmospheric corrosion, liquid corrosion, biocorrosion, contact corrosion and stress cracking.

2. According to the nature of the spread, decay is divided into continuous and local types. On the other hand, continuous decay is uniform and non-uniform. Localized (or limited) erosion pitted, point (or pitting), speckled, subsurface, intercrystalline, intracrystalline, structure-selective, as well as formed after mechanical action (i.e. erosion crack after departure) will be corrosive.

The following types of collapse events are distinguished for main pipeline networks:

1. Pitting electrocorrosion in the zone where stray currents move, in which the melting of the metal is determined by Faraday's law and is 9 kg/A per year in the first approximation for iron. It develops in the zones where the gas pipeline networks have been transferred, in the industrial regions where there are a lot of high-capacity structures that create the transition of currents to the ground.

2. Decay in the zones of alternating signs of stray currents differs from the first type of decay in that it is in the anode zone of gas pipeline networks for a short time and cathodic reactions occur in the same non-insulated sections of gas pipeline networks.

3. Powerful macrocorrosive elements in the anode zone, for example, pitting corrosion in the anode zone of differential aeration. Continuity defects in the insulation are considered extremely dangerous when the macro vapors fall in contact with the anode zones, especially when the defects are in the bottom cover of the pipes. It develops in soil layers with relatively low electrical resistance (up to 20 Ohm*m). The maximum rate of erosion can reach 4-5 mm per year. As shown in the same rule, in the southern climatic zones, in soils with a high concentration of mineral salts, it will have a greater distribution.

4. Decay at the level of fluctuations of the underground water level or in the zones of periodic flooding of gas pipeline networks. In this case, a chain of cavities (caverns) is formed, which gradually merges in the longitudinal direction along the level of the underground water level, and over time, they cover the steel wall of the pipe with the waterline (sinking line). allegedly "cuts" at the level.

They are also formed in the case of polymer film insulation. If the water level oscillates around the bottom container, then multilayer products of corrosion in the form of a "layered cake" up to 4-5 cm thick appear under the insulation. They can be extended to large distances of 20-40 m. The maximum rate of erosion reaches 4 mm per year.

5. Stress corrosion (SCC) is a conventional name for cracking under stress, which is manifested in the form of a colony of longitudinal cracks at the bottom of the pipe, as a rule, they grow later and lead to the rupture of the pipe. the head joins to the crack.

6. Pit rot under the film occurs in stratified zones of insulation, as a rule, in zones with heavy clay soil. The observed rate of erosion is 1.0-1.2 mm per year.

7. Decay of vertical metal structures at the place of their exit from the ground to the surface during the day. It develops at the boundaries of air insulation in the accumulation zones of atmospheric moisture. It is more typical for underground communications (connecting elements) of industrial sites. The maximum rate of erosion is 1.0-1.5 mm per year.

As a rule, the failure of pipeline networks is observed in several types of corrosion damage in the stretched section, which requires the use of protective measures as a whole.

Underground, insulated metal pipeline networks have small connections (contacts) with moisture in the soil through the lack of condensation in the insulation layer. Soil moisture provides an electrolyte of different composition and concentration. The contact of the metal with the soil electrolyte leads to the formation of corrosive elements.

If there are sections with different electric potentials on the surface of the metal immersed in the electrolyte and they are connected by the metal mass, then the current flows from the higher potential to the lower potential in the external circuit connected by the electrolyte. The area with a high potential is the anode, and the area with a low potential is the cathode.

Anodic and cathodic sections on the metal surface of pipe networks can appear when there is some inhomogeneity in the electrochemical potential of the surface. This inhomogeneity is the reason for the appearance of corrosive elements (corrosive vapors) that lead to local corrosion of the metal surface. Non-homogeneity of the metal structure, intrusions into the steel structure, uneven distribution of deformed zones, local stresses, non-uniformity of the quality of the protective insulating layer or defects in it, and non-homogeneity of electrochemical potentials are considered to be the reasons.

When assessing the level of erosive activity of the earth's layers, the electrical conductivity of the soil is taken as such an indicator. Table 1 shows the erosive activity of soils depending on their relative electrical resistance. Table 1 Soils depending on their relative electrical resistance scavenging activity

Specific electricity of soils resistance, om*m	100 from more than	100-20	20-10	10-5	5 from less
Erodibility of soils activity level	Low	Medium	Enhanced High	High Ultra	Medium Enhanced High Ultra

A generalized method of protecting main oil and gas pipelines and gas networks from soil corrosion is insulation coating and cathodic polarization. Due to the fact that the insulation coating has certain defects, it is not able to protect the pipe one hundred percent from corrosion. These defects (holes, cracks) are formed during the process of coating and laying the pipe in the ditch. In addition, during the use of pipes, as a result of wear of the coating and other mechanical effects, the old defects in the coating become larger, and additional new ("hole") defects are formed. Cathodic polarization negatively polarizes the pipe surface with coating defects, stopping the anode process from occurring. Cathodic protection of pipes is carried out through a source (cathode station) that converts alternating current into direct current (Fig.

1). For protection, the negative pole of the cathode station is connected to the pipe, and the positive pole is connected to the grounded anode. As a result, a closed circuit is formed, and the current flows from the station to the anode connected to the ground and spreads through it to the ground. The currents passed to the ground come to the protected pipe, and in the places where the insulation coating is defective (open, hole), it carries out the cathodic polarization process. As a result, the tube becomes negatively charged and becomes a cathode (polarized like a cathode). The potential value of the pipe (on the copper sulfate electrode) shifts to the negative side. At a certain indicator of the generated potential, the degree of protection of the pipe against corrosion is one hundred percent. The value of the potential corresponding to this level is called the protection potential.

The effectiveness of the cathodic protection is evaluated by the indicators of the distribution of the potentials that created it along the length of the pipe (L) (Fig. 1). According to the accepted standard (GOST 25812 - 13), the acceptable maximum value of the protection potential is Exim.max= -1.1(-1.25)V, the minimum value is Exim. min= equal to -0.85(-0.95)V. If the indicators of the potentials given in the protection length (L) of the cathode station are kept, the pipe will be protected against corrosion one hundred percent.

Etab. potential value, depending on the diameter of the pipe, is from minus 0.23 to minus 0.72. In practical calculations, its average value is taken as minus 0.55 V. In that case, the indicators of the protective potentials created in the pipe through the cathode stations will be as follows:

$E_{min}= E_{xim\ min} - E_{tab}$ = -0,85 V - (-0,55 V) = -0,3 V$E_{max} = E_{xim\ max} - E_{tab}$ = -1,1 V - (-0,55 V) = -0,55 V.

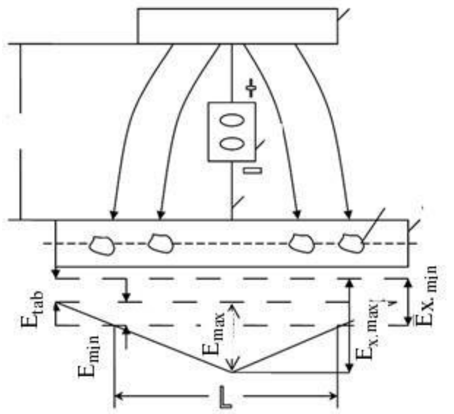
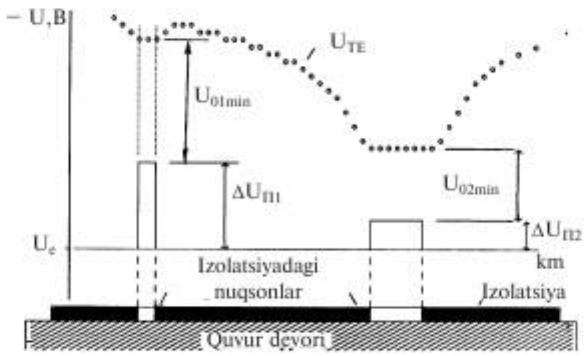


Figure 1. General drawing of cathode protection and distribution of its protection potentials along the length of the pipe: 1 - pipe; 2 - connecting cable; 3 - cathode station; 4 - anode connected to the ground; 5 - coating defects; Etab - natural potential of the pipe; Emax, Emin - respectively, maximum and minimum generated potentials; Ex.max, Ex.min - maximum and minimum protection potentials, respectively; L - protection length of the cathode station; U is the distance between the pipe and the grounded anode.

If the potential value of Exim max in the pipe is increased, the protection length of the cathode station increases. However, when its value is increased, heating occurs at the place where the cathode station is connected to the pipe, and the viscosity and integrity of the insulation coating deteriorates. This, in turn, leads to the occurrence of corrosion processes (under the influence of electrolytes).

The method of protecting underground metal structures from an external source of electric current by applying an electric field that creates cathodic polarization in the structures is called cathodic protection.



In cathodic protection, the anode, which is electrically connected to the structure to be protected, made of metallic or non-metallic conductive materials, is subject to corrosion.

Figure 2. Distribution scheme of potentials on the surface of pipe networks with defects in insulation.

Protection of pipe networks from corrosion is carried out in a complex way: insulating coatings and cathodic polarization. In practice, the insulation is not considered to be completely intact (continuous), but has a certain number of defects that differ in surface and shape. Cathodic protection has the function of braking the corrosion process on the exposed surface of the pipe network with continuous (holistic) defects (Fig. 3).

Thus, cathodic protection of the underground pipeline network is caused by creating a protective potential difference between the pipeline network and the soil layer surrounding it. In this case, the network of pipes is considered to be a cathode in relation to the soil layer surrounding it.

Creating a protective potential difference between pipeline networks and the soil layer is carried out using a direct current source. The negative pole of the current source is connected to the pipe network, and the positive pole is connected to the ground, where the ground is considered as the anode.

The principle scheme of cathodic electroprotection is presented in Fig. 3. The cathode device consists of 2 cathode stations, 3 ground connections, connecting wires and 4 control-measuring columns.

Applying an external electric field to pipelines, which creates a cathode potential on the surface of the pipeline, can ensure complete protection of the pipeline network. The value of the potential applied to the pipeline network, measured with respect to the ground with the help of a non-polarizing electrode, serves as a protection criterion (criterion).

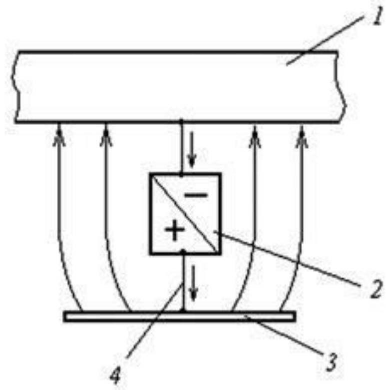


Figure 3. The principle scheme of protection with a cathode device: 1 - network of gas pipelines to be protected, 2 - cathode station, 3 - anode connection to the ground, 4 - connecting wire.

Cathodic protection is one of the options for electrochemical protection against corrosion of metal structures, including oil and gas pipeline networks. It is effective in decaying media with good ionic electrical conductivity and is based on the dependence of the rate of decay processes on the value of the electrode potential.

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