Financial losses of electric power industry, caused by corrosion wear designs lighting poles

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Abstract. Today, the total length of overhead power lines is very high. Supports for power lines and lighting lines exposed to corrosive wear. In this regard, the electricity sector is suffering huge economic losses. The article deals with the problem of the durability of the lighting line supports, reduce the economic costs of maintaining them. Are some of the results of experimental studies.

The known methods for measuring the depth of corrosion on the power lines and light lines, as well as full-scale study designs. It is noted that during the survey revealed the specifics of building structures, which limits the possibility of restoring the protective coating in the field, which affects the financial costs. The methods of predicting the losses from corrosion, data observations. The contribution of corrosion losses in the increased likelihood of component failure and financial loss.

1. Introduction

Economic losses are enormous corrosion metals. In the US, according to the latest NACE corrosion damage and the cost of fighting it amounted to 3.1% of GDP (276 billion $). In Germany, the losses amounted to 2.8% of GDP. According to experts of various countries, these losses in industrialized countries ranges from 2 to 4% of the gross national product. In this case, the metal loss, including an array of failed metal structures lighting poles lines and power lines, products, equipment, ranging from 10 to 15% of annual steel production to the needs of the power industry.

In Russia today, the total length of electric networks with voltage of 0.4-110 kV exceeds 3 million kilometers, and transformer capacity of substations and transformer substations - 520 million kVA. The cost of fixed networks funds is about 200 billion P. And the degree of wear - 40%.

Currently, a new concept of reliability of power plants, based on the standardization of indicators of reliability of electrical networks and consumer power systems. The lack of quantitative criteria for assessing the durability of building structures as one of the grid cells, inhibits the transition from the construction of a deterministic system of norms to a probability.

Newly developed indicators of longevity should take into account the random nature of power, and environmental impacts, as well as based on operating experience. It is necessary to establish methods of predicting the durability of metal elements supports of overhead lines the results of monitoring corrosion.
losses in exploited structures; development of recommendations for the choice of means to ensure the corrosion resistance of the elements supports both the structural design stage, and assess their technical condition to reconstruct power objects.

Questions of forecasting of durability of structures exposed to corrosive wear, have been studied previously by domestic and foreign scientists [1-5]. In [6, 7] the problem of determining the durability of the relay tower, which is a 25-element spatial statically indeterminate farm.

2. Research methods corrosion lighting lines
The general trend in the development of the theory of design is to reduce costs at all stages of the creation and operation of power lines, which are used for electric power transmission and distribution wires located outdoors and fixed by means of insulators and line fittings on the supports. Conducted research on the state of metal constructions for development of design concepts, operating throughout the country. Power transmission line support experience as power load due to wind, ice, design their own weight, wires and equipment, as well as the impact of the open atmosphere, manifested in the contamination of insulators and corrosion destruction of metallic structural elements (figure 1).

Figure 1. Metal multi-element transmission tower with traces of corrosion.

Durability poles laid in the design, dependent on the selected period repeatability climatic loads and structural solutions that determine resistance structures at ambient conditions. As is known, in connection with the development of corrosion, there are cases of premature failure of bearings, disruption of normal operation of lighting lines. It is therefore important to establish the specific cause of the observed violations to, firstly, take measures to ensure the safe operation of structures; secondly, to use this information in predicting the time behavior of the structure in order to create structures that are resistant to corrosion, even at the design stage [8]. Methods of study of atmospheric corrosion are divided into three groups:

- Laboratory studies were carried out, as a rule, with samples of small size; test conditions are set in advance and strictly controlled. Produced artificial acceleration test by tightening conditions (increase in temperature, solution concentration, mixing).
- Field investigations carried out on samples in vivo corrosion in specially equipped stations. It is found that the major factor corrosiveness is uncontaminated atmospheric residence time of the wet film on the metal surface. This time is the sum of the following: the duration of rain, fog, dew, drying the metal surface after each precipitation; thaw in the winter. All of these terms depends on the humidity, temperature, wind speed and other meteorological factors. The
resulting products atmospheric corrosion metals have a protective effect, reducing the corrosion rate with time. Data on corrosion losses obtained on samples do not allow with sufficient accuracy to predict the behaviour of structures in the course of continuous operation. Necessary information can give structural survey in field conditions.

- Operational studies carried out by observation of the structural unit in terms of its actual service. Obviously, if the design data are used corrosion losses of elements which are in operation for a long time, the corrosion rate forecast based on these data will be the most reliable, and design decisions will be close to optimal.

3. Measurement of corrosive wear pylons

To date, the country operates several million metal supports of transmission lines, which may be used for the removal of information about the corrosion of metal worn from the beginning of construction of towers. The feasibility of this approach, because the construction in operation in all the geo-climatic regions of the country, their exposure period is 70 years. Over the long term there is the averaging effects of all the factors that determine the rate of corrosion elements.

Known methods for measuring the depth of penetration of the corrosion, based on the use of a caliper bracket and the indicator. Corrosion losses of these methods are determined as the difference between the design thickness and the thickness at the time of the survey. In this case, the measurement result included tolerances rolling, in addition, measurement with calipers produced by the enveloping surface i.e. excluding roughness profile caused by the corrosion, and in the measurement bracket with the indicator cannot fix the measuring axis with respect to the controlled element, which leads to errors in determining corrosion losses. Portable corrosion gage (figure 2), and the entire corrosion monitoring system (figure 3) are also used.

![Figure 2. Corrosion gage.](image1.jpg)

![Figure 3. Corrosion monitoring system.](image2.jpg)

4. Prediction of the corrosion losses

Full-scale survey of the supports, includes: collecting data on actual conditions of passage of a line of power lines and structural work, their comparison with the envisioned projects, instrumental measurement of corrosion losses, photograph and description of defects at the time of the survey.

Sites for inspection structures are selected on the basis of examination of the technical documentation of the executive. The greatest value to obtain information about the state structures are dismantled and the support sections of power lines with long life.
Forecasting is based on an approximation of the results of monitoring of corrosion losses exponential function of the form:

\[ K_n(T) = M \cdot T^n, \]  

(1)

where \( M \) and \( n \) — empirical coefficients; \( T \) — service life, the value of which is equal to: for unprotected designs - time interval from the start of construction before the planned service life; for structures having a protective coating at the time of construction - the length of time since the exhaustion of the protective properties of the coatings before the planned lifetime.

Results of the enterprise survey in the Magadan region showed that the maximum depth of corrosion damage to structures, operating 10 years, is about 35 microns. Such small corrosion losses are explained by climatic conditions of the area of operation, the duration of the frost period, which reaches 8 months. Steel corrosion hardly occurs at low values of temperature and humidity.

For the conditions of the study area, the values of the empirical coefficients: \( M = 4-7 \) microns/year; \( n = 0.6 \). The maximum value of the predicted corrosion losses in 50 years will be 50-100 microns. The technical condition of structures of power lines indicates inexpediency of measures to restore the protective coatings on the surfaces of the metal elements of support [9].

Materials inspection of electric transmission line supports atmospheric Irkutsk region yielded the following values of the empirical coefficients: \( M = 8-12 \) microns/year; \( n = 0.6 \). The climate is sharply continental examination, the duration of the winter period of 6 months. The results of monitoring of corrosion losses used to predict the durability of metal structures pylons [9].

In the course of the survey revealed the specifics of building structures, limiting the possibility of restoring the protective coating in the field. Harsh climatic conditions do not allow to carry out work on the application of coatings in the field with the implementation of technological requirements, the violation of which leads to a drastic reduction of their service life.

Recovery of protective coatings and complicated design solutions, limiting access to the working tool 10 - 60% of the surface elements. Protective coating for compounds area overlap elements in which the order of 4-6% cannot be effected without disassembling. Severe restrictions on human security recovery support. When repairing energized approximately 10% of the surface area is inaccessible.

Conclusions

Materials surveys indicate that addressing durability of metal poles of power lines must be made at the design stage taking into account the rate of corrosion of metal structures and the specific operation. Prediction of durability of these structures will help to further reduce the financial and economic costs for their maintenance, which will save a lot of money for the entire electricity sector.

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