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NEW APPROACH TO THE TECHNOLOGY OF CORROSION PROTECTION OF POWER DISTRIBUTION PLANTS AND OVERHEAD LINES

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ABSTRACT

The corrosion protection of steel constructions of power distribution plants, is an important parameter that determines their durability.
For optimal protection, apart from the correct selection of protective paint system, preparation of surface takes the important place. Modern technologies of corrosion protection contribute also novices relating to the preparation of surface. Unlikely the "classic" ways of the preparation by mechanical action, the procedure based on new chemical formulations is introduced.
This paper presents the laboratory testing results of the use of chemical means for the preparation of corroded steel surfaces.
By using the chemical means, the reaction occurs which turns the corrosion products into the stable chemical compounds, i.e. the protective coating.
Over the new coating, which is at the same time short time protection, suitable protection systems can be placed (acrylic, epoxy etc.).

INTRODUCTION

The basic condition for the quality corrosion protection is the correct selection of procedures for surface preparation. It should be stressed that there is a very wide variation regarding the condition of steel surface requiring suitable preparation.
The age of the structure and its location, the preceding quality of the surface, the state of the existing coating system and extent of the breakdown of the existing coatings, the type and severity of previous and future corrosion environments and the intended new coating system, all influence the way and extent of surface preparation.
Since the expenses for the quality surface preparation are quite high, it is necessary to take care of the new protection system suggested upon the selection of the preparation procedure. The selected

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grade of surface preparation must be in concordance with the requirements of the corrosion protection system suggested.
The existing corrosion protection of power distribution plants and overhead lines was carried out using protective paints systems or hot-dip-galvanization with zinc. After many years of exploitation of these plants the corrosion of steel surfaces occurred in great extent as well as degradation of old protective paint systems. Besides that the surfaces can be contaminated with other contaminants (oils, greases, salts and other) that should be removed prior to the method of surface preparation for deposition of new corrosion protection.

1 CORROSION PROTECTION OF STEEL CONSTRUCTIONS

There are various methods of surface preparation, and basic classification is as follows:
- mechanical cleaning including blast-cleaning
- water cleaning,
- solvent and chemical cleaning

1.1 Mechanical Cleaning

Mechanical cleaning of rusted surfaces can be done using the following methods:
- cleaning with the hand tools (wire brushes, spatulas)
- power-tool cleaning using typical power tools (rotating wire brushes, various types of grinders, percussion hammers and needle guns.)
- compressed-air abrasive blast-cleaning so called “sanding” (various plants)
- pressurized-liquid blast cleaning
- water blast-cleaning
- flame cleaning (acetylene-oxygen), afterwards the surface must be treated with wire brushes.

1.2 Water, solvent and chemical cleaning

Water cleaning comprises the following methods:
- cleaning with a jet of clean water, and for the removal of greases from the surface, the detergents are added, afterwards the surface is rinsed with clean water;
- steam cleaning.

1.3 Solvent and chemical cleaning

Solvent and chemical cleaning comprises the following methods:
- emulsion cleaning;
- alkaline cleaning;
- organic-solvent cleaning;
- cleaning by means of chemical conversion;
- stripping (removal of old coatings by means of solvent-borne pastes);

All the methods listed are regulated in the Standard JUS ISO 12944-4.

2 SURFACE CLEANING BY MEANS OF CHEMICAL CONVERSIONS

Cleaning by means of chemical conversion (phosphating, chromating) is used for hot-dip galvanized surfaces, surfaces with electroplated –zinc coatings and surfaces with zinc coating done by melting of metal powder (sherardized surfaces), which give the suitable surfaces for painting. Otherwise alkaline solutions or inhibited acids may be used for the preparation of surface. Usually, rinsing with clean water shall follow.
More recently used are water-born corrosion converters, converting the products of corrosion into stabile compounds by chemical reaction. These compounds stop the further progression of corrosion processes by making the passive layer on the steel surface. This paper presents the two means for chemical conversion of corroded surfaces.

- Chemical mean “A”, is water-based and non-toxic, containing tannin in combination with other chemical materials. It works by converting the products of corrosion into stable black surface of hematite (Fe_2O_3) and magnetite (Fe_3O_4), making the stabile link with basic metal through the chemical reaction. The water base of chemical mean “A” plays the important role in the process of conversion. Water enables “transport” of tannin and other chemical materials into the surface with corrosion products. The results of the performance of mean “A” is the conversion of corrosion products into steady black coating on surface of the steel.
After the reaction is finished it is necessary to wash the treated surface with water, in order to remove all materials that are not linked and the dust. On the surface prepared in this way it is possible to put the water based paints even when the surface is still wet.

- Chemical mean “B” is the water based product, that converts corrosion products into new compounds and makes the stabile coating on the surface of the metal. Chemical mean “B” is formulated in such way to penetrate deep into the corroded surface, all the way to the bare metal and to stop further propagation of corrosion processes. The mean contains chelating chemical agent that modifies the corrosion products into hydrophobic passive layer, and after that in the combination with waterborne latex it gives the unique formulation for a primer with excellent protection features. Mean “B” is compatible with final paints based on solvent and water.
Since being water based these means are acceptable from ecological point of view, and the difference is in that the mean “A” should be washed with water before the protection system is being deposited, whereas this is not the case with mean “B”.

What both means have in common is that can be applied in combination with final paints that are recommended by the manufacturers of these means.

The application of these means is also conditioned with the grade of corrosion on the steel surface according to the ISO 8501-1 and JUS C.T7.301. The direct application of these means is not possible on very corroded surfaces (Grade “D”)-Figure 1 where the whole surface of the steel is covered with hollow corrosion and the layer separation of corrosion products occurred. Prior to that the mechanical cleaning should be done, in order to remove loosely tied corrosion products and old degraded paints.

Figure 1

3 LABORATORY TESTING OF MEANS FOR CORROSION CONVERSION

The testing of the quality of corrosion conversion “A” and “B” was carried out in the laboratory of the institute “Kirilo Savic”. The application of listed means was done on steel surfaces having the corrosion Grade “B”-Figure 2, the surface of the steel is covered with surface corrosion.

Figure 2

3.1 Results of Testing of Mean "A"

- Depositing on corroded surfaces

The depositing on corroded surfaces was carried out according to the manufacturer instruction. Immediately before the deposition of the mean, the surface was sprinkled with water. Than the mean was deposited with the brush. The treated surface was left 12-24 hours until the conversion reaction was finished.
Reaction is finished when the treated surface becomes of navy-black color – Figure 3.

Figure 3

All residual dust should be removed from the treated surface with the water.
After the rinsing with water the depositing of the paint system was carried out comprising the following paints:

2 x basic epoxy bitumen paint on water base
2 x final (topcoat) acrylic paint on water base.

In total the deposited protection system with the corrosion converter was 150-170μm.
The testing of the protection system was carried out according to the standard JUS ISO 12944-6 and encompassed the following:

- moisture resistance-continual condensation lasting for 120 hours JUS ISO 6270-1,
- resistance to the sprayed solution of neutral salt in duration of 240 hours according to the standard JUS ISO 7253

Testing results are in concordance with standard JUS ISO 12944-6 considering the durability of the protection "M", life lasting (5-15) years, for the category of high atmospheric corrosion C – 3, according to the standard JUS ISO 12944-2.

3.2 Results of Testing of Mean "B"

- Depositing on corroded surfaces

The depositing on corroded surfaces was carried out according to the manufacturer instruction.
On corroded surface the mean was deposited (diluted up to 10% with water) with a brush. The color of the treated surface was changed from white, through the blue to dark-brown or black, which indicates the end of the conversion reaction – Figure 4. The depositing of paint system was carried out after 12 hours of drying.

Figure 4

The paint system consisted of the following:

- 1 x basic acrylic on water base
- 1 x final (topcoat) on base of epoxy resin.

The total thickness of deposited protection system with corrosion converter was from 160-180 μm.
The testing of the protection system was carried out according to the standard JUS ISO 12944-6 and comprised the following:

- the moisture resistance-continual condensation lasting for 120 hours JUS ISO 6270-1,
- the resistance to the sprayed solution of neutral salt in duration of 240 hours, according to the standard JUS ISO 7253.

Testing results satisfy the conditions of the standard JUS ISO 12944-6 considering the durability of the protection “M”, lasting of life (5-15) years, for the category of high atmospheric corrosion C – 3, according to the standard JUS ISO 12944-2.

4 CONCLUSIONS

- The application of chemical means for the corrosion conversion “A” and “B”, upon the procedure of steel surface preparation (corrosion grade “B”), for the deposition of corrosion protective paint system, have shown satisfactory results.

- The testing results of deposited paint systems on surfaces prepared in such way, satisfy the conditions of the standard JUS ISO 12944-6 concerning the durability of the protection “M”, lasting of life (5-15) years, for the category of high atmospheric corrosion C – 3, according to the standard JUS ISO 12944-2.

- Both conversion means are water-born which is the important parameter from the aspect of easy handling and without any harm to the environment.

- Since we are dealing with power distribution plants and overhead lines, in cases when the objects are not easily accessible, we give the greater advantage to the mean “B”, since after the application there is no need to wash the treated surfaces with waters.

- It should be stressed once more that the testing results are related to the exactly defined corrosion grade of the steel surface and to the paint system recommended by the manufacturer. The additional testing is required for the application of other protection systems, as well as for other corrosion grades of steel surfaces.

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