Studiu comparativ privind coroziunea în timp a electrozilor în sol, Partea 2 – Analize microbiologice

Comparative study regarding corrosion in time of the ground electrodes, Part 2 – Microbiological analyses

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Rezumat*:Obiectivul lucrării este de a prezenta, aspecte referitoare la: coroziunea metalelor acoperite şi neacoperite cu zinc în solul oraşului Timişoara (electrozi de împământare a Instalaţiei de Legare la Pamânt aferentă Instalaţiilor Electrice din Construcţii), analiza parametrilor de sol, prototipuri de electrozi, măsurători electrice, microbiologice şi analiza de prognoză-predicţie matematică, materiale şi dicţionare de termeni aferenţi. Un alt aspect prezentat în acest material este efectuarea de măsurători ale spectrului câmpului elecromagnetic oscilografiat al elementelor de metal acoperite şi neacoperite cu zinc din sol.*

Cuvinte cheie*: coroziune, electrod de împământare, sol, legare la pământ, microbiologia solului*

Abstract: *The objective of this paper is to present aspects related to: corrosion of metals covered, and not covered with zinc in the soil of Timişoara (grounding electrodes of a grounding installation related to Electrical Installations of Constructions), analysis of soil parameters, prototype electrodes, electrical, microbiological analysis and mathematical prognosis analysis-prediction, materials, and dictionaries of related terms. Another aspect presented in this material are the measurements related to the spectrum of the oscillograph electromagnetic field of the grounding electrodes, which are covered, and not covered with zinc.*

Key words*: corrosion, ground electrode, soil, grounding, soil microbiology*

1. Microbial analysis of the soil

Due to the fact that the soil quality legislation, respectively the national soil quality monitoring strategies are based only on determinations of the physical and chemical parameters, therefore they do not include elements of soil microbiology, there is little research on microbial activity in the soils of our country. This is also due to the fact that a microbiological research is very laborious, difficult to quantify and especially very expensive. Numerical determinations of different categories of microorganisms performed by many researchers have highlighted their dependence on the soil horizon, the depth from which they were harvested, the peculiarities of humidity, pH, content of organic substances and the degree of oxygenation. No technique for the estimation of the number of bacteria in the soil can reflect their exact and real situation, as the specific nutritional requirements of each type of bacteria are extremely diverse and complex, no culture medium can simultaneously meet this great complexity. In order to characterize the soil in which the monitoring poles were implanted, samples were collected at a depth of 1.5 m and 2.3 m. The soil samples were characterized by physical, chemical and microbial activity. To characterize microbiologically, the soil samples were crushed and sieved, then the soil sample was extracted. 3 successive dilutions (10-3-10-8) of the soil samples were made, the dilutions being made with distilled water. The total number of germs was determined by the plate culture method, using a solid nutrient medium with meat and yeast extract. Successive dilutions of the soil samples were seeded (1 ml of inoculum) on the solid culture medium, by incorporation, after previously adjusting the pH of the medium to 7.2. After incubation for 48 hours at 36°C, the obtained values from the count were multiplied by the dilution factor, giving the number of colonies forming per 1 g of soil. Bacterial colony counting was done with the Yul Flash & Go automatic colony counter. The results are shown in the following table. Bacteria (col/ml) determined by automatic counting with the Yul Flash & Go colony counter.

Table 1

Microbiological analysis results

Dilution	**No. of colonies at 1.5 m depth**	**Bacteria (col/ml) at 1.5 m depth**	**No. of colonies at 2.3 m depth**	**Bacteria (col/ml) at 2.3 m depth**
10^{-3}	83	$1,09*10^{5}$	43	$5,65*10^{4}$
10^{-6}	29	$3,81*10^{9}$	13	$1,7*10^{7}$
10^{-8}	27	$3,55*10^{7}$	3	$3,94*10^{8}$

Relative to the total soil mass, Alexander (1971) proposes as a calculation basis, a volume of 1 μm^3/cell and a wet weight of 1.5×10^{-12} g / cell. At a density of 10^8 cells/g dry soil, bacteria occupy 0.01% of the total volume of the soil, and at a density of 10^9 bacteria, 0.1%. In terms of weight, at the density of 10^8 cells, the bacteria represent 0.015%, and in the case of 10^9 cells, 0.15% of the total soil mass.

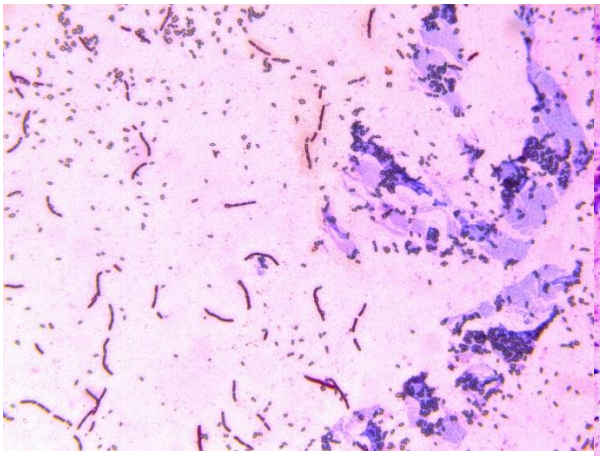


Fig. 1. Gram stain smear made from the bacterial culture at the depth of 1.5m

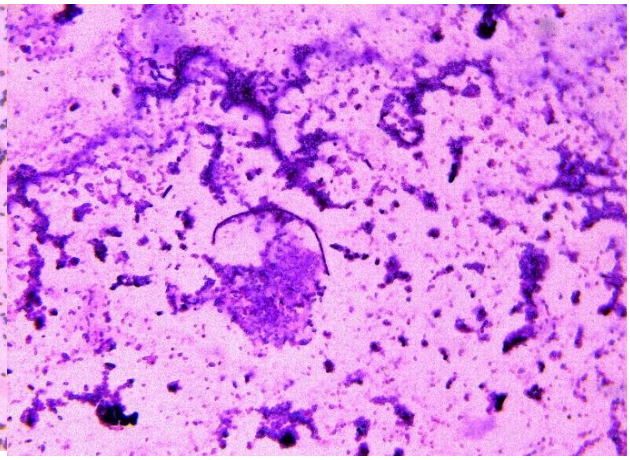


Fig. 2. Gram stain smear made from the bacterial culture at the depth of 2.3m

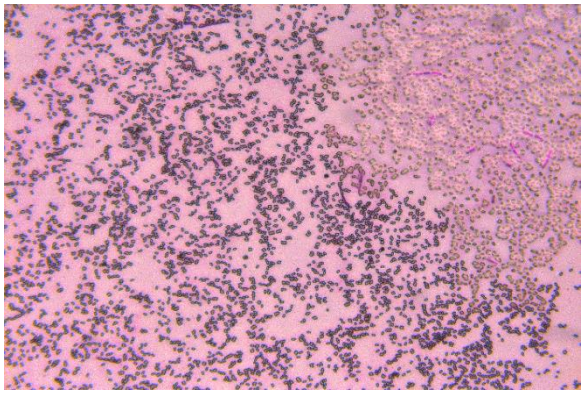


Fig. 3. Gram stain smear made from the bacterial culture at the depth of 1.5m

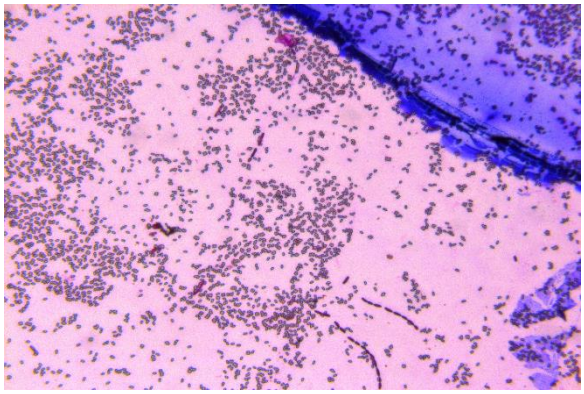


Fig. 4. Gram stain smear made from the bacterial culture at the depth of 2.3m

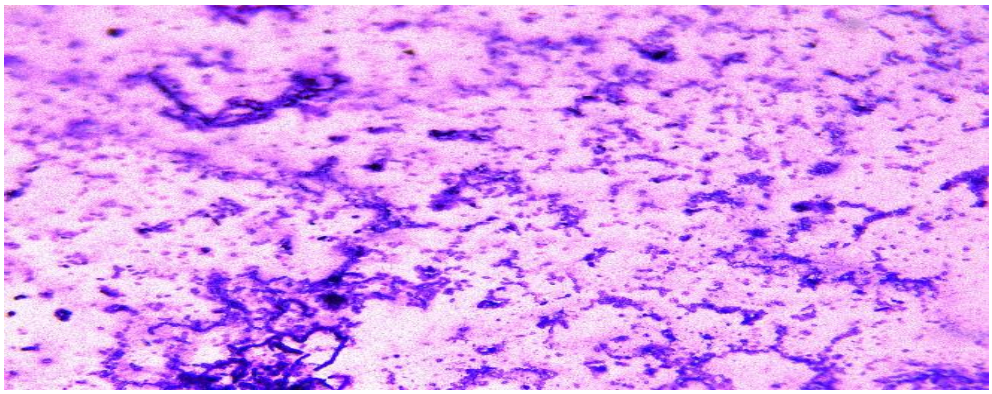
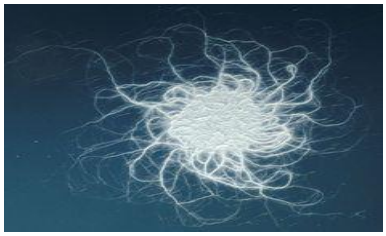


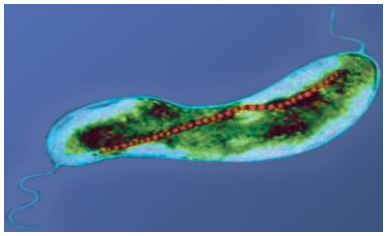
Fig. 5. Gram stain smear made from the bacterial culture at the depth of 1.5m

From the analysis of the smears made after the gram staining, as shown in Fig. 1 and Fig. 2 gram-negative bacteria are predominant. The predominant microbiota at 1.5 m depth consists of filaments of gram-negative bacilli, and a few gram-negative short bacilli, and gram-positive cocci, irregularly arranged. At a depth of 2.3 m, gram-negative are predominant, agglomerated, and irregularly arranged. There are present long filaments of gram-positive bacilli, and cocci chains of gram-positive bacteria.

In the literature [1], the authors mention: *"According to the literature, zinc is easily affected mainly by bacilliform bacterium and can be coated with biofilm. In addition, the binding of bacteria (biofilm) to zinc has led to a more frequent rate of corrosion. Research has shown that Bacillus mycoides accelerates the corrosion of a galvanized metal.* ***Coccus bacteria also have an corrosive effect onto metals.*** *As example; cocci bacteria were found on a corroded rail. According to the summary resulted from the literature it is clear that some biofilms (especially bacillus type) have a corrosion effect onto zinc. In this study, the corrosion of the zinc anode electrode occured. These informations are accepted by the literature. In this study, during this process, a biofilm developed, and the corrosion of zinc occured. The corrosion rate (CR) is calculated according to the formula* $CR = \frac{W}{At}\%$ *where CR is the corrosion rate, w is the weight at the beggining of the experiment, reported to the final weight. A is the metal surface and the exposure time.*



[3] Fig. 6. Bacillus mycoides accelerates the corrosion rate on a galvanized metal



[4] Fig. 7. Magnetotactic bacterium

In the literature [2] it is confirmed that the bacterium *Thiobacillus* (gram negative bacterium) uses sulfur as energy and is abundant present in clay soil, the bacterium oxidises sulfur and produces sulfuric acid, and sulfate, FeS_2 – iron disulfide, Fe2(SO4)3 – iron (III) sulfate, and $CaCO_3$ – calcium carbonate – compounds that are in the soil.

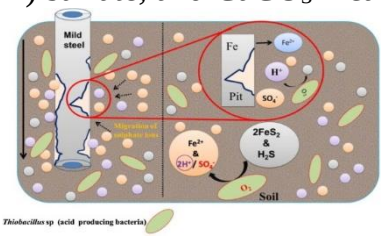


Fig. 8. [2]Corrosion of the galvanized steel in a clay soil, and the acid produced by *Thiobacillus*

[5] Fig. 9. Thiobacillus ferrooxidans are responsible for the oxidation of iron and inorganic sulfur compounds

References

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