Purification the surface of detail from biological contaminations

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Abstract. More than 70% of biodegradation occur due to the corrosion processes. A biological corrosion causes the greatest damage to the oil and gas-production industry, the Navy and pipelines, constructions of water supply, means of communication. This paper proposes an effective method of purification various surfaces from biological contaminations by using of cold plasma.

1. Introduction

The biological corrosion - is the process of destruction of metals under the influence of living organisms (seaweed, bacteria, yeast, fungi) [1-4]. Microorganisms are located in the water environment and the soil may cause the serious corrosive damage.

The biological corrosion can exist as a separate independent type. But often the process of destruction occurs in parallel with soil, marine, atmospheric and other types of corrosion in water solutions and non-electrolytes. Pipelines, the subway, reservoirs, piles and underground pipelines and other constructions are most exposed to biological corrosion. Gas pipelines and pipelines of the oil industry are destroyed in seawater from biological corrosion.

Processes of biocorrosion begin with the appearance on the metal surface of small pits and irregularities, which are often filled by microorganisms and their metabolic products. Usually bacteria provoke the formation of ulcerous or pitting corrosion. By the mechanism action of the biological destruction is classified a number of types: electrochemical processes of destruction; chemical corrosion destructions; direct destruction under the influence microorganisms; - complex destructions (the influence of microorganisms, environmental conditions and other factors).

Microorganisms use the metal as a food medium or they secrete products, which are destroying it. In process life of microorganisms create the alkali, mineral and organic acids, peroxides, increasing the aggressiveness of the external corrosive environment. For example, some fungi, which are present in aviation fuel provoke of the process of biological corrosion of aluminum cisterns of air transport. Thiobacteria produce an acid, resulting in reduced the acidity of the soil, thereby changing of corrosion formation process.

By the nature of the biological factors the corrosion are divided into two types: bacterial; mycological.

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Microorganisms are two types:

- aerobic. In the presence of oxygen perform their activities.

- anaerobic. Their existence extends by without the presence of oxygen.

Iron bacteria and sulfur bacteria, living in the soil, are the most dangerous for metals. And Aerobic and anaerobic bacteria have a common environment.

The environment of life microorganisms are: water; air; the soil; organic medium. Bacterial corrosion is more dangerous and more destructive. Bacteria are perfectly adapted to the changing existence conditions, multiply rapidly at temperatures between 5 to 40 degrees. The process of biodamage has a complicated mechanism. Live microorganisms can destroy the surface and also to stimulate the emergence and course of corrosion.

The biological corrosion for example, also includes the corrosion the taking of hands. On human skin are bacteria and sweat. Some metals have a low resistance to these factors. The biological corrosion causes the greatest damage to the oil and gas-production industry, the Navy and pipelines, constructions of water supply, means of communication [1, 2]. Over 70% of corrosion process becomes a biodegradation. The most frequently microorganisms provoke destructions on aluminum, steel, zinc, magnesium. Copper, lead, nickel are very resistant to biological degradation.

The main and effective method to protect of constructions from biological corrosion is a surface treatment product by antibacterial agents (chlorine, formalin, etc.) [1-4]. It is often bactericidal substances include in structure of paintwork materials and other coatings. But this method of protection is quite expensive and harmful for human and for the environment.

2. Experimental studies

The paper proposes a method of protection from biocorrosion by using cold plasma and device for its implementation. During the treatment by cold plasma creates a wide spectrum of environmentally sound particles (free radicals O and OH, ozone, nitrogen of oxides, ultraviolet radiation, etc.), which destroy the biological harmful contaminants – various microorganisms and chemical toxicants.

For purification various surfaces, a cold plasma generator was developed [5]. In this plasma generator occurs the ionization of the working gas and air at atmospheric pressure by using low-power pulsed arcs. The supply voltage of 3-10 kV with a frequency of 20kHz, the power consumption of up to 100 watts. The plasma temperature at the exit does not exceed $+45^0$C.

Test objects, infected with the bacterial suspension are subjected of the treatment. The bacterium Escherichia coli and Staphylococcus aureus were used as the samples. The results of treatment samples by cold plasma are presented in figures 1-2.

The results of these studies show that the cold plasma is an effective means for the inactivation of microorganisms and it destroys, depending on duration of influence (figures 1-2), to 99% of bacteria.

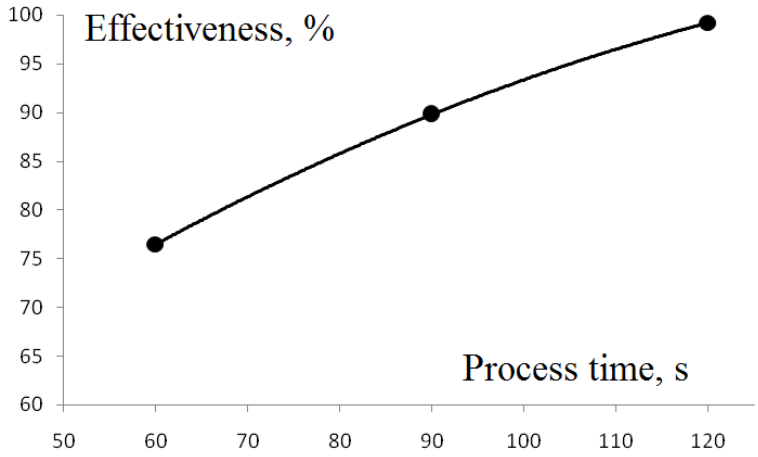


Figure 1. The diagram of relationship the efficiency of the treatment from duration of influence.

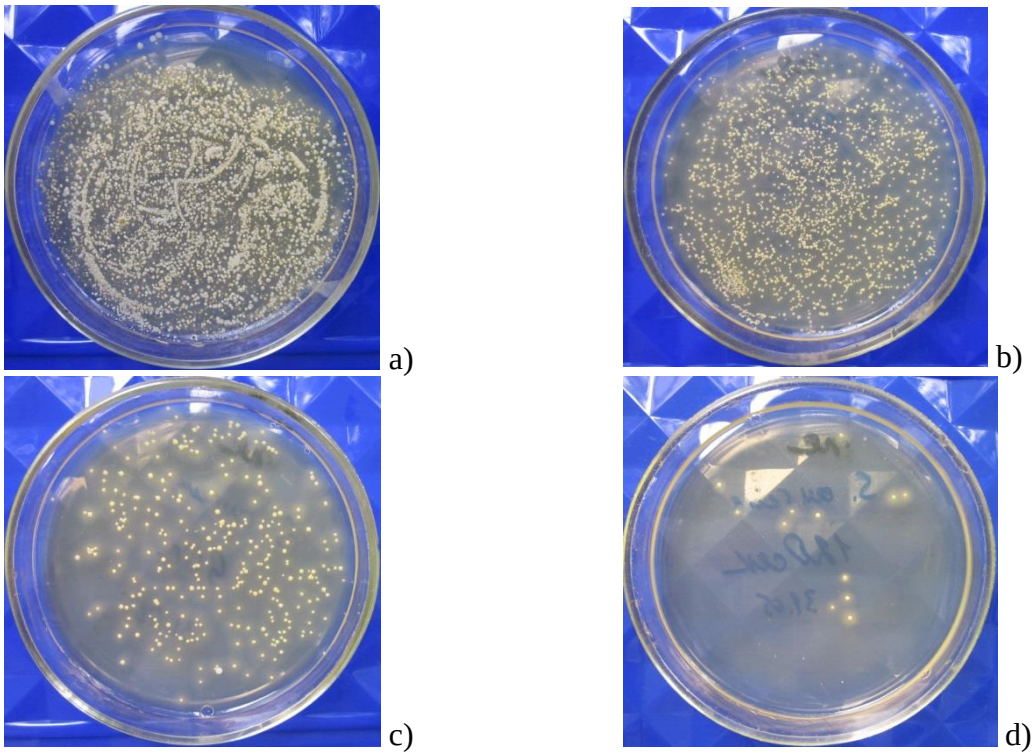


Figure 2. The samples after the plasma treatment: a) the control sample of bacteria Staphylococcus aureus without treatment; b) the sample after treatment for 60 seconds; c) the sample after treatment for 90 seconds; d) the sample after treatment for 120 seconds; bacteria - Staphylococcus aureus.

3. The conclusion

Despite the progress, achieved in the laboratory-scale trials [5-12], the treatment by cold plasma at atmospheric pressure is still not widely of the practical spread. From our point of view, new sources of cold plasma at atmospheric pressure can be widely used in medicine, in the protection of industrial materials from biodamage and bio-corrosion, the disinfection of food and food raw materials, the treatment of tissues, postal envelopes, polymer films, plastic cards and other fields.

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