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Use of electrolytic processes applied as an alternative treatment to chlorine in water pretreatment in reverse osmosis system.

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Abstract. Reverse osmosis filtration is one of the water treatments used by industry because it is very effective in removing dissolved salts from water since it uses a specific type of thin, semi-permeable membrane. These membranes have characteristically small pores to allow the passage of pure water and reject larger molecules, such as ions and other tiny impurities like bacteria and viruses[1]. Several precautions need to be considered in water treatment before starting the filtration process in the equipment. These precautions are necessary to avoid premature loss of the membranes in the reverse osmosis system equipment. One of the most common problems that cause this damage is the oxidation reaction of the polyamide layer by the chlorine-based disinfectant, which corrodes this layer, substantially decreasing its filtration properties. The objective of this study, therefore, was to verify the possibility of substituting the use of chlorine in water treatment, for the removal of microorganisms, by the passage of an electric current, reducing the probability of biofilm formation and membrane perforation. The methodology consisted of experimental research, to verify the efficiency of the electric current as a biocide in a sample of raw water with cultivated microorganisms. An electrical load of 24 volts was applied, varying the exposure time, using Copper and Stainless Steel 304 as electrodes. The final results showed that in the treatment with the copper electrode and 30-minute retention of the water the results were satisfactory, and the treatment, therefore, could be used in conjunction with other biocides or in isolation reaching up to 10^3 CFU/ml of Aerobic Bacteria in the feed water.

Keywords. *Microorganisms; Biofilm, Electric Current, Polyamide, Reverse Osmosis*

Introduction. Water is a fundamental substance for the existence of life. Besides being a solvent widely used in chemical laboratories and industrial processes[2]. According to the National Water Agency, 9.5% of water withdrawn in Brazil is used by industry[3]. In the industrial sector, besides the water being used on a large scale, it often needs to undergo some treatments before its application, so that it can go through the processes as pure as possible, since the membrane is very sensitive to certain agents and contaminants that can damage it, such as high hardness, the presence of silica outside the recommended standards, iron, chemical treatments like chlorination and others[4].

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One solution found for this situation is demineralization by reverse osmosis through electrolytic processes. This is the separation of salts and water, reaching a low conductivity of up to 0.2 µS/cm, this is because the current flows through liquids at the atomic or ionic level and the ease with which the current is transmitted over a defined area helps quantify the ionic concentration of a sample[4]. Ions, therefore, are charged particles that float freely in solution, not coupled to other molecules. They are capable of carrying and transmitting a current, and thus their measurement is done using a conductivity meter.

This retention of microorganisms and contaminants is done by the membrane, in a reverse osmosis system, which contains micropores of an average size of 0.001 micrometers, and can, therefore, deionize the treatment without the use of chemicals to do the same, because the filtration is done mechanically through the respective membranes[5].

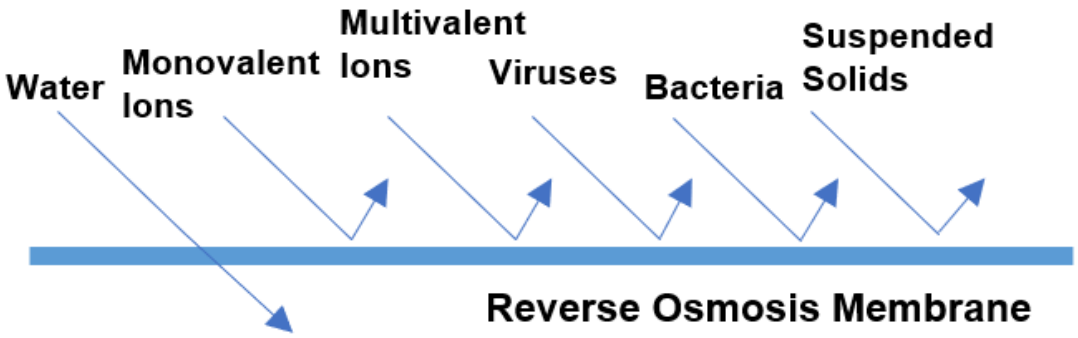

Figure 1. Illustration of the operation of the dam of a reverse osmosis membrane. (Source: Own).

This equipment works inversely to osmosis, that is, between two solutions of distinct concentrations are separated by a semipermeable membrane together with a pressure exerted on the solutes side, allowing only the solvent (pure water) to pass through and retaining the solutes (dissolved salts, microorganisms, and contaminants), as shown in Fig.2 [6].

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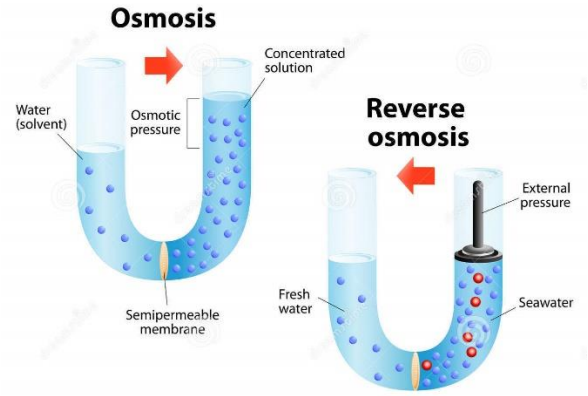

Figure 2. Illustration of the operation of Reverse Osmosis (reverse). (Source: Petrochem, 2021).

However, the Reverse Osmosis Membrane, the industrial equipment used to make these filtrations, can present certain problems if not taken care of properly. One of these problems, which is quite common, is the appearance of fouling on the membranes, called fouling which is caused by the accumulation of inorganic materials on the layers of the membrane. Usually, chemical cleaning is performed to remove the deposits. This aggregation leads to physical and chemical deterioration of the membranes and consequently increased pressures due to the increased resistance of the water to pass through. Accumulations can be avoided by effective water pretreatment [7].

In addition to fouling, the accumulation of biological material can also occur on the surfaces, also from the feed water of the equipment, with the presence of microorganisms such as bacteria, viruses, algae, and fungi called biofouling. The formation of biofilm is the most worrying deposition because it radically reduces the efficiency of the membranes. In this situation, the flow is impaired by reducing the area available for water passage and by increasing roughness[7]. Some biofilms are also difficult to remove by chemical cleaning because the organisms produce extracellular polymers that promote greater attachment to the walls and protection against water friction. For these reasons, pre-treatment, control and monitoring care are indispensable[8].

To avoid biofouling, several different types of disinfection treatments can be used in raw water, such as ozonation, hydrogen peroxide application, filtration, surfactants, and especially chlorination, which although it has one of the lowest costs and highest efficiencies, nevertheless irreversibly damages the physical structure of the membrane[8].

In this context, the need arose to seek alternatives to chlorine for the elimination of microorganisms before passing through the Reverse Osmosis Membrane, so this work will verify the possibility of replacing the application of chlorine by the passage of electric current in water before use in the equipment, in order to eliminate or reduce the microorganisms present in order to avoid or even reduce the formation of biofouling.