Medio ambiente:

Preservación, salud y sobrevivência 2

Cleiseano Emanuel da Silva Paniagua
(Organizador)

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PRESENTACIÓN

El e-book: “Medio Ambiente: Preservación, Salud y Sobrevivência 2” consta de seis capítulos de libros de investigación científica que sacan a la luz la preocupación de la relación hombre-medio ambiente que incrementa la degradación del medio ambiente y sus recursos naturales.

El primer capítulo nos presenta la importancia de desarrollar la conciencia/educación ambiental como una forma de promover una relación más armónica y sostenible con el medio ambiente, garantizando los recursos naturales para las generaciones futuras. El segundo trabajo presenta una reflexión sobre la importancia de la educación ambiental y el saneamiento básico para estudiantes de secundaria de una escuela pública ubicada en la zona rural del municipio de Unaí, en el estado de Minas Gerais - Brasil.

El Capítulo 3 presentó un estudio con el fin de investigar el poder caloríflc superior e inferior generado a partir de los residuos sólidos urbanos (RSU). Los resultados mostraron que el uso de energía es representativo y recomendado para generar energía en ciudades con poca población. El Capítulo 4 investigó el uso de nanopartículas magnéticas asociadas con coagulantes orgánicos e inorgánicos. Los resultados mostraron que el uso de coagulante a partir de semillas de *Moringa oleifera* presentó una remoción del 99,85% luego del proceso de filtración aplicado al efluente galvánic

Finalmente, el capítulo 5 presenta un trabajo que investigó la estructura poblacional y ecológica de la especie de Polylepis rugulosa en la región del Perú. Los resultados mostraron que la etapa de plántula es más alta que la etapa adulta. La especie de P. rugulosa tiene una densidad menor que las otras especies en los bosques de Quenoa en Perú y Colombia. En el capítulo 6 se estudió el banco de fragmentos de bosque y estrato herbáceo-subarbusto en la ciudad de Sorocaba (SP), lo que resultó en baja riqueza y densidad de plántulas de especies arbóreas, actuando como indicador de fragilidad.

En esa perspectiva, la Editora Atena viene trabajando para estimular y animar a cada vez más investigadores de Brasil y de otros países a publicar sus trabajos con garantía de calidad y excelencia en forma de libros, capítulos de libros y artículos científicos

Cleiseano Emanuel da Silva Paniagua

SUMÁRIO

CAPÍTULO 4

MAGNETIC NANOPARTICLES ASSOCIATED WITH ORGANIC AND INORGANIC COAGULANTS IN THE TREATMENT OF GALVANIC EFFLUENT

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ABSTRACT: With the aim at minimizing the environmental impact coming from the washing of parts in the electroplating industry, the present work has the objective to compare the efficiency of the organic coagulants *Moringa oleifera* and Tanino and the inorganic Aluminum Sulfate, Bufloc 5122 and Bufloc 5158 (as an aid to 5122) once associate or not with magnetic nanoparticles. Thus, it was used simulation processes of coagulation, flocculation sedimentation and, filtration and at the end of the tests it was observed that both the treatments that used or not nanoparticles did not show little variation in the result of electrical conductivity and pH, however, they showed a variable and positive results for the turbidity removal parameter, where the treatment with coagulant extracted from the seed of *Moringa oleifera* showed the best result, having a removal rate after filtration equal to 99.85%. Notably, the use of magnetic nanoparticles proved to be efficient for shorter sedimentation times however it was not demonstrated a significan artifact in the post-filtration performance for this effluent in question

KEYWORDS: Magnetit, coagulant, electroplating.

NANOPARTÍCULAS MAGNÉTICAS ASSOCIADAS A COAGULANTES ORGÂNICOS E INORGÂNICOS NO TRATAMENTO DE EFLUENTE GALVÂNICO

RESUMO: Visando a minimização do impacto ambiental causado pelo excesso de efluent advindo da lavagem de peças da indústria de galvanoplastia o presente trabalho tem como objetivo comparar a eficiência dos coagulantes orgânicos Tanino e *Moringa oleifera* e dos inorgânicos Sulfato de Alumínio, Bufloc 5122 e o Bufloc 5158 (auxiliar ao 5122) quando associados ou não a nanoparticulas magnéticas. Utilizou-se a simulação dos processos de coagulação, floculação, sedimentação e filtração e ao fina

dos ensaios observou-se que tanto os tratamentos que utilizaram nanoparticulas quanto os que não utilizaram apresentaram pouca variação de resultado para a condutividade elétrica e pH, no entanto mostraram um resultado variável e positivo para remoção do parâmetro turbidez, onde o tratamento com o uso do coagulante extraído da semente de *Moringa oleifera* apresentou o melhor resultado, tendo uma taxa de remoção após a filtração igual a 99,85%. Ressalta-se que a utilização das nanoparticulas mostrou-se eficiente para tempos menores de sedimentação, no entanto não se demonstrou um artifício significativo no desempenho pós filtração para este efluente em questã
PALAVRAS-CHAVE: Magnetita, coagulante, galvanoplastia.

1 | INTRODUCTION

Electroplating can be characterized as a branch of the metallurgical industry that consists of chemical processes of bathing or washing parts to deposit metallic layers on material, from oxidation and reduction reactions in order to protect against corrosion, beautify objects for decorative purposes, improving the thickness and conductivity of the object (INSTITUTE OF THE ENVIRONMENT, 2014; PEREIRA, 2017).

The main environmental impact of this industrial process is the high demand for water used due to the various washings involved, as well as the solid residue and sludge generated. In addition, the liquid effluent has a high load of heavy metals such as chromium, zinc, copper, nickel, and lead, all of which are harmful to public health (INSTITUTE OF THE ENVIRONMENT, 2014).

The use of nanotechnologies as an aid to the use of coagulants in the treatment and removal of physical and chemical parameters has been observed to minimize environmental impacts, given that when the magnetic field is applied through the nanoparticles, the flake formed in the process are attracted by the electrostatic force, so that sedimentation occurs more quickly, in addition to removing small particles (GILPAVAS et al., 2017; MATIAS, 2012).

Therefore, this study aims to analyze the treatment of effluent from electroplating with the aid of different types of organic and inorganic coagulants associated with the use of magnetic nanoparticles.

2 | MATERIALS AND METHODS

The effluent used for the development of this research came from an electroplating industry located in the North of Paraná and the experiments were carried out at the Water Resources Laboratory at UTFPR - Londrina. Were used for the treatment Organic coagulants extracted from *Moringa oleifera* seeds and Tannin and inorganic coagulants Aluminum Sulfate, Bufloc 5122 and Bufloc 5158 as an auxiliary to 5122. For the *Moringa oleifera* coagulant solution, 50g of the seed was weighed, which underwent a process of agitation in a blender together with 1 L of distilled water and 1M of NaCl, and then the mixture was strained through a cloth strainer. For the other coagulants, 10 mL of the coagulant was diluted in 1 L of distilled water.

The ideal dosage of each coagulant was defined from a pre-assay, which established the dosage of 2 mL L^{-1} of Bufloc 5122 together with 2 mL L^{-1} of Bufloc 5152, 12 mL L^{-1} of *Moringa oleifera*, 8 mL L^{-1} of Aluminum Sulfate and 4 mL L^{-1} of Tannin. After testing in Jar-test, 10 mg of concentration was adopted for the use of the magnetic nanoparticle. The nanoparticle used was magnetite, which was produced following the methodology described by Schwertmann and Cornell (2000). Thus, the treatments used were 1: Tannin without nanoparticles; 2: Tannin with nanoparticles; 3: Aluminum Sulfate without nanoparticle; 4: Aluminum Sulfate with nanoparticles; 5: *Moringa oleifera* without nanoparticle; 6: *Moringa oleifera* with nanoparticle; 7: Bufloc 5122 and Bufloc 5158 auxiliary without nanoparticle and 8: Bufloc 5122 and Bufloc 5158 auxiliary with nanoparticle. The treatments without nanoparticles were performed in duplicates.

To simulate the coagulation, flocculation and, sedimentation processes, the Jar-test test was adopted, where after homogenization of the effluent, 3 minutes of rapid agitation (150 rpm) were used for the coagulation process, 10 minutes of slow agitation (15 rpm) for the flocculation process, and then the device is turned off, starting the sedimentation process (adapted from THEODORO, 2012). Collections were performed at 3 minutes (t1), 13 minutes (t2), 23 (minutes) and 33 (minutes). After the last time, the samples still passed through a filter whose filter medium was determined from a test with three different materials and from the filter that presented the best result, the filters used for this study were built containing 1 base layer of blanket. non-needled geotextile and another layer with sand from 0mm to 0.425mm. Using the methodology of APHA (2012), the parameters pH, electrical conductivity, and turbidity were analyzed.

3 I RESULTS

The raw effluent presented pH 6.31 as results; electrical conductivity 11.22 $mS.cm^{-1}$; and turbidity 1335 NTU. The behavior of the pH during the test is shown in Fig 1.

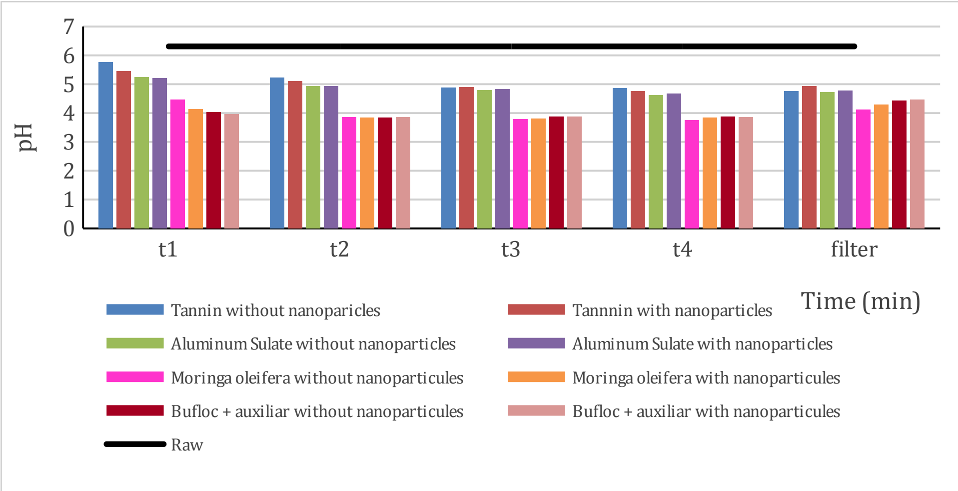

Figure 1 – The pH variation during the test.

Source: own authorship (2021).

In comparison with the raw effluent, all treatments showed a decrease in pH. The treatment with Tannin without the association of nanoparticles showed a decrease in pH, which ranged from 5.76 (t1) to 4.75 after filtration; already the treatment of this same coagulant with the nanoparticles showed little variation, having its value after filtration 4.94. For the treatment with aluminum sulfate, there was little difference when comparing the use or not of nanoparticles, having after filtration values of 4.78 and 4.73, respectively.

The coagulants *Moringa oleífera* and Bufloc + auxiliary showed lower pH values when compared to the two previous coagulants, with values below 4.47 from t1 onwards. During the test, the values changed in behavior after filtration (with the exception of the Tannin treatment without the nanoparticles) when all had an increase in pH, especially the treatment with Bufloc together with the nanoparticles, however, the use of nanoparticles did not change the pH behavior. It is noteworthy that the treatments with *Moringa oleífera*, Bufloc 5122 + auxiliary, Tannin, and Aluminum Sulfate presented a pH value below that required by CONAMA Resolution 430/2011 (BRASIL, 2011) which must be from 5 to 9 to be released in a water body suggesting that there was a need for correction for its proper release for this treatment. The variation of the electrical conductivity of the treatments used is shown in Fig.2.

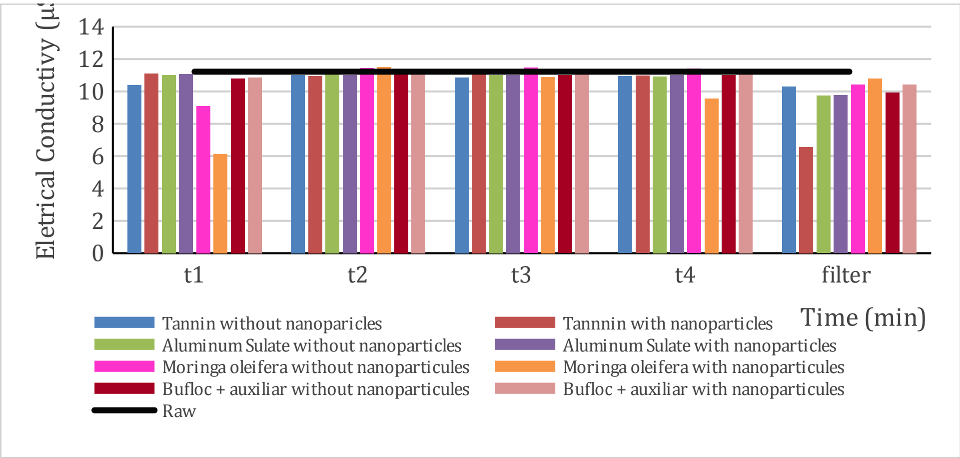

Figure 2 – Behavior of eletrical conductivity.

Source: own authorship (2021).

It is observed from Fig. 2, that the values for electrical conductivity varied little compared to the raw value (11.22 $mS.cm^{-1}$) throughout the sedimentation process. The lowest value was for *Moringa oleífera* 6.13 mS.cm-1, referring to treatment with nanoparticles.

After filtration, all treatments had a drop in the values related to this parameter, with emphasis on the treatment using Tannin together with the nanoparticles, which reached a value of 6.57 $mS.cm^{-1}$, a value well below that found in the raw. For the other coagulants, the variation occurred from 10.8 mS.cm-1 to 9.73 $mS.cm^{-1}$ for *Moringa oleífera*, this is due to the presence of salt in the coagulant solution of this treatment, which triggers the release of ions increasing electrical conductivity, corroborating Vizibelli et al. (2017) and Ribeiro et al. (2018). Almeida (2019), when using *Moringa oleifera* and Aluminum Sulfate as coagulants for the treatment of electroplating effluent, observed the same behavior for electrical conductivity after filtration, with a decrease in the values of this parameter. Figure 3 shows the values obtained for the turbidity parameter, which converted into removal percentage**s**.

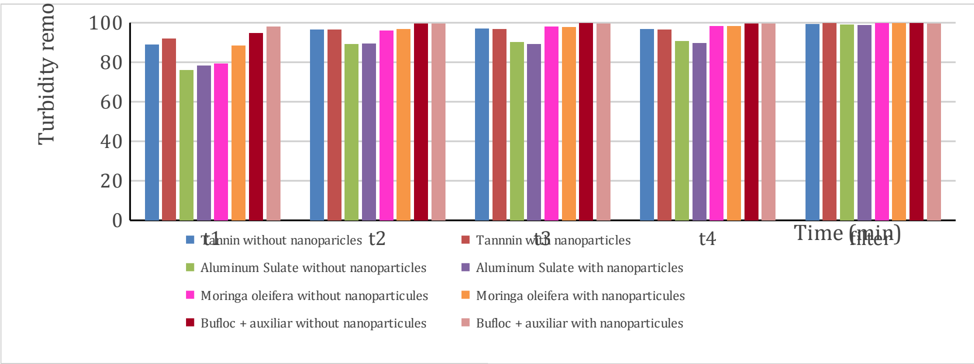

Figure 3 – Percentage of turbidity removal efficienc .

Source: own authorship (2021).

When analyzing the turbidity removal efficiency data (Fig.3), it is observed that the Bufloc + auxiliary coagulant, with and without the nanoparticles, has a fast action, and during the sedimentation process, the organic and inorganic coagulants showed an evolution in the removal of turbidity over time. Tannin presented values above 96% in the last collection, while *Moringa oleifera* rates above 98% at the end of the sedimentation process. On the other hand, the Aluminum Sulfate among all coagulants was the one that presented a later action, reaching values close to 90%. Vaz (2009) worked with *Moringa oleifera* in different concentrations for the analysis of apparent color and turbidity in the treatment of effluen from electroplating, their studies *Moringa oleifera* showed a maximum removal of turbidity close to 92%, which demonstrates the efficiency of this coagulant for effluent treatments in this industrial branch.

The action of the nanoparticles was positive when there was little sedimentation time, but in the end, the results were equal to the treatments without the nanoparticles, a similar outcome to Andrade's (2019), where at the end of the sedimentation the treatments with maximum efficiency of removal of turbidity with and without the use of nanoparticles reached similar removal values in the range of 96% with no significant variation. After passing through the filte , all treatments with and without nanoparticles reached values above 99%. A highlight for *Moringa oleífera* after filtration, which obtained a removal rate equal to 99.85%, having, therefore, the best result compared to the other treatments.

By applying the ANOVA analysis of variance, Table 1, it is possible to observe that there is a significant variation in turbidity removal, both between treatments and throughout the process, as both sources of variation present a P-value of less than 5% of significance and an F distribution value above the values that delimit the areas of acceptance and rejection given by F critical.

Fonte da variação	SQ	gl	QM	F	P-value	F-crit
Treatment	529,3927	7	75,62753	7,782948	3,08348E-05	2,35926
Time	692,9234	4	173,2308	17,82746	2,21713E-07	2,714076
Error	272,0783	28	9,71708			
Total	1494,394	39				

Table 1. ANOVA analysis of variance to double factor without repetition.

Source: own authorship (2021).

Thus, the hypothesis that at least one of the sources of variation is statistically different from the others is valid. However, due to the small volume of data, it is not possible to statistically determine which of the sources of variation is different from the others, presenting a greater or lesser ability to influence turbidity removal, to determine such influence, a complementary test with a greater number of sample data is pivotal.

4 | CONCLUSIONS

It is concluded that for the treatment of effluent from electroplating, the treatments adopted in this study showed positive results in the turbidity removal parameter and little variation in the electrical conductivity and pH parameters. The use of nanoparticles showed significant action in shorter sedimentation times but did not present effective results for the post-filtration. It is observed that the organic coagulants extracted from the seeds of *Moringa oleifera* and Tannin obtained excellent rates of turbidity removal, equaling to the other inorganic coagulants. Such analysis shows that in addition to the environmental and public health advantages that organic coagulants have, their performance compared to inorganic coagulants is similar and at times even superior.

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