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Reduction of Lead present in the waters of the Tulumayo river through the use of chitosan

[Reducción de plomo presente en aguas del rio Tulumayo mediante uso de quitosano]

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Resumen

La investigación tuvo como objetivo determinar la eficiencia del quitosano para disminuir la concentración de plomo presente en el Rio Tulumayo, Chanchamayo. Se realizó un pre muestreo en 8 puntos equidistante de 20 metros cada una, con la finalidad de hallar el punto con más alta concentración de plomo. Se recolectó una muestra de 19 litros de agua del Rio Tulumayo y se mandó analizar al laboratorio. Conociendo el resultado (0.121 ppm de plomo), se hicieron 12 tratamientos de 0.5 L cada una con 3 repeticiones respectivamente, en total se trató 36 muestras. Se usó ácido acético al 90% para bajar el pH de cada muestra dejando burbujear por 30 minutos, para luego ser filtrado. Se trató a diferentes pH y concentraciones de quitosano. El mayor rendimiento fue 90% a un pH 5 con 0.3g de quitosano.

Palabras clave: Plomo, quitosano, eficiencia, remocion.

Abstract

The research aimed to determine the efficiency of chitosan to decrease the concentration of lead present in the Tulumayo River, Chanchamayo. A pre-sampling was carried out in 8 equidistant points of 20 meters each, in order to find the point with the highest concentration of lead. A sample of 19 liters of water from the Tulumayo River was collected and sent to the laboratory for analysis. Knowing the result (0.121 ppm of lead), 12 treatments of 0.5 L each were made with 3 repetitions respectively, in total 36 samples were treated. 90% acetic acid was used to lower the pH of each sample, allowing it to bubble for 30 minutes, then be filtered. It was treated at different pH and chitosan concentrations. The highest yield was 90% at pH 5 with 0.3g of chitosan.

Keywords: Lead, chitosan, efficiency, removal

1. Introduction

Mining is one of the most important economic activities that contributes to the growth of the country, since at the Latin American level Peru occupies the first place in the production of zinc, Lead, tin, silver and gold, however in the process of obtaining said Minerals generate negative impacts on natural resources such as alteration of rivers, soil lakes, flora and fauna. On the other hand, a study carried out by the National Water Authority (ANA) reveals that 129 of the 159 water basins in the country are contaminated with thermotolerant coliforms and heavy metals, the latter being generated by mining or hydrocarbon activity.

Heavy metals such as Lead, Zinc, Chromium, Cadmium, etc. and some chemical reagents used in short-term mineral treatment plants do not degrade biologically or chemically in nature, so they

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are considered toxic, since they can be toxic. agglomerate as ions or organic compounds in most organisms for long periods (Chiang, 1989).

Previous research demonstrates reduction and / or adsorption of Lead in water, these are: iron-modified chitosan (Calderon et al., 2017), chitosan with different degree of deacetylation in flake and bead form (Laly et al., 2017), chitosan -glutaraldehyde and chitosan-ferric nitrate (Davila, 2011), chitosan from shrimp skeletons (Altamirano, 2015).

Chitosan is a polysaccharide obtained from the deacetylation of chitin. Chitin is one of the main components of the exoskeletons of arthropods (insects, crustaceans, spiders), fungal cell walls, chitosan has a linear structure of high molecular weight consisting of joined N-acetyl-D-glucosamine units by β-D links (1,4). Chitin and chitosan are complementary compounds. Chitosan is the second most important polymer after cellulose, biocompatible, biodegradable and non-toxic (Araujo, et al. 2012).

2. Materials and Methods

The research is applied because it aims to solve Lead contamination. It is of quantitative approach, since it will be checked and explained if the application of chitosan will reduce the concentration of Lead in the Tulumayo River; experimental design, because one or more independent variables are manipulated, to observe and analyze its effect on the efficiency of chitosan adsorption treatment.

The research had the following stages:

Stage 1. Sample collection

8 liters of Lead contaminated water were collected from the Tulumayo River, Vitoc district, Junín department in 8 equidistant points of 20 meters each (see figure 1). The highest Lead concentration point was determined to treat the waters with chitosan (see table 1)

Figure 1. Water sampling from Tulumayo and La relavera Rivers.

Stage 2. Initial Lead analysis.

A water sample of high concentrations of Lead was taken (see table 1).

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Table 1. Results analysis summary of the Tulumayo River samples

Samples of river Tulumayo (SART)	initial concentration of Lead (ppm)
SART - 01	0.086
SART - 02	0.073
SART - 03	0.067
SART - 04	0.054
SART - 05	0.120
SART - 06	0.047
SART - 07	0.047
SART - 08	0.035

Stage 3. Treatment of water contaminated with Lead using chitosan.

Two contact columns were constructed for the treatment of contaminated water. Each contact column has a diameter of 0.05 m and a height of 0.50 m, together with a reduction coupled to a 2 ”gate valve, which fulfills the function of controlling the flow of water in each column. Subsequently an air pump was installed, which pass through a hose attached to a diffuser stone to fulfill the function of acrylic atomizer (See Figure 2)

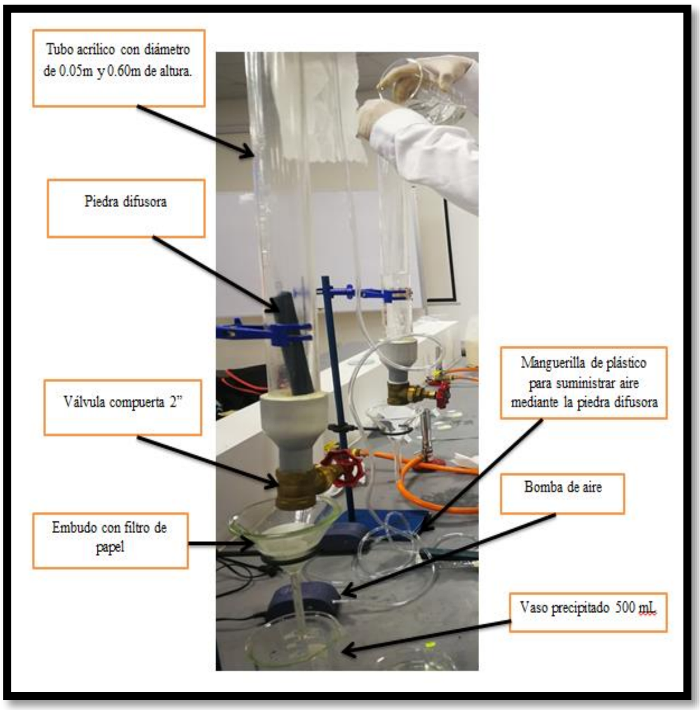

Figure 2. Parts of the equipment for chitosan treatment.

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Three chitosan masses were then weighed on clock moons: 0.3g, 0.5g and 0.7g. Then the samples of Leaded water were added to the acrylic contact columns, followed by this the chitosan was added to different masses in each column and finally, After 30 minutes of bubbling, it was allowed to stand for 5 min, then the key slowly, so that the chitosan does not pass the filter paper is used, once the filtered samples are obtained, it was sent to the laboratory to observe the results of the final concentration of Lead.

Stage 4. Final analysis of the research.
Samples were analyzed to determine treatment efficiency.

3. Results

The results of the investigation of repetition 1, repetition 2 and repetition 3 with a treatment time of 30 minutes are detailed below.

Repetition 1: Table 2 shows data obtained after chitosan treatment at different amounts and different pH levels, for example in this repetition 1 the greatest reduction in Lead concentration was at pH 5 with 0.3g of chitosan varying from 0.121 ppm to 0.010 ppm.

Table 2. Results of repetition 1 treated with chitosan

	Amount of chitosan adsorbent (g)	Initial concentration of Lead (ppm)	Final concentration of Lead (ppm)	initial pH	Amount of acetic acid to 90% (mL)	final pH
M 1	0.3	0.121	0.021	8.20	2	2.5
M 2	0.3	0.121	0.022	8.20	1.50	4
M 3	0.3	0.121	0.010	8.20	1	5
M 4	0.3	0.121	0.030	8.20	0.5	7
M 5	0.5	0.121	0.043	8.20	2	2.5
M 6	0.5	0.121	0.064	8.20	1.50	4
M 7	0.5	0.121	0.052	8.20	1	5
M 8	0.5	0.121	0.041	8.20	0.5	7
M 9	0.7	0.121	0.065	8.20	2	2.5
M 10	0.7	0.121	0.080	8.20	1.50	4
M 11	0.7	0.121	0.068	8.20	1	5
M 12	0.7	0.121	0.073	8.20	0.5	7

Repetition 2. Table 3 shows data obtained after chitosan treatment at different amounts and different pH levels, for example in this repetition 2 the greatest reduction in Lead concentration was at pH 2.5 with 0.3g of chitosan varying from 0.121 ppm to 0.010 ppm

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Table 3. Results of repetition 2 treated with chitosan

	Amount of chitosan adsorbent (g)	Initial concentration of Lead (ppm)	Final concentration of Lead (ppm)	initial pH	Amount of acetic acid to 90% (mL)	final pH
M 1	0.3	0.121	0.010	8.20	2	2.5
M 2	0.3	0.121	0.020	8.20	1.50	4
M 3	0.3	0.121	0.016	8.20	1	5
M 4	0.3	0.121	0.018	8.20	0.5	7
M 5	0.5	0.121	0.030	8.20	2	2.5
M 6	0.5	0.121	0.056	8.20	1.50	4
M 7	0.5	0.121	0.044	8.20	1	5
M 8	0.5	0.121	0.053	8.20	0.5	7
M 9	0.7	0.121	0.047	8.20	2	2.5
M 10	0.7	0.121	0.076	8.20	1.50	4
M 11	0.7	0.121	0.064	8.20	1	5
M 12	0.7	0.121	0.073	8.20	0.5	7

Repetition 3. Table 4 shows data obtained after chitosan treatment at different amounts and different pH levels, for example in this repetition 3 the greatest reduction in Lead concentration was at pH 5 with 0.3g of chitosan varying from 0.121 ppm to 0.010 ppm.

Table 4. Results of repetition 3 treated with chitosan

	Amount of chitosan adsorbent (g)	Initial concentration of Lead (ppm)	Final concentration of Lead (ppm)	initial pH	Amount of acetic acid to 90% (mL)	final pH
M 1	0.3	0.121	0.023	8.20	2	2.5
M 2	0.3	0.121	0.018	8.20	1.50	4
M 3	0.3	0.121	0.010	8.20	1	5
M 4	0.3	0.121	0.031	8.20	0.5	7
M 5	0.5	0.121	0.045	8.20	2	2.5
M 6	0.5	0.121	0.058	8.20	1.50	4
M 7	0.5	0.121	0.055	8.20	1	5
M 8	0.5	0.121	0.045	8.20	0.5	7
M 9	0.7	0.121	0.063	8.20	2	2.5
M 10	0.7	0.121	0.082	8.20	1.50	4
M 11	0.7	0.121	0.071	8.20	1	5
M 12	0.7	0.121	0.076	8.20	0.5	7

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Percentage of Lead removal using chitosan.
To determine the efficiency of chitosan the following equation was used

$$\% \text{ Removal} = \frac{\text{CI} - \text{CF}}{CI}\ X\ 100\%$$

Luego:

CI = Concentration initial = 0.121 ppm
CF = Concentration final = 0.012 ppm

Table 5. Percentage removal of Lead.

Treatment	Chitosan concentration (g)	pH	Initial concentration of Lead (ppm)	Final concentration of Lead (ppm)				Percentage removal
				Repetition1 (ppm)	Repetition 2 (ppm)	Repetition 3 (ppm)	Average (ppm)	
M 1	0.3	2.5	0,121	0.021	0.010	0.023	0.018	85
M 2	0.3	4	0,121	0.022	0.020	0.018	0.02	83
M 3	0.3	5	0,121	0.010	0.016	0.010	0.012	90
M 4	0.3	7	0,121	0.030	0.018	0.031	0.0263	78
M 5	0.5	2.5	0,121	0.043	0.030	0.045	0.0393	67
M 6	0.5	4	0,121	0.064	0.056	0.058	0.0593	51
M 7	0.5	5	0,121	0.052	0.044	0.055	0.0503	58
M 8	0.5	7	0,121	0.041	0.053	0.045	0.0463	61
M 9	0.7	2.5	0,121	0.065	0.047	0.063	0.0583	51
M 10	0.7	4	0,121	0.080	0.076	0.082	0.0793	34
M 11	0.7	5	0,121	0.068	0.064	0.071	0.0676	44
M 12	0.7	7	0,121	0.073	0.073	0.076	0.074	39

Replacing It is obtained:

$$\% \text{ Removal} = \frac{0.121 - 0.012}{0.121}\ X\ 100\% = 90\%$$

Table 5 shows Lead data obtained after treatments at different pH levels and different amounts of chitosan. It is observed that the initial Lead concentration was 0.121ppm and after using the procedure, it was obtained that treatment 3 (pH 5 with 0.3 g of chitosan) was the one that presented a greater reduction of Lead (90%) in the water obtaining a value of 0.012 ppm of Lead. On the other hand, treatment 10 (pH 4 with 0.7g of chitosan) was the one that presented a lower Lead reduction (34%), compared to the rest of treatment.

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4. Conclusions

- The highest efficiency of chitosan was 90% having an initial concentration of 0.121 ppm of Lead and a final concentration of 0.012 ppm at conditions of pH 5 and 0.3 g of chitosan, while the lowest efficiency was 39% with pH 7 and 0.7g chitosan mass
- The chemical factors of adsorption using chitosan influence Lead removal. The adsorption of Lead in aqueous media is favored between pH 5 and 6, since at lower pH there is a competition between Pb and H+ ions for the active sites of chitosan, which Leads to a lower efficiency of removal capacity. As for pH higher than 6, crystallization and precipitation of Pb in the form of hydroxides occurs

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