THE USE OF WATER TREATMENT PLANT - WTP RESIDUE TO REMOVE TOXIC COMPOUND FROM WATER

Maira Cardoso Monje; Evelyn Loures de Godoi, Nilce Ortiz

Abstract *— A small unit of water treatment plant produces about 15 ton/ month of sludge on the sedimentation tank – the WTP sludge. When the impurities of the raw water are dissolved the water treatment have to be more demanding, specific and costly, turning the process almost economically inaccessible. The use of WTP sludge as abundant and low cost adsorbent bed can help the water treatment to be accessible, also for industrial and domestic discharge with the adsorption of soluble heavy metals, phosphate and organic compounds. The pellets prepared with WTP sludge were used on column with ascendant flux for the adsorption of lead ions on solution. The obtained results indicates the adsorption of 89% of the total lead ions presents in solution and the initial concentrated solutions shows the tendency to be adsorbed more efficiently them the diluted ones with 10h of continuous pumping to reach the equilibrium time.*

Key-words— Lead, water, adsorbent, adsorber, sludge, treatment, plant, residue, effluent.

I. INTRODUCTION

The treatment of industrial effluents and domestic sewer is an important factor for the health of any community. In the past, the wastewater discharge method was the dilution in the near stream, river or lake, where the oxygen would facilitate the process of organic matter decomposition. This procedure, however, is not more accepted, due the large amounts of effluent discharge generated for the increasing of the population and the development of the industry. Nowadays, the main purposes of the wastewater treatment plants are the null discharge of pollutants, with the possibility of the treated water to be discarded directly into the water bodies reducing the environmental contamination into water bodies.

Many chemical processes have been developed to reduce the cost of wastewater treatment to reach the environmental patterns for water discharge adopted for the government environmental control agency.

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The process of adsorption with non conventional adsorbents to remove soluble toxic ions of domestic discharges have shown promising due the low cost, the resultant reduction of water toxicity and the maintenance of the water quality with the control of the eutrofization process with the undesirable seaweed growth on surface waters.

The method usually applied to wastewater treatment is divided three steps first the physical treatment, second the biochemist treatment and the tertiary treatment .The primary treatment remove about 60 % of suspended solids with the reduction of the Biochemist Oxigen Demand (BOD), in this step the effluent is chlorinated to eliminate the bacteria and virus. In the primary treatment the some coagulants are added to increase the sedimentation of fine particles, some salts of iron or aluminum are added to form iron or aluminum hydroxide, they also can be used some organic polymers [1]. The primary treatment, when made separately, is considered insufficient by the modern standards, therefore it leaves part of fine particles and the all soluble ions in suspension. The secondary treatment is applied trying to dissolve and oxidated organic substance to reduce the values of BOD on 85% to 90%. The process reproduces the natural conversion carried through by the microorganisms by the addition of the resultant active silt of a previous treatment in the entrance of the sewer system, the system is submitted to air pumping to increase the decomposition rate of the organic matter, after that the treated water is separate by sedimentation and the resultant silt of the process can be sent as fertilizer. The tertiary treatment of sewers involves a processing to be applied after the secondary treatment, usually more costly then the two others steps; It is applied to remove soluble toxic pollutants that do not represent variation in the values of BOD. In many cases the quality of the water after the secondary treatment can be not considered satisfactory, the water still contains soluble toxic ions as some metals, phosphate, nitrogen and carbon and when they are bioacumulated they can be toxic or a nutrient for the seaweed growth and other aquatic plants.

A. *Soluble lead on wastewaters*

The toxic metals are common to appear in industrial effluents, they are a result of the effluent discharge of industrial chemicals compounds such as the generated on metallurgy, industries of inks and pigments and especially the metal treatment plants. In natural waters the metals are present as solubilized ions, precipitated as inorganic particles or in water suspension, they can be adsorbed in particles for sedimentation, they can also be accumulated in aquatic organisms and living creatures. The ways which the metals are carried in the water depends on factors as physical, chemical and biological nature [2]. Usually the toxic metals reach the man by water, air and sediments, tending to be bioacumulated. Some metals are accumulated by the alimentary chain, and the predators show the largest concentrations. However, the vertebrates are the animals that present the higher concentrations. The lead and the soluble cadmium have the preference to be accumulated in macroinvertebrates, zooplancton and fish. The lead is present in the contaminated air, the tobacco, some drinks and foods, these last ones, of course, for contamination with the packing. The lead as metallic ion has been present in the water due to the industrial effluent discharges as the industrials discharge of batteries producers, as well as the use in the production of inks and accessories based on lead. The maximum limit of the lead content at the potable is established on 0,05 mg L^{-1}.

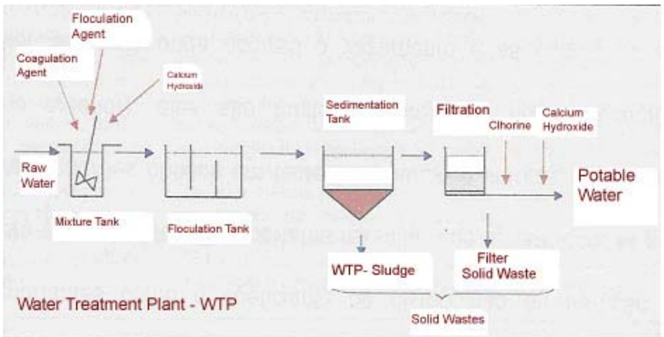
B. Water Treatment Plant Sludge

In spite of the raw water is usually collected at higher quality rivers and streams, it always has a variety of impurities which demand a removal treatment before use. The applied treatment always depends on the water quality but usually include flocculation, decantation, filtration and disinfection. The water treatment for potable water supply for the population, any lack of water treatment will result on endemic diseases directly related with the contaminated water drinking. The two most important requirements for the water supply are the absence of pathogenic microorganisms and the low solid content [3]. The first step of water treatment plant will depends of the quality of the collected raw water. If the water to be treated were not with correspondent quality the treatment will be very costly and in many cases it will turn the treatment almost economically impracticable [4], see Figure 1.

The flocculation process is responsible for the separation and sedimentation of the impurities presents in raw water, the forming flakes are separated from the water by sedimentation on the sedimentation tank, after that the liquid phase is pumped to a series of press filters where the remained flakes will be collected. The stages of flocculation, decantation and filtration receive the name clarification. In this phase, all the particles of impurities are removed after the disinfection step, Figure 1.

The silt composition on the water will depend of the quality of the raw water. In many cases it is almost integrally composed by fine and colloidal particles with the predominance of clay fraction. The total solid particles presents at WTP silt vary between 1.000 and 40.000 mg L^{-1}, with 75% to 90% of suspended solids [5].

The present work is a part of another project to study the solid residues composed by small particles with high surface area to be used as adsorbent material to remove toxic compounds of contaminated water[6]. Water samples of the urban streams with dense pollution as Jaguaré and Pirajuçara will be analyzed and solutions with similar concentrations will be prepared and submitted to the adsorbent processes to remove lead ions in solution. The study indicate if pellets of Water Treatment Plant – WTP sludge can be used as adsorbent bed on columns to remove lead ions dissolved in residuary urban stream waters.



ADAPTED FROM [5]
FIGURE 1: THE FLOW CHART OF WATER TREATMENT PLANT -WTP

II. MATERIALS AND METHODS

The sludge was collected at the sedimentation tank. It was dried, crushed and send to the characterization, a part of the powder was mixtured with bentonite to prepare the pellets. After the preparation they were dried and calcinated at 800°C for 1h. The mixture with bentonite was necessary to improve the plastic properties to obtain the pellets with suitable properties for the adsorption processes.

The adsorption column was prepared using the WTP pellets with the water entrance from the bottom of the column. A Pump was installed at the upper part of the column; it was the responsible for the ascendant water flux. The pellets was weigh after and before the adsorbent process in the beginning it was about 12 g and after 10 h continuous flow the weigh was usually higher. The lead solution was prepared using lead nitrate obtained as chemical reagent. The lead content was chosen to be near the values measured at the Pirajuçara and Jaguaré urban stream. The volume of 6 L of solution of lead was treated on flow rate of 60 L min^{-1}, in pH 5 and different initial concentrations. The lead concentrations were measured on different time for pumping as 2, 10, 30, 60, 120, 240, 300, 360 min and 8, 24, 26, 28, 30 and 32h. The collected samples on different time intervals were centrifuged and in the solution the lead concentration was analyzed. Initially the results of lead concentration were obtained using complex titration, but at the end of the adsorber process the concentration level became to low for titrations and the concentrations were obtained by Induced Coupled Plasma Spectrometry - ICP/AES.

III. RESULTS E DISCUSSION

The WTP sludge was characterized and the results show a particle matter mainly composed by silicate, aluminum and iron oxide. The results obtained by X Ray Diffraction shows main composition of quartz and aluminum oxide.

The removal percentage presented at Table I confirm the possibility of the use of WTP sludge as adsorbent to remove lead ions on solution and shows the removal percentage for lead ions on different initial concentrations.

The results indicate the concentrated solutions as the higher removal percentage of lead with the tendency to reduce for diluted ones. The higher removal percentage was observed for initial lead solution of 14, 92 mg L^{-1} with 89% of removal percentage.

TABLE I

THE REMOVAL PERCENTAGE OF LEAD IONS IN SOLUTION

Initial Concentration (mg L^{-1})	Removal Percentage(%)	Sigmoidal Qui^2	Sigmoidal R^2
14,92	89	0,003	0,985
4,02	56	0,008	0,879
3,80	67	2,037	0,969
1,66	45	0,009	0,692
1,57	58	0,003	0,997

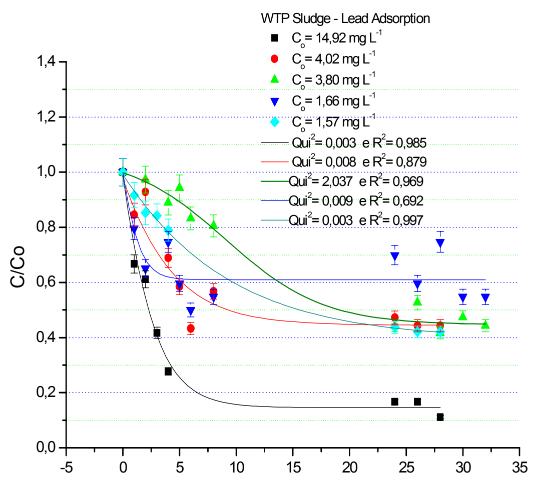


FIGURE 2: THE RELATION BETWEEN THE CONCENTRATIONS (C/CO) FOR LEAD IONS ADSORPTION.

The sigmoidal curves were obtained by experimental measurements and the relation between the lead concentration (Ct) at time interval t and the initial concentration (Co) shows better correspondence for the concentrated lead solutions, see Figure 2. The equilibrium time was observed by time interval of 10 h of continuous pumping, when the adsorption process reaches the equilibrium condition for all initial concentrations.

VI. CONCLUSION

The collected sludge at the sedimentation tank of a small unit of Water Treatment Plant is main composed by quartz and aluminum oxide in small particle size and can be use as adsorbent for soluble lead ions removal, showing the removal percentage of 89% and 10h for continuous pumping to reach the condition of equilibrium. The experimental data confirm the possibility of the WTP sludge be used as adsorbent bed in the tertiary step on the sewage and wastewater treatment plant to remove soluble toxic ions in solution.

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