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New Treatment for Industrial Wastewater of Batteries Industry

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الملخص العربى

نتيجة التلوث البيئى الناتج من الزيادة المستمرة فى الصناعات ، وتمثل المعادن الثقيلة الموجودة فى المخلفات الصناعية السائلة مشكلة اساسية وتمثيل خطورة كبيرة على البيئة ومن الملوثات الخطيرة شديدة السُمية. ويوجد طرق عديدة لازالة المعادن الثقيلة لكنها مكلفة وبالتالى تم الاتجاه لاستخدام طرق ومواد غير مكلفة ولذلك تم تجربة استخدام الطين فى ازالة المعادن الثقيلة (الرصاص) عن طريق الادمصاص.

واوضحت الدراسة زيادة نسبة الازالة كلما زاد العمق المستخدم وقل معدل سريان المياه خلال المادة المدمصة بنسب ازالة للرصاص تصل الى 92.25 % باستخدام الطين الاسوانى كمادة مدمصة والتى تعتبر مادة رخيصة وغير مكلفة ولا تحتاج الى معالجة خاصة قبل الاستخدام لمعالجة مياه الصرف الصناعى من المعادن الثقيلة وبالتالى تحقق توفير كبير فى التكلفة الخاصة لمعالجة الصرف الصناعى وايضا المادة متوفرة و بتكلفة رخيصة.

ABSTRACT:

The environmental pollutions which produced from the rapid industrialization become a serious issue, and therefore efficient methods are needed for the different industries. The Heavy metal ions are reported as priority pollutants, due to their mobility in natural water ecosystems and due to their toxicity. There are many ways to remove the heavy metals but with a high cost and therefore there is a need to use a low cost materials and methods for the removal process. In this study the adsorption method using a low cost material (clay) to remove the heavy metal (lead) from the industrial wastewater. The study shows that the removal ratio increases as the media depth increases and as the rate of filtration decreases with lead removal ratio up to 92.25 % using the clay as Adsorbent filtration media which its cost not high and doesn't need a pretreatment before using for the heavy metal removal from the industrial wastewater, and therefore it saves a lot of cost and also the material is available.

KEY WORDS

Wastewater treatment, Industrial wastewater treatment, Batteries wastewater, Removal of heavy metals, Lead (II), clay.

INTRODUCTION

The environmental pollutions which produced from the rapid industrialization become a serious issue. Heavy metals which are presented in the industrial effluent wastewater is a major environmental pollution concern. The Most elements which fall into this category are greatly water soluble, recognized toxics and carcinogenic agents. Heavy metals are considered to be as the following elements: Silver, Copper, Cadmium, Zinc, Gold, Lead, Mercury, Chromium, Tin, Iron, Selenium, Nickel, Arsenic, Manganese, Molybdenum, Cobalt, and Aluminum[1].

These heavy metals are not biodegradable and their presence in streams and lakes leads to bioaccumulation in living organisms causing health problems in animals, plants, and human beings. They could be absorbed and accumulated into the human body causing severe health effects such as cancer, nervous system damage, organ damage, and in acute cases, death. It also reduces development and growth[1].

Since even the low amounts of these heavy metals are extremely toxic, the heavy metals removal from wastewater has lately become the considerable interest subject as a result of strict legislations. Wastewater regulations were founded to lessen human and environmental exposure to the hazardous chemicals. These include limits on the heavy metal types and concentration which may be existing in the discharged wastewater[1]. The mix between the toxic wastewater streams and other wastewater streams should never be allowed or then the whole mixed volume will have to be treated as toxic, which then the load on the treatment effluent and pollution control would be increased tremendously[2].

LITERATURE REVIEW

In a study [3], the adsorption method using raw agricultural wastes (Ficus trees trimming output) to remove heavy metals Zn^{+2} and Cr(VI) from industrial wastewater was made. The obtained removal ratios using Ficus trees trimming output were 68.67%, 77.80% for Zn^{+2} and Cr (VI), respectively. The result showed that, the removal efficiency increased by increasing the adsorption contact time, and the flow rate were decreased. It also showed that, the removal efficiency for zinc better than Cr (VI) using Ficus trees trimming output.

El Nadi et al, [4], in their work applied the adsorption method using activated carbon prepared from carrot juicing waste to remove heavy metals Cd^{+2}, Zn^{+2} and Mn^{+2} from industrial wastewater. The obtained removal ratios were 73.5%, 91.75%, 68.5% in average for Cd^{+2}, Zn^{+2} and Mn^{+2}, respectively. The result showed that, the removal efficiency increased by increasing the adsorption contact time. It also showed that, the removal efficiency for zinc better than the other metals.

A research [5] is devoted to remove of the nitrogenous compounds from the industrial wastewater of fertilizers industry. To minimize the treatment cost the natural clay from Aswan commonly known as "Hebba" was applied to adsorb the main three nitrogenous compounds of wastewater which are nitrate, nitrite and ammonia. The results of study achieved removal efficiencies 53% for NO_3^-, 58% for NO_2^- & 55% for NH_4^+ that give the acceptance to dispose this wastewater to the stream bodies according to Egyptian law permissible limits.

STUDY OBJECTIVE

Heavy metals present with high concentration in the industrial effluent wastewater and these metals have sever effects on the environment and to the human health if they disposed directly to the environment. The heavy metals removal cost from the wastewater is high and therefore this study main purpose is to check the best treatment for the removal of some heavy metals (lead) from the wastewater by adsorption with filtration using low cost materials which are easily available.

MATERIALS AND METHODS

This study was conducted to reduce the lead concentration from the batteries industry's wastewater by applying a low cost technique. This study was placed at the sanitary engineering laboratory, faculty of engineering, Ain Shams University.

Operation was done on synthetic water consisted of tap water with lead represented in the batteries industry's waste water.

The treatment process were the adsorption with filtration and the materials used for treatment process were: Aswan clay with density (1900 kg/m3) & void ratio (40 – 45 %) as illustrated in figure (1).

Figure (1) Aswan Clay

The used pilot is illustrated in figures (2) & (3) consisted from the following:

1. Four Plexiglass pipe columns, each pipe's diameter is 100 mm and its height 2m.
2. Feeding tank with capacity 200 liters contains the raw water for the study
3. Connecting pipes with diameter = 0.5 inch (12.7 mm).
4. Control valves on each pipe column influent and effluents as well.
5. Motor for delivering the raw water from the feeding tank to pipe columns.
6. Adsorbents filter media

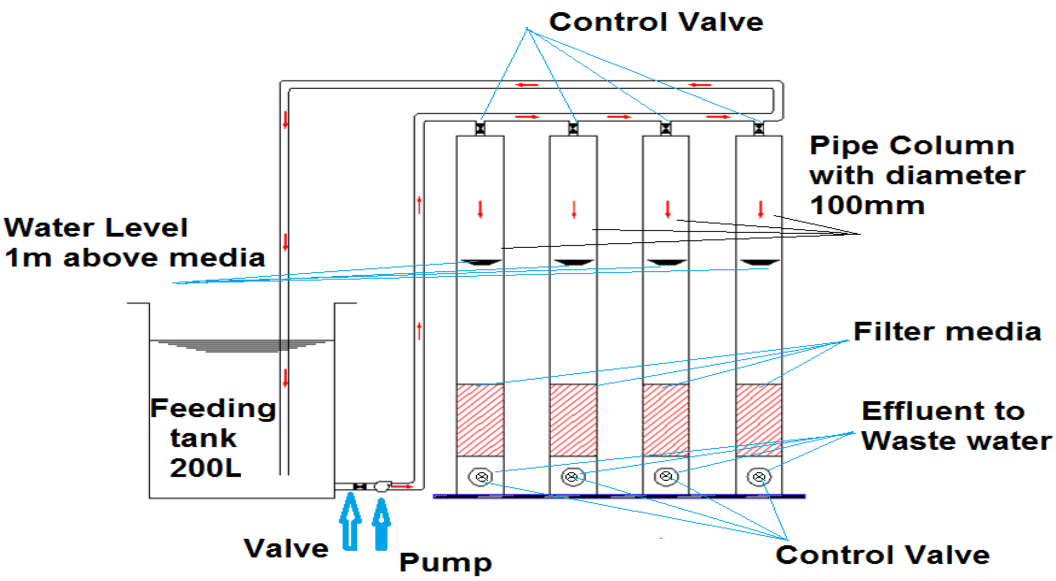

Figure (2) schematic of pilot used in the study

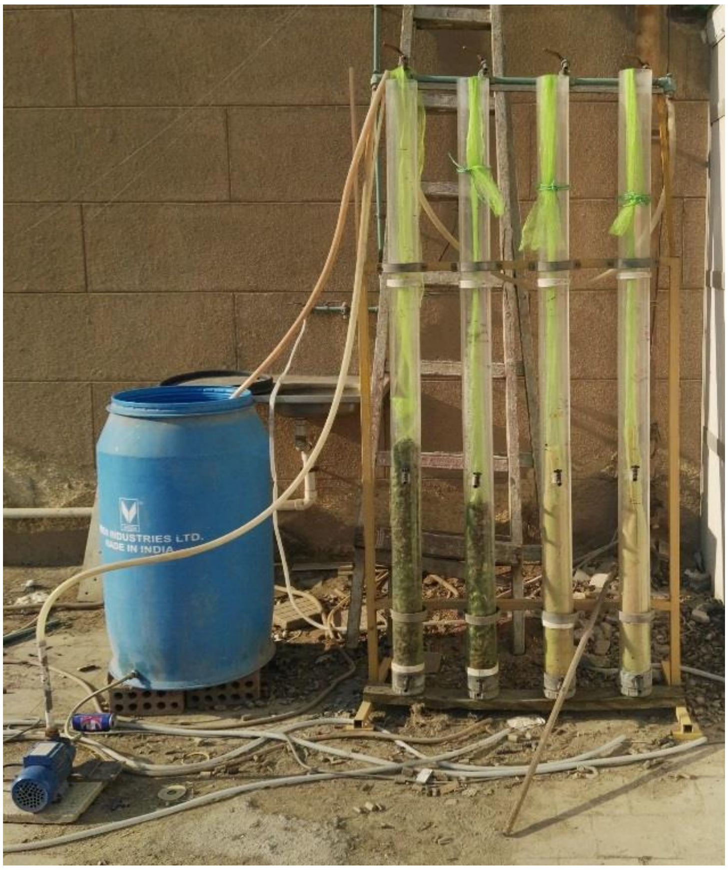

Figure (3) Pilot used in the research

The study was done on two runs. The first run we change the depth of the selective media (Clay) to find the most effective depth and the life time for each depth, and at the second run we take the effective depth as the result of the first run and change the rate of filtration to find the optimum rate of filtration.

The heavy metals concentration had been measured according to the standard methods at the Central lab of Ain Shams University using Spectrophotometer (C109 type, HANNA Instruments, Italy.

Figure (4) C109 – Spectrophotometer instrument

The pH value was measured by using the pH meter (portable pH meter HANNA Instrument, Italy) at the chemistry lab of the Engineering Faculty of Ain shams university as shown in figure (5) we've measured the pH value.

Figure (5) PH Meter

The sample locations were at each pipe's influent and at each pipe's effluent column, the sampling was taken every day, the sampling was taken until it was the same between two successive days' readings.

The sampling numbers were six samples each day, three samples at the pipe's influent and three samples at the pipe's effluent as presented in table (1).

Table (1) Samples Taken from synthetic water contains lead only

Time		Column 1	Column 2	Column 3
First day	**Influent**	-	-	-
	Effluent	-	-	-
Second day	**Influent**	x	x	x
	Effluent	x	x	x
Third day	**Influent**	x	x	x
	Effluent	x	x	x
Fourth day	**Influent**	x	x	x
	Effluent	x	x	x
Fifth day	**Influent**	x	x	x
	Effluent	x	x	x
Sixth day	**Influent**	x	x	x
	Effluent	x	x	x

-No samples were taken.

X Samples were taken.

RESULTS

RUN I (MEDIA EFFECTIVE DEPTH):

This run was going on getting the effective depth. The media were placed in the pilot as follows:

a. First column: Depth of the clay 100 cm.
b. Second column: Depth of clay 80 cm.

c. Third column: Depth of the clay 60 cm.

Figure (6) shows the relation between the time in days and the effluent lead concentration for Run I.

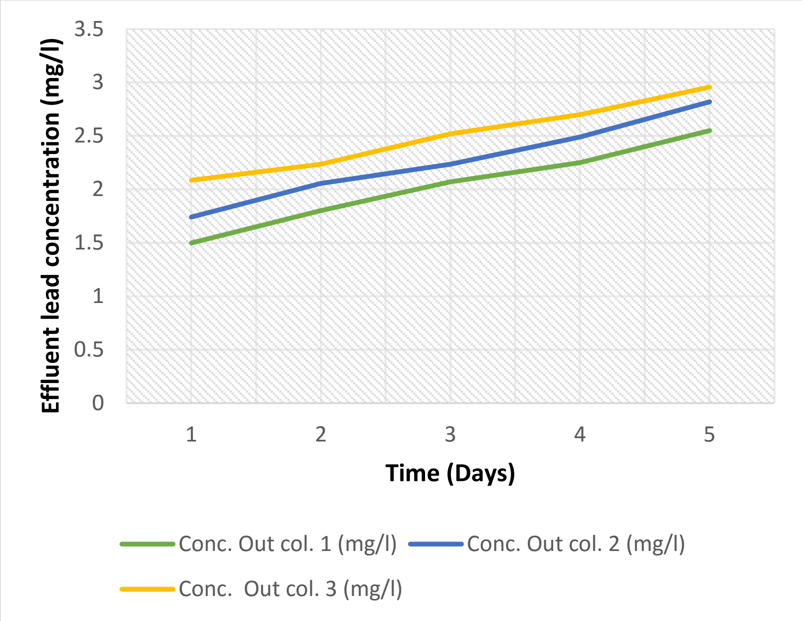

Figure (6) Effluent lead concentration versus Time in Run I.

Figure (7) shows the relation between the time in days and the removal efficacy for Run I.

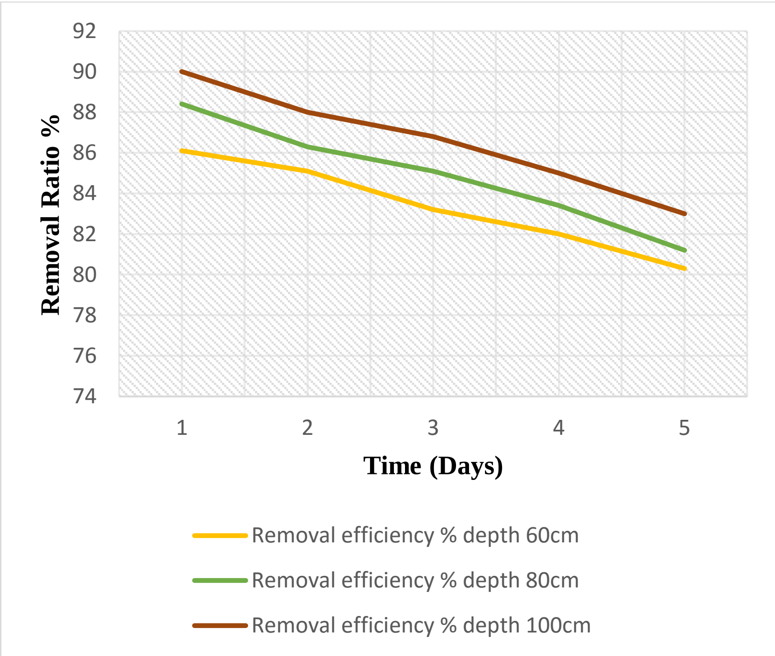

Figure (7) removal efficiency with different depths of Clay at run I

From the previous results the most effective depth would be 1m with Removal Ratio ≈90 %.

RUN II (OPTIMUM FILTRATION RATE):

This run was going on getting the Optimum Filtration Rate. The media were placed in the pilot as follows:

a. First column: media depth 100 cm with rate of filtration 3l/h (0.382 m3/m2/h).
b. Second column: media depth 100 cm with rate of filtration 2l/h (0.255 m3/m2/h).
c. Third column: media depth 100 cm with rate of filtration 1l/h (0.127 m3/m2/h).

Figure (8) shows the relation between the time in days and the effluent lead concentration for Run I.

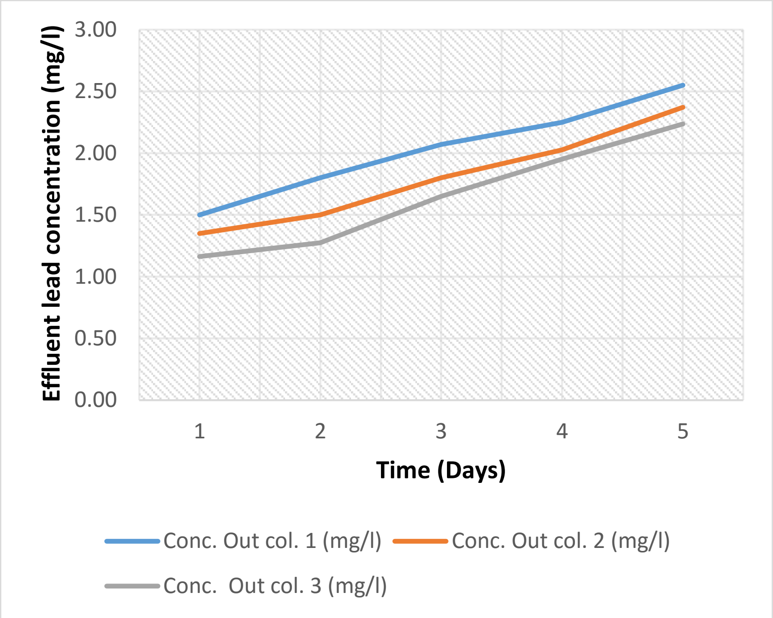

Figure (8) Effluent lead concentration versus Time in Run I.

Figure (9) shows the relation between days and the removal efficiency percentage for each column in run II.

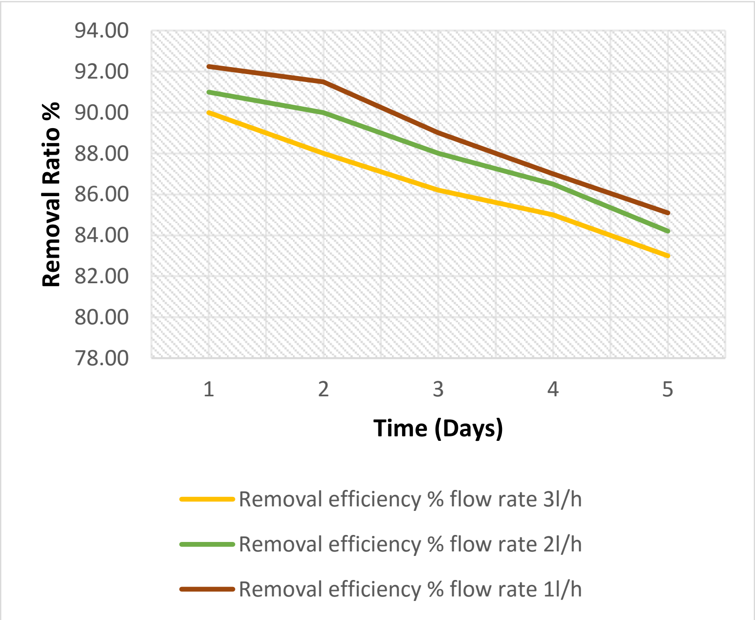

Figure (9) removal efficiency with different filtration rate for Clay at run II.

So, the most effective rate of filtration in removing lead from the wastewater is 1l/h where its removal ratio ≈92.25 %.

So, as the rate of filtration decreases the contact time increases and the removal ratio increases.

Finally, from the previous two runs it can be concluded that the most suitable media of clay for high efficiency removal of lead is with 100 cm depth and filtration rate 1l/h.

CONCLUSIONS

From the results of the study the following conclusions could be illustrated:

- The most effective depth and hydraulic load in removing lead were 100cm depth and hydraulic load 1.0 l/h for clay.
- The clay removal ratio for lead were 92.25 %.
- The pH value of water did not change through the study, so it doesn't affect the removal efficiency of heavy metals using these materials.
- The change in temperature was limited and did not affect the removal ratio of the heavy metals.

RECOMMENDATIONS

The following recommendations could be resulted from this study as follows:

- The use of low cost materials as (clay) for removing the lead from the wastewater instead of using a high cost methods.
- The use of these low cost materials clay at factories of high level of lead, to minimize the cost of treatment of wastewater.

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