International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Heavy Metals Removal from Agricultural Drains using Rice Husk inside the Stream

El Nadi, M. H., Abd Alla, M.A.F.

Abstract: ***With the stabilization in water amounts on earth and the population growth and the water use increase in human life with the progress of all facilities and industries, the need to reuse of all available water resources be the most important issue for the research specially the reuse of all wastewater types. For the agricultural wastewater is the huge amount of wastewater and also it is the main disposal for all other wastewater, so its treatment became the most easy way to get new water resource with big quantities and continuity. The most serious problem in the drain wastewater is industrial wastewater pollutants for its containing of heavy metals and toxic substances. The study concentrates on finding a low cost and easy treatment procedure to make the dream of the agricultural drain wastewater reuse possible.***

Several studies applied agricultural wastes as an adsorbent material for removing successfully heavy metals from wastewater. So, in this study rice husk was used by putting as a block across the steam to work as adsorbing filter to remove the existing zinc and chromium appears due to industrial wastewater direct disposal in agricultural drains wastewater.

The obtained Zn+2 removal ratios was 94.33% and Cr (VI) removal ratio was 89.2%. The study illustrated that the removal ratio is proportional with the adsorption media length for the contact time increase. The rice husk waste achieved removal efficiency for zinc better than Cr (VI).

The success of use the agricultural waste as cheap adsorbent in treatment of agricultural drains wastewater polluted from industrial wastewater open the door for the existing drains to be easily treated with minimum cost and no effect on their profiles and saving the environment from heavy metals harm pollution.

KEY WORDS: Agricultural drains treatment, Industrial wastewater treatment, Removal of heavy metals, Reuse of agricultural waste.

I. INTRODUCTION

With the stabilization in water amounts on earth and the population growth and the water use increase in human life with the progress of all facilities and industries, the need to reuse of all available water resources be the most important issue for the research specially the reuse of all wastewater types.

For the agricultural wastewater is the huge amount of wastewater and also it is the main disposal for all other wastewater, so its treatment became the most easy way to get new water resource with big quantities and continuity..

Revised Manuscript Received on December 30, 2019.
***** Correspondence Author
El Nadi, M. H., Emeritus Professor of Sanitary & Environmental Engineering, PWD, Fac. of Eng., ASU, Cairo, Egypt. Email: mhnweg@yahoo.com
Abd Alla, M.A.F. *, Assistant prof. of Irrigation and Hydraulics, civil Eng. Dpt., Fac. of Eng., CIC, 6th of October City, Giza, Egypt. Email: marwa_solamody@yahoo.com

Industrial wastewater is the most serious pollutants in the drain wastewater for its high contents of toxic substances and heavy metals

The removal of heavy metals from water is mainly made by three techniques, physical, chemical and physico-chemical techniques. The choice between them depends on the amount of pollutant and its concentration and continuity. The technique choice depends on several factors as the optimum conditions, removal efficiency, chemical residues and operating cost.

Industrial wastewater normally contains high levels of traces metals. The metals in low concentrations as zinc and chromium are harmless, but may be toxic in combination with other metals or under specific environmental conditions. These metals are the source of water pollution due to industrial wastewater disposal. That raises the need to treat these metals from even the industrial wastewater before its disposal to water streams which is very difficult and expensive even with small quantities of water or from agricultural drains wastewater after disposing this industrial wastewater in it to take the dilution effect.

The required chemicals and power made most of treatment applied methods with very complicated and high cost. The study concentrates on finding a low cost and easy treatment procedure to make the dream of the agricultural drain wastewater reuse possible. Several studies applied agricultural wastes as an adsorbent material for removing successfully heavy metals from industrial wastewater, But with small amounts of polluted wastewater.

II. LITERATURE REVIEW

Agriculture waste is applied for water and wastewater treatment as natural low cost material in several studies. It is used as raw material or used as activated carbon after conversion to be applied as an adsorbent material for removing metals or any substances. Also it is used as a biodegradable media for decreasing organic loads from all types of wastewater. And it is used as physical filter for decreasing suspended solids.

Generally, the activated Carbon prepared from plants bases was used successfully for heavy metals removal from water resources, wastewater and industrial wastewater [1]. This was for its high adsorption properties that achieved the activated carbon success with the removal of all types of heavy metals. Several agricultural wastes had used to produce activated carbon that applied for heavy metals removal from water as coir pith [1], pecan shell [2] and carrot juicing waste [3&4], Hazelnut shell [5] & Tamarind wood [6].

The activated carbon is a very expensive material and it consumes a lot of plants as raw material. That make the treatment by activated carbon to remove heavy metals is not the happy solution especially with huge amounts of water like agricultural drains water streams [4].

Several studies applied the agricultural wastes direct as an adsorbent in the treatment of industrial wastewater of low amounts before its disposal in the environment to minimize the treatment cost and get very cheap solution for environment protection without increasing the manufacturing cost that reflect on the industry success [7].

Several types of agricultural wastes were applied as ficus trees trimming outputs [8], palm fibers [9] & rice husks [7&10]. These applications were for different purposes as its application as biodegradable material for encourage the biological action to take place inside the stream [7 & 8], or heavy metals removal [9] or generally enhancing the water quality [8]. One of these successful agricultural wastes was the Rice husk [7].

Rice husk is used for pollution control inside water stream bodies after the sewage disposal points by working as biodegradable material to encourage the biological action to take place that minimize the time and distance for self purification required by 70-80 %. This showed the success of application [7].

Rice husk was applied in adsorption treatment of dye industrial wastewater to remove heavy metals and dye from it before its disposal. It was studied to replace the currently expensive material as activated carbon. The heavy metals removed successfully were As+5, Au+3, Cr+4, Cu+2 and Pb+2, Fe+3, Mn+2, Zn+2 and Cd+2 [1].

Fixed bed of carbonate treated rice husk was studied to remove Cd2+ from wastewater. The removal ratios results for the different depths of media were varied between 70.30% and 30.40 % that presented the success of such agriculture waste media in removing Cd2+ from wastewater [11].

- Rice husk as an economic and cheaper natural material was used for nickel removal from wastewater. The removal efficiency depends on the properties of the adsorbent, pH, contact time, adsorbent dose and initial concentration of nickel. Maximum removal ratio was 51.8% with dilute solution at 20 g/L adsorbent dose [12].

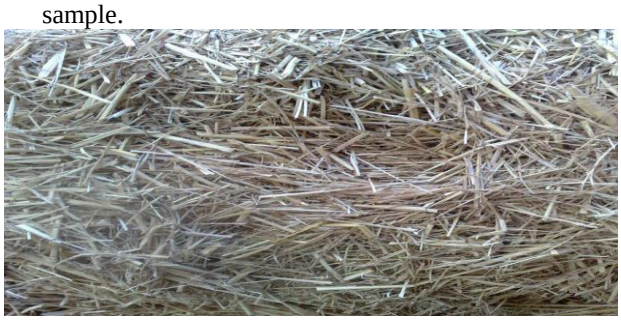
III. STUDY OBJECTIVE

In this study the application of agricultural waste (rice husk fiber) is made to check its suitability to be applied with the agricultural drains wastewater to remove heavy metals from it as Zinc (Zn+2) and Chromium (Cr(VI)) to determine alow cost treatment procedure with the huge amount of water in the agricultural drains.

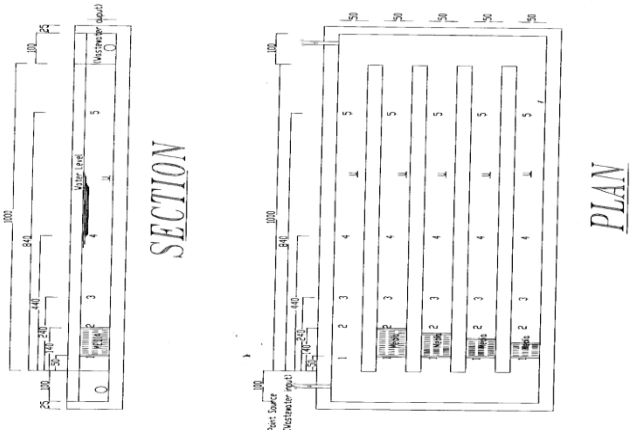
IV. MATERIALS AND METHODS

The experimental work in this study was divided to two main divisions, one for zinc removal and other for chromium removal. Each was aimed to obtain the best media width inside the stream by run each channel with new media width that varied between 30 cm to 120 cm. The work was done due to the following steps:

- Submerge the rice husk fiber that illustrated in figure (1) in water for one week to ensure its volume stabilization during experimental work.
- Build five channels from plain concrete bottom and bricks walls with width 30 cm, depth 70 cm for 50 cm water depth and length 10m for each in the site of Fakous city Drainage station at Baher El Bakar Drain Sharkiyah Governorate. Figure (2) shows the pilot sizing and figure (3) illustrates the pilot photo.
- Put the rice husk fiber in the channels with depth less than water depth by 2cm and variable widths 30, 50, 80 & 120 cm respectively for each channel.
- The feeding with drain water from the source drain made by submersible pump erected in the drain before its bed by 30 cm.
- Zinc or Chromium was added to the inlet channel from two concentrated chemical solution tanks to achieve concentration 3 ppm for Zinc and 5 ppm for chromium for the test needs to ensure the dose and the homogeneity..
- Enters wastewater from inlet channel to the longitudinal channels by open the control gates of it that let the flow passes through the media according to each run.
- Take five samples every day after two hours from operation to ensure continuity and concentrations stability. The sampling was taken one from inlet channel and one from each channel effluent (figure (4)).
- Measure the heavy metals (zinc or chromium) concentrations and also the pH & temperature for each sample.



1. **Pic. 1. Rice husk**



2. Fig. 1. Study Pilot

3. Pic. 2. Study Pilot

4. Pic. 3. Samples Collection

V. RESULTS & DISCUSSIONS

The study results of zinc removal from wastewater by rice husk fibers are presented in table (1).

Table- I: Results of run I

Days	Inflow Zinc conc.	Channels Effluent Zinc conc.at				Temp.	PH
		line1 (30cm depth)	Line 2 (50cm depth)	Line 3 (80cm depth)	Line 4 (80cm depth)		
1	3	1.860	1.620	1.300	0.870	26	6.5
2	3	1.750	1.500	1.180	0.830	27	6.5
3	3	1.620	1.330	1.060	0.750	26	6.5
4	3	1.480	1.190	0.990	0.610	25	6.5
5	3	1.290	1.070	0.820	0.490	24	6.5
6	3	1.180	0.950	0.710	0.320	26	6.5
7	3	1.180	0.890	0.650	0.270	25	6.5
8	3	1.130	0.86	0.600	0.250	25	6.5
9	3	1.110	0.800	0.600	0.210	26	6.5
10	3	1.125	0.800	0.590	0.170	24	6.5
11	3	1.150	0.780	0.530	0.170	21	6.5
12	3	1.180	0.76	0.450	0.180	20	6.5
13	3	1.210	0.75	0.390	0.250	23	6.5
14	3	1.240	0.65	0.430	0.320	22	6.5
15	3	1.310	0.75	0.480	0.440	20	6.5

From table (1) the results shows that the 120 cm media width achieved the best Zinc removal efficiency than other applied media widths of 30, 50 & 80 cm. This was acceptable and fit with previous studies [11& 7] due to more media surface area available for adsorption action.

The results of chromium (Cr(VI)) removal efficiency from wastewater by rice husk waste fiber are shown in table (2).

Table- II: Result of run II

Days	Chromium conc. at inflow	Chromium conc. of at channels effluent				Temp.	PH
		line1 (30cm depth)	Line 2 (50cm depth)	Line 3 (80cm depth)	Line 4 (80cm depth)		
1	5	2.53	1.87	1.58	1.37	12	6.5
2	5	2.37	1.71	1.44	1.23	11	6.5
3	5	2.22	1.57	1.32	1.16	9	6.5
4	5	2.08	1.45	1.26	0.98	7	6.5
5	5	1.93	1.32	1.18	0.85	7	6.5
6	5	1.84	1.28	1.12	0.68	8	6.5
7	5	1.75	1.16	1.04	0.63	12	6.5
8	5	1.67	1.09	0.94	0.55	14	6.5
9	5	1.52	0.99	0.85	0.54	14	6.5
10	5	1.52	0.99	0.79	0.65	15	6.5
11	5	1.54	0.93	0.75	0.63	17	6.5
12	5	1.53	0.92	0.73	0.61	15	6.5
13	5	1.55	0.94	0.70	0.63	15	6.5
14	5	1.61	1.02	0.64	0.69	14	6.5
15	5	1.56	1.09	0.65	0.73	15	6.5

Similarly, table (2) illustrates that the best media width for chromium removal efficiency was 120 cm compared with other applied media widths due to the more media surface area available with its small voids for adsorption to take place. This fits the previous studies [9] that showed the increase of removal efficiency with the increase in contact time through the adsorbent material. From the tables (1) & (2) the higher efficiency for heavy metals removal achieved with media width 120cm, achieving Zn+2 removal efficiency 94.33% and Cr(VI) removal by 89.20%.

VI. CONCLUSION

The study determined the following conclusions:

1. The adsorption method is the best easier treatment for heavy metals removal for its high removal efficiency, minimum modifications requirements in the stream and low cost especially with the agricultural wastes usage as adsorbent.
2. The rice husk fiber is a very successful adsorbent in zinc and chromium removal from agricultural drain water since it achieved 94.33% for Zn^{+2} and 89.20% for Cr(VI), respectively.
3. The rice husk fiber width of 120 cm achieved the highest removal efficiencies.
4. The adsorption action with rice husk media did not affected by both pH of water and the change in water temperature.

REFERENCES

1. K. Kadirvelu, K. Thamaraiselvi and C. Namasivayam,; "Removal of heavy metals from industrial wastewaters by adsorption onto activated carbon prepared from an agricultural solid waste", Bioresource Technology, V 76, P 63-65. (January 2001)
2. R.R. Bansode , J.N. Losso , W.E. Marshall , R.M. Rao and R.J. Portier,; "Adsorption of metal ions by *pecan shell-based granular activated carbons*", Bioresource Technology, V 89, P 115–119. (2003).
3. Abd Alla, M. A., "The Environmental Effect of Wastewater Disposal on Drains Water Pollution", M.Sc., Institute for Environmental Studies and Research, Ain Shams Univ, (2010).

4. El Nadi, M. H. & Abd Alla, M. A. F., " The Use of Carrot Juicing Waste in Removal of Heavy Metals from Industrial Wastewater", El Azhar Univ., Faculty of Eng., CERM of civil Eng., vol. 34, No. 2, March, (2012).
5. Demirbas E., Kobya M., Oncel S. and Sencan S.,; "Removal of Ni (II) from Aqueous solution by Adsorption onto Hazelnut Shell Acivated Carbon: Equilibrium studies", Bioresource Technology, V 48, P 291-93. (2002)
6. J. Acharya, J.N. Sahu, B.K. Sahoo, C.R. Mohanty and B.C. Meikap,; " Removal of chromium(VI) from wastewater by activated carbon developed from Tamarind wood activated with zinc chloride", Chemical Engineering Journal, V 150, P 25-39. (July 2009).
7. El Nadi ,M.H., El Azizy, E.M., Samy, Gh.M., Abdalla, M.A.F., "Pollution Treatment In Water Stream Bodies Using Rice Husk.", 10th International Conference on Civil & Architecture Eng., Military Technical Collage, (May 2014).
8. El Nadi ,M.H., El Azizy, E.M., Samy, Gh. M., Abdalla, M.A.F., "Using Ficus Trees Pruning For Pollution Treatment Inside Water Stream Bodies.", Faculty of Engineering Scientific Bulliton, Vol.1.,1687-1695, ASU, Cairo, Egypt. July, 2014.
9. El Nadi, M.H., ALi, N ., Ismail, S. and Abdelmomen, M.M., "Usage Of Palm Wastes Fiber In Removing Heavy Metals From Wastewater.", Australian Journal of Basic and Applied Sciences, 8 (16), Pages: 85-92, October, 2014.
10. Farag Allah M. Sh., El Nadi M. H., Bassioni GH. M. & Ibrahim M.S., "New Treatment for Industrial Wastewater of Batteries Industry,.", El Azhar Univ., Faculty of Eng., Civil Eng. Research Magazine CERM, vol. 41, No. 1, January 2019.
11. U. Kumar, M. Bandyopadhyay, "Fixed Bed Column Study for Cd(II) Removal from Wastewater Using Treated Rice Husk", J. of Hazardous Materials, B129, 253-259, (2006).
12. M. Bansal, D. Singh, V.K.Garg and P. Rose, International Journal of Civil and Environmental Engineering 1:2, (2009).

AUTHORS PROFILE

Prof. Dr. Mohamed El Hosseiny El Nadi
Prof. of Sanitary & Environmental Eng., Faculty of Eng., ASU.
B.Sc. in civil Eng. 1972 -1977, ASU.
M.Sc. in Sanitary Eng. 1979 – 1983, ASU.
Ph.D. in Environmental Eng. 1984 – 1989, ASU.
Fields of interest: Development of Biological filtration, developing of stabilization ponds in wastewater treatment, Anaerobic treatment for both wastewater & sludge, low cost technologies for sanitation, sludge dewatering and reuse, pollution control for water streams, desalination of sea water by new techniques, flotation in water treatment, Dynamic filtration in water treatment, leak detection in water networks, fire fighting techniques, groundwater contamination & air pollution control.

DR. Marwa Abdel Fattah Abd Alla Abdel Fattah
Assistant Prof. of Irrigation & Hydraulics, Civil Eng. Dept., CIC, Zayed Campus, Egypt. B.Sc in Civil Eng. ,2001, BHIT, Benha Univ. M.Sc. in Environmental Eng. , 2010, Institute of Environmental Studies and Researches, ASU Ph.D. in Irrigation and Hydraulics, 2015, Faculty of Eng. ASU Fields of interest: Water treatment, pollution control in water stream, environmental impact assessment