

Heavy Metal Extraction from Industrial Waste-Water: A Comparative Study

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ABSTRACT: Heavy metals consists of different heterogeneous group of elements which are persistent and toxic in nature. They are non-biodegradable hence if once they get entered into an eco-system, they are accumulated in an environment. Hence, there is an urgent need is generated to search out different methods to extract heavy metals from different contamination sources and let stop an environment being polluted. Now-a-days, different methods like precipitation, reverse osmosis, activated sludge process, adsorption are available for elimination of heavy metals from industrial waste water effectively. In the recent years, Adsorption method has been proved to be one of the best alternatives for collection of heavy metals from industrial effluent and is as efficient as conventional methods. In this article, an attempt has been made to use two alternatives as an adsorbent- activated carbon and pumpkin to treat the metal contaminated industrial waste water. The efficiency of heavy metal removal was checked by monitoring effluent quality parameters like BOD, COD, pH and intensity of heavy metal. It is found from the experimental work that pumpkin power is as efficient as activated carbon in heavy metal removal and hence can be used as more economical option for removing heavy metal from industrial effluent.

KEYWORDS: Heavy metal, Industrial waste water, Bio-sorption, Effluent, Pumpkin, Activated carbon

I.INTRODUCTION

Among all the pollutants, Industrial waste water is unsafe for all living organisms. From last few decades, a huge amount of industrial waste water containing different heavy metals is discharged into the rivers and lakes. It causes adverse effect on water environment and human's life. Due to discharge of a large amount of metal contaminated industrial effluent into the river, industries carry heavy metals such as Cd, Cr, Pb, Zn, Cu and As etc. which are most hazardous in nature and can be absorbed by all living organisms. Once they enter into the food chain, accumulation of heavy metals take place in the human body. If digested beyond the permissible limit, it causes serious health disease. Hence, it is necessary to treat the metal contaminated waste water efficiently by using different methods.

Different conventional methods are being utilized as per types of heavy metals and efficiency of the methods to eliminate heavy metals from effluent. However, there are two sides of coin, every methods have their own limitations. Hence, now-a-days, it is indispensable to look out for means to collect heavy metals from industrial waste water which is as efficient as conventional methods. For that, Adsorption is an innovative process for treating industrial waste water to achieve the treatment standards. Due to high degree of micro porosity, activated carbon is one of the adsorbents which is generally used to treat the metal contaminated waste water. Even though its inclusive uses to exclude the

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 5, May 2017

metals from waste water stream, it is an expensive adsorbent comparatively. So, it is necessitated to find out safe and economical methods as low-cost alternatives.

The need of less expensive adsorbent has been directed towards bio-sorption. Bio-sorption is one kind of adsorption process in which heavy metal elimination takes place by means of organic waste which is known as bio-sorbent. This process is described as less disruptive and quite effective method to collect heavy metal from industrial waste water in low-cost and environment friendly manner. Different bio-sorbents like rice husk, coconut shell, neem bark, banana pith have been generally used for treatment of metal contaminated industrial waste water. For this study, Agricultural waste by-product such as pumpkin has been used as a bio-sorbent by us for extraction of heavy metals from industrial effluent. The properties of Pumpkin which are responsible for removal of heavy metal is high cellulose content and presence of carboxylic acid in pumpkin.

Objectives of this work is to analyze the efficiency of heavy metal removal from industrial waste water by using activated carbon and pumpkin powder. Assessment of different waste water parameters like BOD, COD and pH is to be done by using various laboratory tests. It represents, the utilization of less expensive adsorbents for the elimination of heavy metals from industrial waste water.

II.LITERATURE SURVEY

T. Raja Rajeswari, Namburu sailaja et. Al. have discussed that density more than 5 gm per cubic centimetres is considered as heavy metal which is toxic in nature and non-biodegradable. Heavy metals are persistent in nature due to which accumulation of heavy metals takes place in soils and plants. Hence, heavy metals are put into environment pollutant category which is harmful for all living organisms. Different Anthropogenic activities such as mining, smelting, operation and agriculture promotes the heavy metal contamination of soil which leads to increase the levels of heavy metals like Cd, Pb, Co, Cr, As and Ni in an environment up to dangerous level. Amongst all the pollutants, heavy metals are the major cause likely to be concern for aquatic environment. Once, they enter into an environment, it causes various diseases and disorders which disturbs the biological system. Hence, Requirement of monitoring the agents is generated, which are responsible for contamination of heavy metals in Krishna river of Andhra Pradesh. High exposure of cadmium can cause lung diseases and bone defects in humans and animals. Long term exposure of chromium has side effect on kidney and liver. It can also lead to damage to circulatory and nerve tissues. Monomethylmercury is known to damage to the brain and the central nervous system. All types of arsenic exposure promotes damage to kidney and liver damage and in the most severe exposure there is erythrocyte hemolysis. High doses of copper causes anemia, liver and kidney damage, and stomach and intestinal irritation. Long term exposure of nickel can cause decreased body weight, heart and liver damage and skin irritation. A major source of cadmium exposure is Cigarette smoking. In non-smokes, food is the most relevant source of cadmium exposure. Adverse health effects of cadmium exposure may occur at lower exposure levels. Long-term exposure to arsenic in drinking water is mainly related to increase risks of skin cancers. The relation between clear exposure response and high risks have been observed. It reviews, the necessity of to study the factors responsible for contamination of heavy metals in Krishna river water of Andhra Pradesh and prevention should be taken to control the contamination caused by heavy metals. [1]

Gunatilake S.K. had given an insight regarding the various methods used for treating industrial wastewater containing heavy metals. These various often involve technologies for reduction of toxicity in order to meet technology-based treatment standards. The paper deals with the recently developed and newly applicable various treatment processes for the removal of heavy metals from industrial wastewater. The various Physico-chemical removal processes such as adsorption on new adsorbents, ion exchange, membrane filtration, electro dialysis, reverse osmosis, ultrafiltration and photo catalysis including the advantages and drawbacks are discussed. It has been found that Bio-adsorption is a new biological method and various low cost bio-adsorbents (agricultural waste, forest waste, industrial waste, algae etc.) are used for maximum removal of heavy metals from wastewater. Bio-adsorption

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 5, May 2017

techniques are eco-friendly best solutions for removing heavy metals from wastewater rather than physico-chemical methods. But chemical methods are most suitable treatments for toxic inorganic compounds produced from various industries which cannot be removed from any biological and physical techniques. [2]

Hala Ahmed Hegazi had discussed that for elimination of heavy metal from waste water, Adsorption process is widely used by researchers. In adsorption process, Activated carbon is extensively used as an adsorbent to remove heavy metals from water or wastewater stream. However, it is used in large amount for treatment of waste water, it is more expensive. In recent years, Searching for low cost alternative is necessitated to treat the waste water. Our objective is to study the utilization feasibility of less expensive materials like industrial by-product and agricultural waste as an adsorbent to exclude the heavy metals from waste water effluent. For that, waste water had been collected from EL – AHLIA Company for electroplating industries. Then after, it was treated by using rice husk and fly ash and heavy metal removal efficiency would be checked. It reviews, Risk husk can be fruitfully used to eliminate Fe, Pb, Ni and Fly ash can be effectively used to remove Cd and Cu. It was also concluded that the percentage removal of heavy metals was dependent on the dose of low cost adsorbent and concentration of adsorbent. For heavy metal adsorption, the optimum pH range was 6-7.[3]

S.Murugavelh, D.Vinothkumar et. Al. had been reviewed that Different conventional methods had been continuously used to eliminate the heavy metals from industrial waste water stream are precipitation, reverse osmosis and thermal treatment. But it was proved costly and produced some sludge after treatment. These limitations were overcome with the invention of new low-cost technology like Bio-sorption by using natural biomass which is known as bio-sorbents. In this article, they were checked removal efficiency of heavy metals from industrial waste water by using different bio-sorbents like Plants, Reed, Saw dust, Sunflower stem waste, Wheat straw, Microbial biomass, Algae, Fungi and Bacteria. Results were accomplished on the basis of experiments, it reviews (i) Saw dust was investigated to remove Cr from waste water effluent. (ii) By using sunflower stem waste, Batch adsorption study was done for treatment of waste water containing Cr. (iii) The study suggests wheat straw as a low cost bio-sorbent for removal of heavy metal. (iv) Microbe has a large number of polysaccharides in their cell wall which helps in accumulation of metal ions from waste water. (v) Chladophora albida and Scenedesmus were preferred as a potential sorbent for the removal of Cr. (vi) Bacteria was referred to treat Cr containing waste water. This literature reveals that for treatment of heavy metal containing waste water, the cost of the bio-sorption process is less as compared to other conventional methods and also concluded that particular bio-sorbent could be used to remove a wide range of heavy metals from all kind of industrial waste water. It results that Fungi and algae were found to have more efficiency to accumulate heavy metals from waste water stream as compared to bacteria.[4]

III.PROPOSED METHODOLOGY

PREPARATION OF SYNTHETIC WASTEWATER

It was very difficult to arrange the industrial waste water containing heavy metals, so we prepared the synthetic waste water as shown in Fig.1.



Fig. 1. Synthetic waste water

As we were able to arrange the waste water of an industry, in which there was no presence of heavy metals. So we added 75 gram of lead-oxide in 2.25 liter of waste water, i.e. **33.33 gram/liter**.

International Journal of Innovative Research in Science, Engineering and Technology

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PREPARATION OF PUMPKIN POWDER

As we were used pumpkin as a bio-sorbent, pumpkin of 3 kg was obtained from market and washed properly. After removing stems, seeds, and inner membranes, pumpkin was sectioned and sliced into strips of approximately 0.125 inches each. Fig.2. represents the sliced pumpkin is given below.



Fig. 2. Pumpkin Slice

First of all the strips were sun dried for two days for the duration of 8 hour a day as shown in Fig.3.



Fig. 3. Sun-dried Pumpkin

Then due to presence of excess moisture it was kept in an oven at 100°C for 1 hour and where at the interval of 30 minute the sides of pumpkin were changed or shuffled, to prevent excess heating of any side, which may get over burnt. Since there was no major difference in the presence of moisture content, it was again sundried and heated under oven for 8 hours and 1 hour respectively as shown in Fig.4.

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Fig. 4. Oven-dried Pumpkin

There after pumpkin strips were pulverized into a fine powder in a blender, so we obtained pulverized pumpkin powder about 208 gram as shown in Fig.5. Then after the pumpkin powder was sieved using a 75 μ m sieve and we observed 48 gram homogeneous pumpkin mixture was able to pass through it.



Fig. 5. Pulverized Pumpkin Powder

Further, 48 grams of pumpkin powder was divided into two proportions of 16.5g & 30g and were mixed thoroughly in containers containing 500ml of waste water. So we got two samples of wastewater treated with pumpkin powder as shown in Fig.6. Then the samples were mixed by using stirrer for 10 minutes. After that, samples were kept as it is for 24 hours, to let settle down the particles and at the end, sludge was formed at bottom of the containers.



Fig. 6. Wastewater sample treated with Pumpkin Powder

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METHODOLOGY OF ACTIVATED CARBON

First we converted an activated carbon particles into pulverized form. Then after the fine powder of activated carbon was divided into two proportion of 5g & 10g which was added in 500ml of two different sample containing synthetic waste water. Then the samples were mixed by using electric stirrer for 10 minutes. Fig. 7. represents the proper mixing of sample by using electric stirrer.



Fig. 7. Wastewater sample mixing by using electric stirrer

Same way, we prepared two samples of wastewater treated with activated carbon as shown in Fig.8. Then after, two samples were kept as it is for duration of 24 hours as the particles were settle down and at the bottom of container sludge was formed.



Fig. 8. Wastewater sample treated with Activated carbon

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IV. RESULTS AND DISCUSSION

Table 1: Initial & Final Parameters of Pumpkin Powder

Sr. No.	Parameters	Initial	Final	
			16.5 g	30 g
1.	BOD	1450 mg/l	9000 mg/l	15500 mg/l
2.	COD	5669 mg/l	43330 mg/l	76661 mg/l
3.	Lead	33333.33 mg/l	785 mg/l	670 mg/l

Table 2: Initial & Final Parameters of Activated Carbon

Sr. No.	Parameters	Initial	Final	
			5 g	10 g
1.	BOD	1450 mg/l	1575 mg/l	3062 mg/l
2.	COD	5669 mg/l	7082 mg/l	15832 mg/l
3.	Lead	33333.33 mg/l	965 mg/l	523 mg/l

Table 1 & 2 represents the results of effluent quality parameters like BOD, COD and Intensity of Lead before and after treatment of Industrial effluent by using pumpkin powder and activated carbon respectively. Significant reduction is observed in the Intensity of Lead but Continuous addition is observed in the results of BOD and COD simultaneously.

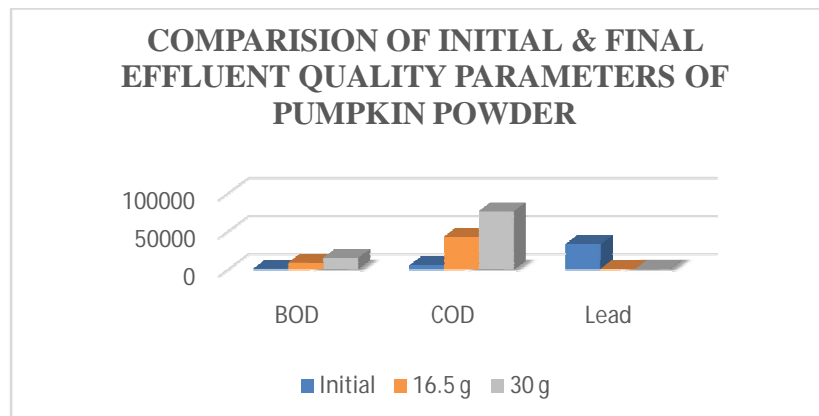


Fig. 9. Comparison of effluent quality parameters of pumpkin powder

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Fig. 9. represents the comparison of effluent quality parameters of pumpkin powder. It clearly shows that after treatment of Industrial waste water by using pumpkin powder, the intensity of lead as decreases as activated carbon at its optimum level.

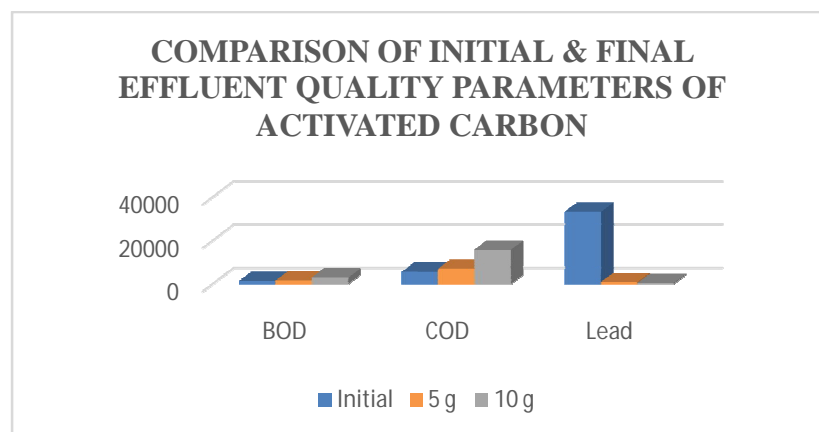


Fig. 10. Comparison of effluent quality parameters of activated carbon

Fig.10. represents the comparison of effluent quality parameters of activated carbon. It shows that activated carbon can be used as an adsorbent for removal of lead from industrial waste water.

From the results, we get higher value of BOD and COD after treatment of industrial effluent. Hence, for the reduction of BOD and COD simultaneously, we could use Activated sludge process as an alternative.

V.CONCLUSION

The experimental results obtained in this work clearly show that pumpkin powder is as efficient as activated carbon for removal of lead from industrial waste water. Because of its low cost as compared to activated carbon and it is easily available in nature, the pumpkin should be introduced in the industries as a better alternative of activated carbon to eliminate lead from effluent. The recent running rate of activated carbon is 900-1000 Rs. /kg and pumpkin cost is 70 Rs. /kg, excluding the cost of man power or machinery used. As per the industrial effluent, the most optimum material should be used by the industries to keep our environment safe and healthy and the pumpkin is fitted into that category.

REFERENCES

- [1] T. Raja Rajeswari and Namburu sailaja, "Impact of Heavy metals on environmental pollution", Journal of Chemical and Pharmaceutical Sciences, Special Issue 3, pp. 175-181, ISSN: 0974-2115, October-2014.
- [2] Gunatilake S.K., "Methods of Removing Heavy Metals from Industrial Wastewater", Journal of Multidisciplinary Engineering Science Studies, Vol.1, Issue 1, pp. 12-18, ISSN: 2912-1309, November-2015.
- [3] Hala Ahmed Hegazi, "Removal of heavy metals from waste water using agricultural and industrial wastes as Adsorbents", Housing and Building National Research Center Journal 9, pp. 276-282, 2013.
- [4] S.Murugavelh and D.Vinothkumar, "Removal of heavy metals from waste water using different bio sorbents", Current World Environment, Vol.5, Issue 2, pp. 299-304, 2010.
- [5] Avail Abbas, M.Munir, Faiza Aslam, Sumera Naheed and Amna Zafar, "Removal of chromium by bio sorption using different agricultural by-products of some important cereal crops as bio sorbents", Middle East Journal of Scientific Research, Vol.6, Issue 5, pp. 512-516, ISSN: 1990-9233, 2010.
- [6] Harmon, G., R. Patrick, and T. Spittler, "Removal of heavy metals from polluted waters using lignocellulosic agricultural waste products", Industrial Biotechnology, Vol.3, Issue 4, pp. 366-374, December 2007.
- [7] Renata S. D. Castro, Laércio Caetano and Guilherme Ferreira, "Banana peel applied to the solid phase extraction of copper and lead from river



ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

- water: Pre-concentration of metal ions with a fruit waste”, Industrial and Engineering Chemistry Research, Vol.50, Issue 6, pp. 3446-3451, February 2011.
- [8] Thomas Anish Johnson, Niveta Jain, H C Joshi and Shiv Prasad, “Agricultural and agro-processing wastes as low cost adsorbents for metal removal from wastewater: A review”, Journal of Scientific & Industrial Research, Vol.67, pp. 647-658, September 2008.
- [9] Duruibe.J.O, Ogwuegbu, M.C. and Ekwurugwu.J.N. “Heavy metal pollution and human biotoxic effects”, International journal of Physical science, Vol. 2, Issue 5, pp. 112-118, ISSN: 1992-1950, May 2007.