RESEARCH ARTICLE

REMOVAL OF HEAVY METALS BY SURFACE ASSIMILATIVE.

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Manuscript Info	*Abstract*
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Wastewater contamination is an ever increasing problem which the whole world is facing now. Industrialization & globalization has led to the tremendous increase in use of heavy metals over the past decades. This has gradually resulted in increased flux of metallic wastes in marine, ground, industrial &even treated waste waters. As far as the modern treatment processes are concerned, removal of heavy metals are very expensive, require high energy and generate toxic sludge which pose serious threat to the whole ecosystem. Nowadays, the uses of natural, low cost & effective adsorbents are being highly recommended. As well as the method of bio sorption can help in removing heavy metals to a greater extent. For this project, agricultural waste i.e. Tea waste is used as bio sorbent for the removal of heavy metal like, chromium, cadmium & lead. With this new combination, it is possible to produce pollutant-free water & pollution-free ecosystem thereby reducing metallic pollution at low cost, simple, efficient & by natural means. In the present study, heavy metal contamination in textile industrial waste water has been discussed .The conventional methods of treatment are very costly, energy intensive and generate toxic sludge. Thus, the bio-sorption has been investigated as cost effective method for removal of heavy metals. The study involves the examination of experimental conditions such as pH of the solution, concentration of the solution, contact time and adsorbent loading on the removal of heavy metals from textile industry. Finally, the maximum adsorption of 96% is achieved by adding **1.0** g of tea waste per 100 ml of wastewater.

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Introduction:-
Water pollution is a major problem in the global context. Several industrial wastewater streams may contain heavy metals such as Cr, Cu, Pb, Zn, Ni, etc. including the waste liquids generated by metal finishing or the mineral processing industries. The toxic metals, probably existing in high concentrations, must be effectively treated/ removed from the wastewaters. If the wastewaters were discharged directly into natural waters, it will constitute a great risk for the aquatic ecosystem. In recent years, the removal of toxic heavy metal ions from sewage, industrial and mining waste effluents has been widely studied. Among the many methods available to reduce heavy metal concentration from wastewater, the most common ones are chemical precipitation, ion-exchange, adsorption and reverse osmosis (Chao *et al*., 2005).   Heavy metals are the non-degradable, toxic and possess high density. Some of

the heavy metals are lead, cadmium, mercury, arsenic, chromium and thallium. Heavy metals are major pollutants and dangerous in marine, ground, industrial and even treated wastewaters because they tend to bio-accumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. The purpose of this research is to improve the method to remove high concentration of heavy metals from industrial wastewater. It is important to ensure there are no harmful heavy metals in the water stream because it can accumulate in the environment elements such as food chain and pose a significant danger to human health. The method of bio sorption offers many potential advantage in energy saving, process enhancement and processing time to remove heavy metal. In this research, tea waste was used as an adsorbent to assist bio sorption process because of its low cost, availability and its efficiency to remove heavy metal. Bio sorption is the best purification and separation techniques of heavy metals from waste water but in industries cost is very important parameter in comparison to the efficiency of adsorbent materials from waste water.

Research objective:-
The purpose of this research is to harness the potentials of tea waste by converting it to adsorbent used for adsorption of heavy metals like lead, chromium and cadmium from the textile industrial waste water collected from textile industry. To efficiently remove the metal contaminants and reuse the treated water for various agricultural and domestic purposes. To study the physio-chemical characteristics, analyze the toxicity range and their effects in environment of textile industrial waste water. To stress the advantages of bio sorption method & removal efficiency of heavy metals.

Scope of research:-
1) To improve current research by increasing the percentage of heavy metal removal from wastewater using tea waste as adsorbent.
2) To prevent the heavy metal concentration release to the water stream, reduce the cost & open up opportunities to increase the demand on wastewater treatment by using natural absorbent like tea waste.
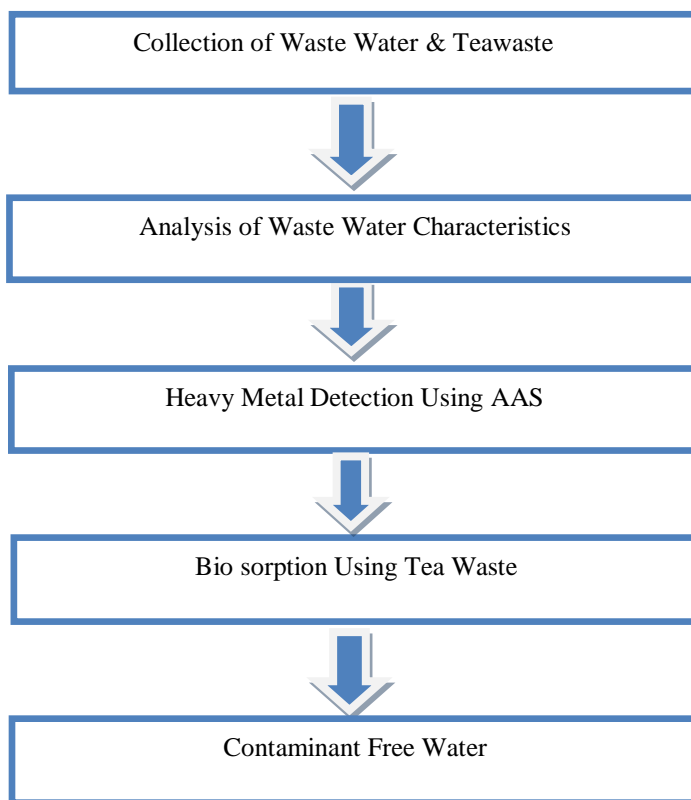
Methodology:-

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│      Collection of Waste Water & Teawaste    │
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┌─────────────────────────────────────────────┐
│       Analysis of Waste Water Characteristics │
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┌─────────────────────────────────────────────┐
│         Heavy Metal Detection Using AAS      │
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┌─────────────────────────────────────────────┐
│          Bio sorption Using Tea Waste        │
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│            Contaminant Free Water            │
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Fig:- Flowchart for Experimental Investigation

Collection Of Sample:-

The textile industry which consumes very large volume of clean water for a sequence of processes produces large amount of wastewater. The use of different synthetic dyes during dyeing process contaminated the water drastically. The effluents, thus generated from textile industry, are strong in color, high in COD and BOD and less biodegradable. Textile industrial waste water is one of the most pollution sources. It can cause environmental problems related to its high organic matter, suspended solids and heavy metal concentration. The sample is collected from the textile industry in Madurai district. Initially the sample is stored in the plastic bottle and is preserved in a refrigerator in order to prevent the attack of micro-organisms.

Fig 1:- Discharge Of Textile Industrial Wastewater

Biosorbent Used:-

a) Tea waste

Tea beverages are available as green, black or oolango tea depending on the way of manufacturing. Waste tea leaves contains lignin, cellulose & hemi-cellulose. Their high adsorption capacity is observed in solutions with pH range more than 4.The aminated bio-sorbent is used to remove metallic pollutants like lead and zinc.

b) Properties &Characteristics:

Formation of surface complexation mechanism between metal ions & lingo cellulosic adsorbent are responsible for the absorption of metal contaminants. The rough surface and widely distributed pores can offer greater surface area and more binding sites for metals.

Fig 2:- Extract of tea waste.

c) Applications of tea waste: Utilized in agricultural field to enhance the production under heavy metal stress. Abundantly available &cheap. High metal binding capacity& Helps in reducing turbidity. After adding tea waste in industrial water, the water can be reused for various agricultural and domestic purposes.

Adsorbent Preparation:-

The extract of tea powder, after it is being used as beverage is taken and is boiled till the extract gets decolorized .This tea waste is again washed with distilled water and then dried in hot air oven at 100°C. The obtained dried tea waste is screened through 150micron IS Sieves and is used as adsorbent. The tea waste is sealed in polyethylene for

preservation so that it does not react with neighboring environment. These poly ethylene are placed in freezer so that tea waste does not get degraded. The experiments were performed using two different concentration of adsorbent dosage i.e.0.5g and 1.0g of tea waste

Experimental Study Of Waste Water Sample Before Adding Tea waste:-
Atomic Absorption Spectroscopy:-
Atomic Absorption spectroscopy is a "**spectro-analytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state**". As per the results obtained from atomic adsorption spectroscopy, the metals present in our sample collected from textile industry are as listed below:

Table 1:- Concentration of heavy metals in sample using AAS

S.NO	PARAMETERS IN SAMPLE	UNITS	AS PER MCL STANDARDS(TOXICITY RANGE)	RESULTS
1.	Lead	mg/l	0.006	<0.01
2.	Chromium	mg/l	0.05	0.37
3.	Cadmium	mg/l	0.01	<0.01

Over-review of results obtained from AAS & Applications:-
From the results of atomic .adsorption spectroscopy, the concentration of chromium is found to be high i.e. (0.37) compared to lead and cadmium with respect to IS Specifications. So the removal of chromium from the sample is necessary. Now, the sample containing chromium is treated by varying the dosage of tea waste and the results are compared.

*Applications***:** It is useful in chemical analysis because of its specificity and its quantitative nature. It is widely applied in the fields of water resources because of its identity in detecting the heavy metals even in significant value.

Physio-chemical characteristics of waste water:-
Table 2:- Physio-chemical characteristics of Waste Water before adding Bio-sorbent

S.No	PARAMETERS	VALUES BEFORE ADDING BIOSORBENT
1.	Color	Brownish yellow
2.	pH value	6.68
3.	Turbidity value	12.3 NTU
4.	BOD(3days)	5.65 mg/l
5.	Total suspended solids	52900 mg/l
6.	Total dried solids	38000 mg/l
7.	Total fixed solids	1000 mg/l
8.	Total volatile solids	2000mg/l

Results and discussions:-
Effect on ph and turbidity:-
pH and turbidity variation are one of the important parameters controlling the uptake of heavy metals from waste water and aqueous solutions. pH is a term generally used to express the intensity of the acidic or alkaline condition of a solution. It is defined as the negative logarithm of reciprocal of the hydrogen ion concentration in moles per liter. The pH scale value ranges from 0 to14; the value of 0 to less than 7ranges indicates acidity and greater than 7 to 14 alkalinity. The effect of adsorbent on pH increases with increase in the concentration of adsorbent dosage and the turbidity in the sample decreases with increase in the concentration of tea waste.

Effect on total suspended solids:-
Total suspended solids are the dry weight of particles trapped by a filter. It is a water quality parameter used to assess the quality of wastewater after treatment plant. TSS was previously called non-filterable residue (NFR) but was changed to TSS because of ambiguity in other scientific disciplines. The amount of total suspended solids shows drastic decrease in value with increase in the concentration of adsorbent dosage of 50mg and 100 mg for an optimum contact time of 120 minutes

**Effect of total fixed solids & total volatile solids:-**

Total dissolved solids is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form .Although TDS is not generally considered as a primary pollutant it is used as an indication of aesthetic characteristics of drinking water. Primary source for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. In our present study to determine the amount of total dissolved solids present in the waste water a silica crucible is taken and its empty weight is taken as w1.About 100 ml of sample is filtered using filter paper, and the silica crucible along with the filtered water is placed in the water bath maintained at 900°C till the water is evaporated to dryness. After drying, the crucible is cooled to a little above the room temperature and kept in a desiccator for1 hour, and that crucible is weighted as w2, the difference between w1 and w2 gives the value of total dissolved solids. The amount of total fixed solids decreases with increase in the concentration of adsorbent dosage. The graph shows the variations in total fixed solids values for the addition of adsorbent dosage of 50mg and 100mg. The amount of total volatile solids decreases with increase in the concentration of adsorbent dosage. The graph shows the variations in total volatile solids values for the addition of adsorbent dosage of 50mg and 100mg

Effect on Biosorption efficiency:-

The concentration of chromium decreases with increase in concentration of chromium for the contact time of 120 minutes. The maximum percentage of adsorption is found to obtain for 100 mg of tea waste per 100 ml of sample solution.

Table 3:- Physio-chemical characteristics of Waste Water after adding Bio sorbent

S.NO	PARAMETERS	0.5g TEAWASTE	1.0g TEAWASTE	CONTACT TIME
1	COLOUR	Mild yellow	Pale yellow	120 min
2	pH	7.17	7.22	120 min
3	Turbidity	8.6	4.4	120 min
4	Total suspended solids	200mg/l	20mg/l	120 min
5	Total fixed solids	360mg/l	70 mg/l	120 min
6	Total volatile solids	340 mg/l	50mg/l	120 min
7	Adsorption efficiency	81%	96%	120 min
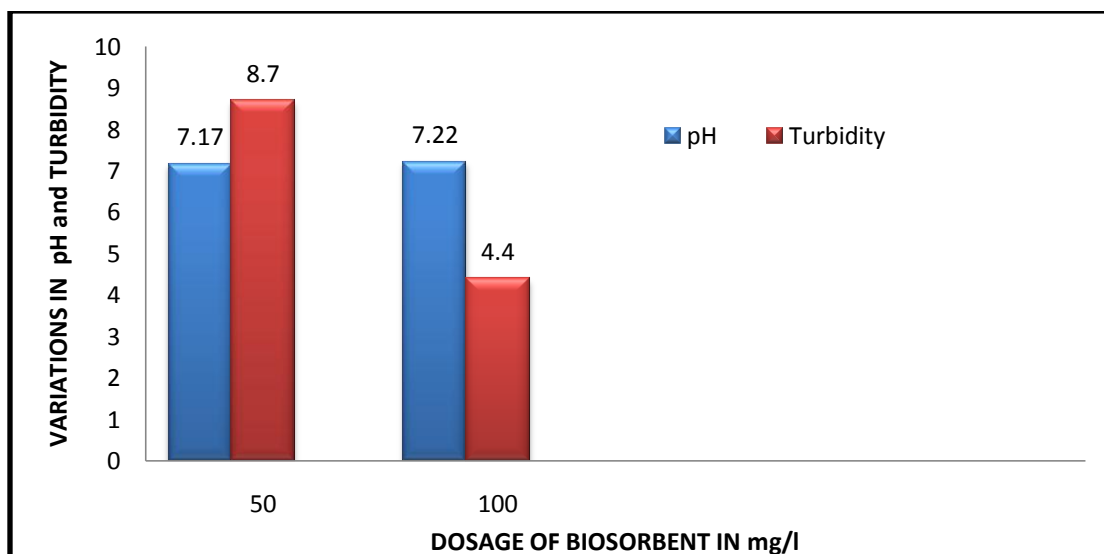
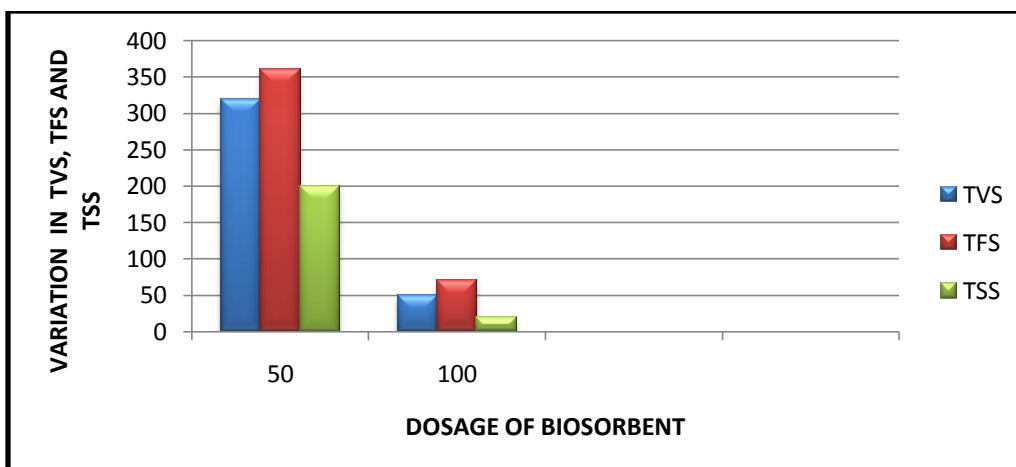**Fig 3:-** Effect of biosorbent in ph and turbidity

Fig 4:- Effect of biosorbent dosage in TVS, TFS and TSS
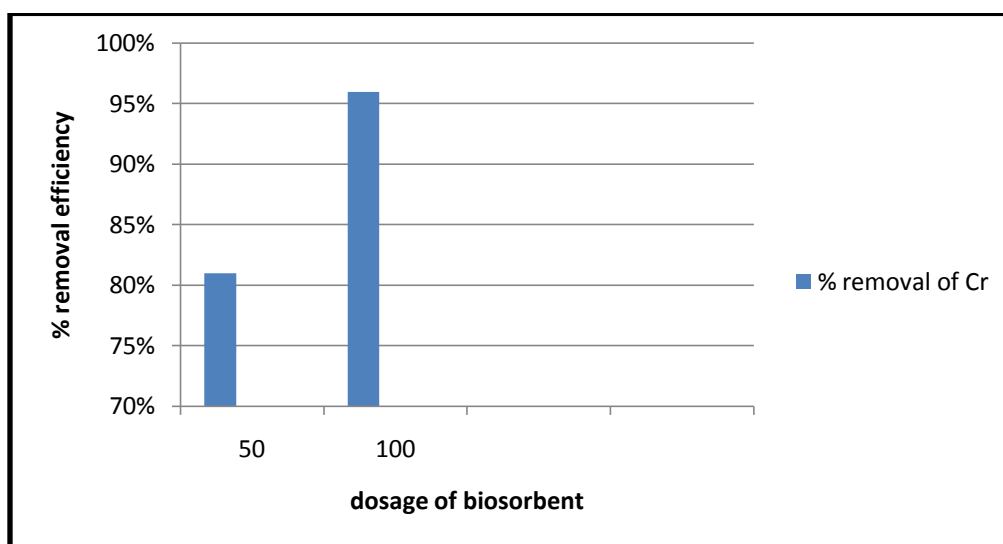

Fig 5:- Biosorption efficiency of chromium

Conclusion:-

Wastewater contamination is an ever increasing problem which the whole world is facing now Industrialization & globalization has led to the tremendous increase in use of heavy metals over the past decades. This has inevitably resulted in increased flux of metallic wastes in marine, ground, industrial &even treated waste waters. As far as the modern treatment processes are concerned, removal of heavy metals are very expensive, require high energy and generate toxic sludge which pose serious threat to the whole ecosystem. Nowadays, the use of natural, low cost & effective biosorbents are being highly recommended. As well as the method of bio sorption can help in removing heavy metals to a greater extent. For this project, agricultural waste i.e. Tea waste is used as adsorbent for the removal of heavy metal like, chromium, cadmium & lead. With this new combination, it is possible to produce pollutant-free water & pollution-free ecosystem thereby reducing metallic pollution at low-cost, simple, efficient & by natural means. From the results and discussion, the maximum adsorption of 96% is found by adding 1.0 g of tea waste per 100 ml of wastewater.

References:-

1. Firoze Ahmad.,(2015).,Removal efficacy of biosorbents and lowcost adsorbents for toxic metal ions:chemical free purification of water.,Journal of Chemical and Pharmaceutical Research,volume.7., issue1.,PP:209-213.
2. Ashutosh Tripathi* and Manju Rawat ranjan.,(2015).,Heavy metal Removal using low cost adsorbents., J.Bioremediation &Biodegradation.,Vol.6.,Issue.6.

3. Zahir Hussain A and Mohamed Sheriff K M.,(2014),Removal of Heavy metals from wastewater using lowcost adsorbents.,Archives of Applied Science Research,vol 6,PP:52-54.
4. Meenakshi Nandal,A. Rajni Hooda,A. and Geeta Dhania,A. (February 2014).,Tea wastes as a sorbent for removal of heavy metals from wastewater.,International Journal of Current Engineering and Technology.,Vol.4, No.1.
5. Lokendra singh Thakur, Mukesh parmar (2013)., "Adsorption of heavy metal from synthetic waste adsorbent".,International journal of Chemical and physical science research, vol .2,No.6.
6. Dr.parag dalal(2012).,"Heavy metal removal from Tea waste".,International Journal of plant,animal and environmental sciences.,vol.2,issue4.
7. BindraShrestha*,Homagai.P.L.,Pokhrel,M.R.,Ghimire,K.N.(2012),Exhausted Tea leaves- a low cost bioadsorbent for the removal of Lead(II) and zinc(II) ions from their aqueous solution.,J.Nepal Chem.Soc.,vol.30.
8. Amarasinghe BMWPK and Williams AR (2007).Tea waste as a low cost adsorbent for the removal of Cu and Pb from wastewater. Chem. Eng. J.,132: PP: 299-309.
9. Robinson, T.,McMULLAN, G. Marchant, R. and Nigam, P. (2001). : Remediation of dyes in textile effluent: a critical review on current treatment technologies with proposed alternative.bories.technol.,77. PP: 247-255.
10. Ajmal,MA. Mohammad, R. Yousuf and Ahmad,A. (1998). Adsorption behavior of Cadmium, Zink, Nickel, and Lead from aqueous solution by Mangifera India Seed Shell. India J.Environment Health.40: PP:15- 26.
11. Indian Standards 3025Part41:1992 RA: 2003, Determination of cadmium metal, Bureau of Indian Standards: New Delhi.
12. Indian Standards 3025Part47:1994RA:2003, Determination of lead metal , Bureau of Indian Standards: New Delhi.
13. Indian Standards 3025:Part52:2003, Determination of total chromium , Bureau of Indian Standards: New Delhi.