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Removal of Heavy Metals from Wastewater by Using Low Cost Adsorbents

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ABSTRACT

Groundwater vulnerability has become a major issue for the past many years. This study assessed the groundwater vulnerability in the region around Vrishabhavathi River, near Mylasandra, Bengaluru Urban District. In order to assess the groundwater vulnerability, a zone, roughly of 3km radius was identified. This zone was divided into parts on directional basis and six sampling points were identified from which 4 water samples have been collected from each station. These samples were tested for various parameters such as pH, total hardness, total dissolved solids, total suspended solids, total dissolved oxygen, BOD etc. DRASTIC model in a GIS (Geographic Information System) environment was used in this study to generate vulnerability maps and the topographical and hydrological parameters are used to analyse the overall vulnerability of the groundwater in the study area. The longitudes and latitudes of each of the collected samples were noted and a spatial map was prepared using ArcGIS and the data was imported. The seven basic parameters considered for the analysis were Depth to water, Net recharge, Aquifer media, and Soil media, Topography, Impact of vadose and Hydraulic conductivity. Each of the parameter values were divided into ranges and a rating was allotted to them, higher the rating greater is the extent of vulnerability.

OBJECTIVES

- Selection and identification of various agricultural wastes for removal of heavy metals.
- Analysis of the characteristics of selected absorbents.
- To study the removal efficiency of the selected absorbents.
- To identify the possibilities of regeneration of absorbents.

LITERATURE REVIEW

1. REMOVAL OF HEAVY METALS FROM WASTE WATER USING AGRICULTURAL AND INDUSTRIAL WASTE AS ADSORBENTS

The use of agricultural waste to remove heavy metals from waste water has attracted much attention due to its economic advantages and high removal efficiency. It has been observed that coconut waste showed adsorption capacities of 263 to 285 mg/g in removing lead and cadmium irons, respectively and back oak bark has adsorbed mercury in an adsorption capacity of 400 mg/g, while wheat barns have adsorption capacity for chromium of 310 mg/g. It can be concluded that, using real wastewater showed that rice husk was effective in the simultaneous removal of Fe, Pb and Ni, whereas fly ash was effective in removal of Cd and Cu.

2. REMOVAL OF HEAVY METALS FROM EMERGING CELLULOSIC LOW COST ADSORBENTS.

Cellulosic materials are of low cost and widely used and are available in abundant quantity. Different forms of cellulosic materials are used as adsorbents such as fibres, leaves, roots, shells, barks, husks, stems and seed as well as other parts also. The cellulosic plant materials used in heavy metal detoxification are rice husk, wheat straw, banana peel, grape bagasse, bel fruit shells, coir pith, hemp fibres and corn cob. In the category of low-cost adsorbents, both non-cellulosic and cellulosic materials are used. In non-cellulosic materials zeolites, clay, red mud, dairy sludge and metal oxides are utilized as adsorbents.

3. REMOVAL OF HEAVY METALS FROM WASTEWATER AN ALTERNATIVE GREEN SONOCHEMICAL PROCESS OPTIMIZATION AND PATHWAY STUDIES.

This chapter deals with technical feasibility of nonchemical process for the removal of heavy metal pollutants from aqueous environment. The removal of heavy metal pollutants using adsorption materials in the presence of ultrasonic irradiation shows better efficiency compared to reactions in the absence of ultrasonic irradiation. It is concluded that ultrasonic technology is a simple and possibly cost- effective alternative for the oxidation of heavy metals with and without assistance of external catalysts. This research paper concludes that combination of ultrasound with adsorbent materials exhibits excellent performance to remove heavy metals from the polluted environment, and this process is economic and eco-friendly.

4. REMOVAL OF HEAVY METALS FROM WASTE WATER USING BLACK TEA WASTE.

Removal of heavy metals (Cobalt, Cadmium, and Zinc) from waste water was possible using black tea waste. Under the experimental conditions, pH plays an important role in the adsorption process, particularly on the adsorption capacity of tea waste for the heavy metals under study. The pH level allowing for an optimum rate of adsorption was found to be 6 for Co, Cd, and Zn. This paper concludes that it is possible to remove heavy metals (cobalt, cadmium, and zinc) from waste water using black tea waste. This has an advantage of being applicable in developing countries due to the low cost and availability of tea waste.

5. METHODOLOGIES FOR REMOVAL OF HEAVY METAL IONS FROM WASTE WATER.

Heavy metal is a serious problem nowadays. These heavy metals are discharged into water from various chemical industries. There are several methods for heavy metal removal: chemical precipitation, adsorption, ion exchange, membrane filtration, coagulation- flocculation and floatation. In this paper, an attempt is made to review various methodologies for heavy metal removal from wastewater with their advantages and disadvantages. It is evident from the literature survey that adsorption method is widely used over conventional methods, (i.e., chemical precipitation, ion exchange, membrane filtration, coagulation- flocculation and floatation) because of its low cost, availability and eco-friendly nature.

REMOVAL OF HEAVY METALS FROM WASTEWATER BY ADSORPTION

Adsorption is presumed to be an efficient and cost-effective method as compared to other wastewater treatment technologies for heavy metal removal. The main advantage this method provides is the production of a high-quality effluent. The process of adsorption has an edge over other processes since it is an economic method for heavy metal remediation. In most cases, the adsorbent can be regenerated back and can be used further. Adsorption is easy to use and does not generate any toxic pollutants; hence it is an environment friendly technique. The prominent criteria of selection of adsorbents include their cost effectiveness, high surface area and porosity, distribution of functional groups and their polarity. Conventional and commercial adsorbents comprise of activated carbon, zeolites, graphenes and fullerenes and carbon nanotubes. Carbons and their derivatives are the most prominently used adsorbents due their great adsorption efficiency. Their exceptional ability comes from their structural characteristics giving them a large surface area with easy chemical modifications which makes them universally acceptable to a wide spectrum of pollutants. The activated carbons suffer from a few flaws which make their use quite limited. They are expensive to manufacture; the spent activated carbon is difficult to dispose and their regeneration is cumbersome and not economical. Thus, there was extensive research in the area of low-cost adsorbents. The non-conventional adsorbents are cheap, abundantly available and have great complexing capacity due to their varied structure which binds the pollutant ions. They range from agricultural waste to industrial waste sludge and spent slurry.

DISCHARGE STUDY AT VRISHABHAVATHI RIVER

The Vishabhavathi River drains 40% of Bangalore city. On an average today it flows 600 million liters day (MLD) carrying waste water discharged by city.

SAMPLE POINTS	**1**	**2**	**3**	**4**	**5**	**6**
TIME	**DISCHARGE (MLD)**					
9AM	598	587	547	587	547	547
11AM	569	577	530	577	530	530
12 NOON	555	547	455	547	455	455
1PM	576	547	456	547	456	547
2PM	587	530	480	530	480	530
3PM	577	455	540	455	540	455
4PM	547	456	587	456	547	456
5PM	547	480	577	480	530	480
6PM	530	540	547	540	455	540

GROUND WATER VULNERABILITY INDEX

The vulnerability index computed as the sum of the products of weights and ratings assigned to each of the input considered above. Considering Low, Medium, High and Very high vulnerability zones percentage area falling under each zone is computed and tabulated below.

Vulnerability Zone	Area (Sq.kms)	Area (%)
Low	1.611	13.78
Medium	6.145	52.6
High	3.604	30.84
Very High	0.323	2.76

RESULTS AND DISCUSSION

Agricultural wastes have the constitution of lignin, cellulose, hydrocarbons, sugars, water and starch along with other functional groups which enhances the adsorption capacity of these agricultural wastes. These wastes can range from rice husk to wheat shells, egg shells, coconut husk, palm fruit, bagasse, groundnut shell, fruit peels, biochar etc. These wastes can be used directly in which they are washed and grounded first. Then they are sieved to get the desirable particle sizes which are used for adsorption tests. They can also be modified into chars and further activated to increase the adsorption sites. Table below shows the different agricultural wastes used for heavy metal ions removal.

Sl. No.	Type of Adsorbent	Adsorbent Dosage (g/L)	Metal Ion	Amount Adsorbed (mg/g)	Contact Time (min)	Temperature (°C)	pH
1.	Banana Peel	8	Pb	4.6	60-80	42.45	8.5
			Cu	7			
2.	Rice Husk	5	Cl	16.70	25-50	27	1.5
3.	Coconut Husk	1.5	Mg	4.32	160	24	6.0-7.0
4.	Papaya Seeds	2	Ni	16.68	20	32	4

- Samples collected were tested for different parameters from 6 sampling stations located in Vrishabhavathi River near Mylasandra and obtained test results were compared with the water quality standards [IS 10500 (2012)].

- From the studies it is found that ph of collected sample at all the sampling points are well within the limits. Alkalinity at points S2, S4 and S6 is high and S3, S5 is moderate and S1 is less. Turbidity at S1 is very high and high at S2, less at S3, S4, S5 and S6.

- Total dissolved oxygen at all points are very less within permissible limits which indicates aquatic organisms cannot survive .Hardness at point S2 is very high,S1,S3,S4,S6 is high and S5 is low. Total dissolved solids at S1, S2, S3; S4 is high and S5 moderate, S6 low whereas BOD at all the points is very high.

CONCLUSION

- Vrishabhavathi River was a source of holy water to the people lived in the early years. Eventually, urbanization has led to the significant contamination of air, soil and water (groundwater specifically) is happening in the region.
- The DRASRTIC model parameters and the additional parameter such as pH, hardness, iron content etc show some major zones of contamination and hence **the water clearly is unfit for drinking**.
- A drastic index map was finally prepared by finding the 'drastic index' which is the sum of products of rating and weight age of each of the seven basic parameters. Higher the drastic index, greater is the vulnerability for groundwater pollution.
- The model indicates that 13.78% of the area is low vulnerable, 52.6% of the area is moderately vulnerable, 30.84% of the area is highly vulnerable, 2.76% of the area is very highly vulnerable.

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