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PHOSPHATE REMOVAL USING HERBAL FILTER

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ABSTRACT

Availability of fresh water is crucial nowadays in many parts of the world. Many natural water bodies are contaminated with chemicals. Phosphate is one among them. The study focuses on removal of phosphate using various herbs like neem, tulsi, rice husk by filtration. There is also a need for introducing a low-cost filter mechanism so as to make this water purification process available to everyone within the society. A lake water sample is also tested to determine the efficiency of the filter.

KEYWORDS: phosphate; neem; tulsi; rice husk ash;filtration; phosphate solution; filter model; rate of filtration; adsorption

I. INTRODUCTION :

Phosphate is a common component of agricultural fertilizers, organic wastes, and industrial wastewater. It is an indispensable element for plant life, but it accelerates Eutrophication of rivers and lakes when over-phosphate is present. In addition, high concentration of phosphate from drinking water can lead to various health diseases such as diarrhea, hyperphosphatemia, hypoparathyroidism, cell destruction, respiratory problems, muscle damage, joint pain, severe constipation, nausea, vomiting. In this project, wemainly focus in the removal of phosphate from surface water by adsorptiontechnique. We also developed the "Low Cost Water Filtration Technique" and developed the methodology by using some of the locally available materials such as Tulsi leaf powder, Neem leaf powder, Rice husk ash, fine sand and activated charcoal. Among them, the most efficient filter medium is identified. Using this efficient medium, a lake water sample is tested for phosphate removal. Vattakayal backwater was chosen as the place where lake water samples were taken. The main sources of waste water in Vattakayal are industrial wastewater, domestic wastes,agricultural water flow and laundryeffluents.

II. OBJECTIVES :

The scope of this project is to examine existing water filtration methods and use information to design a low-cost water filtration technique. This water filtration system will focus on reducing costs while maintaining filter efficiency. By offering affordable water filters for rural and remote areas, it will greatly improve the quality of life of people and reduce the risk of waterborne disease and thus save lives.The main objectives of this project are:

- Removal of phosphate from water using different adsorption media which are locally available at low cost.
- Critical analysis of various herbs used to measure phosphate removal.
- Compare the efficiency of filters.
- Selection of most efficient filter medium
- Analysis of lake water sample using the most efficient filter media

III. MATERIALS USED :

Scientists and ecologists have studied the feasibility and efficacy of using herbs as adsorbents in plants to adsorb heavy metals in polluted water. The following substances were used to remove phosphate from water:

PLAIN SAND

Sand are natural glacial deposits containing a high percentage of silica and low in calcium, magnesium and soluble iron compounds and are very useful in removing sediments. Here the plain sand is used to remove phosphate from drinking water which is passed through 600 Micron IS sieve.

TULSI LEAVES POWDER

Tulsi's scientific name is OcimumTenuiflorum, Holy Basil or Ocimum Sanctum Linn. Leaves are left into drinking water for treatment and medicines. The chemical composition of Tulsi is highly complex including many nutrients and other biologically active compounds. It can remove fluoride levels in drinking water. There are mostly two kinds of Tulsi. The first is Shyam Tulsi with dark stems and leaves, and thesecond Rama Tulsi has whitish stalks and green leaves. Here, Tulsi leaf powder was used to remove phosphate from water.

NEEM LEAVES POWDER

The scientific name of the Neem is Azadirachtaindica. Toxic elements in water can be removed by using neem leaf powder.Every part ofNeem is used in medicines. Newly born babies are laid upon the Neem leaves to provide them with the protective aura.Neem emits more oxygen than other trees.

RICE HUSK ASH

Rice husk is a major threat that can damage the soil and the environment. It is thought that there are many ways to discard them by using this rice husk commercially. It is obtained from the inner shell of husk of rice. The shell contains about 75%

organic volatile matter and the balance of 25% of the weight of this shell is converted into ash. The rice shell was sifted in the sieve in the range of 600 microns to increase the surface area.

ACTIVATED CARBON

Activated carbon, also called activated charcoal is a solid, porous, black carbonaceous material with small pores that increases the surface area for adsorption or chemical reactions.Carbon adsorption has a wide range of applications for removing contaminants from air and water streams, groundwater treatment, drinking water filtration, air purification, airborne volatile organic compounds, dry cleaning, gasoline dispensing processes and other operations. It is effective in removing low levels (ppb range) of inorganic pollutants.

IV. METHODOLOGY AND DISCUSSION :

COLLECTION OF MATERIALS

The materials to be used are collected. Neem leaves are collected from Bishop Jerome Institute campus. Tulsi leaves are collected from different places and houses. Rice husk were purchased from local factory. Sand and activated carbon is collected from the local market.These collected materials are washed thoroughly to make it free from dust and dirt particles and then dried under sunlight for several days. The dried materials were then pulverized into fine particles.

PREPARATION OF PHOSPHATE SOLUTION

Add 0.5005 gm of KH_2PO_4 in one litre distilled water. Pipette out 10ml of the prepared solution and addto one litre measuring jar. Fill remaining with distilled water up to the one litre mark.

EXPERIMENTAL SETUP

Here we have made a simple filter model which is in the figure:

Φιγ. 1. Model of the Filter

- Experimental setup consist of inlet bottle, filter bottle,collecting jar and a tap.
- Several holes are provided on the top and bottom of the filter bottle for passing water for filtration.
- Tap is provided at the bottom of the collecting jar.
- Following are the dimensions of the filter model:
- Inlet bottle – length = 15.5cm, diameter = 14cm
- Filter bottle – length = 15cm, diameter = 8cm
- Collecting jar – length = 24.5cm,top diameter = 21cm, bottom diameter = 19cm
-

EXPERIMENTAL PROCEDURE

Fig 1 : Filter Arrangement

Fig 2 : Material Arrangement In Filter Bottle

THE PROCEDURE OF THE EXPERIMENT IS:

* The filter model is made of three layers.
* Each layer is separated by a non-woven synthetic fiber in order to prevent mixing of each layer.
  - Top layer - sand with 4 cm thickness.
  - Middle layer - Herb (Neem / Tulsi / Rice Husk Ash) with varying thickness (2cm, 4cm, 6cm)
  - Bottom layer - Activated charcoal (granular) 4 cm thickness

* Phosphate solution of 250 ml is passed through the filter.
* The filtrate is collected at the bottom.
* The final phosphate concentration was measured using UV spectrophotometer.
* Phosphate removal efficiency and rate of filtration is calculated.

V. EXPERIMENTAL RESULT AND COMPARISON :

METHOD 1- TULSI LEAVES POWDER

The results obtained by removal of phosphate using Tulsi leaves powder as described herein. The rate of filtration and the effect of phosphate removal are shown here:

Table I. Results of filtration in tulsi leaves powder

Sample no.	Middle Layer thickness (cm)	Phosphate removal (%)	Rate of flow (ml/min)
1	2	68.37	150
2	4	74.86	142
3	6	78.24	135

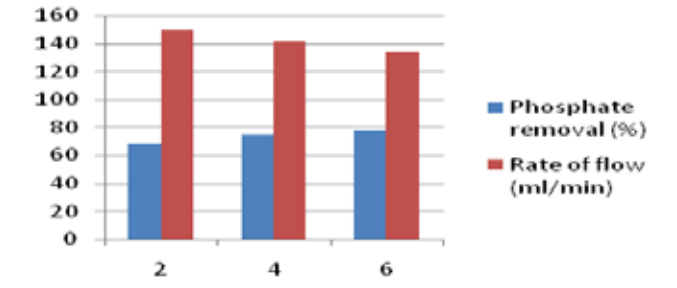

Fig. 1. Phosphate Removal in Tulsi Leaves Powder

The top layer consists of sand with 4cm thickness. The Middle layer consists of tulsi leaves powder with varying thickness. Trial 1, tulsi leaves powder were filled with 2cm thickness and in trial 2, 4cm thick and in trial 3, 6 cm thick. The Lower layer of the filter consists of activated carbon of 4cm thickness. Firstly known concentration of 250ml phosphate solution was passed through the filter. The filtrate was collected into the collecting jar. The rate of filtration was calculated as 150 ml per minute in the first trial,142 ml per minute in the second trial and 135ml per minute in the third trial. The final phosphate concentration was measured using UV spectrophotometer.

METHOD 2- NEEM LEAVES POWDER

The results obtained by removal of phosphate using neem powder as described herein. The rate of filtration andthe effect of phosphate removal are shown here.

Sample no.	Middle Layer thickness (cm)	Phosphate removal (%)	**Rate of flow (ml/min)**
1	2	67.83	91
2	4	72.86	86
3	6	76.45	78

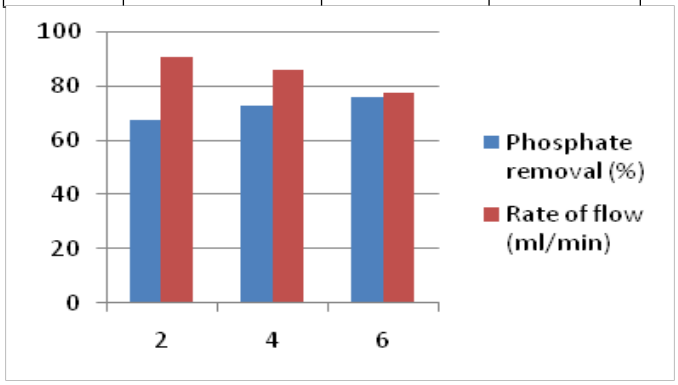

Fig 5 . Phosphate Removal in Neem Leaves Powder

The top layer consists of sand with 4cm thickness. The Middle layer consists of Neem leaves powder with varying thickness. Trial 1, Neem leaves powder were filled with 2cm thickness and in trial 2, 4cm thick and in trial 3, 6 cm thick. The Lower layer of the filter consists of activated carbon of 4cm thickness. Firstly known concentration of 250ml

phosphate solution was passed through the filter. The filtrate was collected into the collecting jar. The rate of filtration was calculated as 91 ml per minute in the first trial,86 ml per minute in the second trial and 78ml per minute in the third trial. The final phosphate concentration was measured using UV spectrophotometer.

METHOD 3- RICE HUSK ASH

The results obtained by removal of phosphate using rice huskash powder as described herein. The rate of filtration and the effect of phosphate removal are shown here.w

Table III. Results of filtration in Rice Husk Ash

Sample no.	Middle Layer thickness (cm)	Phosphate removal (%)	Rate of flow (ml/min)
1	2	78.6	67
2	4	82.57	59
3	6	86.73	52

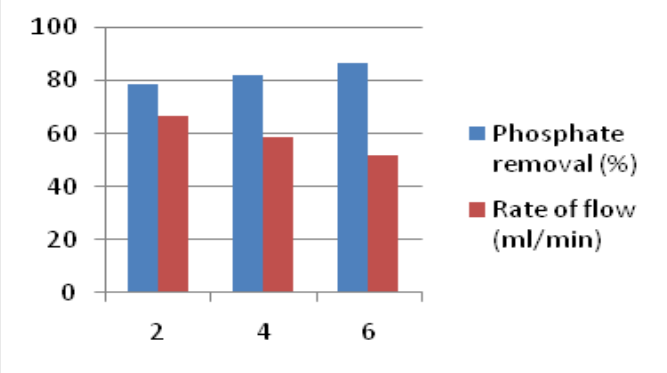

Fig. 6. Phosphate Removal in Rice Husk Ash

The top layer consists of sand with 4cm thickness. The Middle layer consists of rice huskash powder with varying thickness. Trial 1, rice husk ash powder was filled with 2cm thickness and in trial 2, 4cm thick and in trial 3, 6 cm thick. The Lower layer of the filter consists of activated carbon of 4cm thickness. Firstly known concentration of 250ml phosphate solution was passed through the filter. The filtrate was collected into the collecting jar. The rate of filtration was calculated as 67 ml per minute in the first trial, 59 ml per minute in the second trial and 52ml per minute in the third trial. The final phosphate concentration was measured using UV spectrophotometer.

COMPARISON OF RESULTS

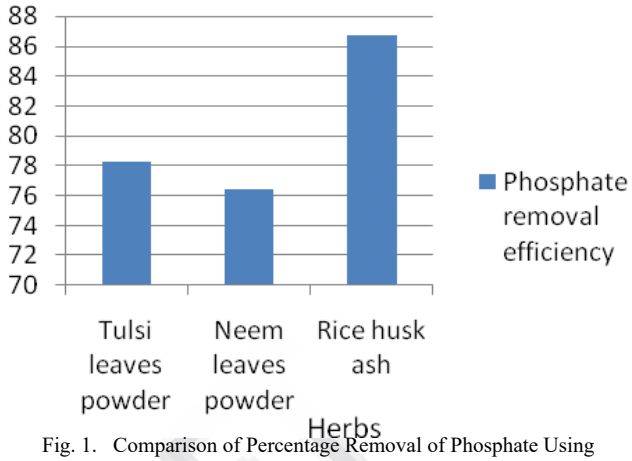

Fig. 1. Comparison of Percentage Removal of Phosphate Using Different Herbs

From the above graph, it is noted that rice husk ash is the most effective one while Neem leaves is the least effective. Using rice husk ash powder provided an efficiency of 86.73% phosphate removal.

IV. LAKE WATER SAMPLE :

The present investigation was carried out on the Vattakayal backwaters (8° 55' 2.28" North Latitude and 76° 32' 54.16" East Longitude) near Maruthadi, Sakthikulagara, kollam. The mouth of the river was a nursery ground for the various resources of several fishes and isthe source of livelihood for fishermen and other citizens.The Vattakayal receives a sewer line that joins thewater body where the colour of the water and sediments is pale yellowish or brownish. Eutrophication is another serious problem of the backwaters that led to the growth of Cabombaaquatica and many floating weeds. The major sources of phosphate in vattakayal are agricultural fertilizers, organic wastes, industrial wastewater and laundry effluents.

TESTING AND FILTRATION OF LAKE WATER

The sample water was collected from Vattakayal Lake using a one litre bottle. From this, 250 ml was taken for filtration. Since rice husk ash was obtained as the most efficient filter media,

filtration of real water sample was done with same. The rate of filtration was measured during filtration and given in the table below. The filtrate is collected into a beaker. This filtered sample and initial sample is then tested in UV Spectrophotometer. The test results are as follows:

Sl. No	Sample	Phosphate Concentration (PPM)	Rate of Filtration (ml/min)
1	Before filtration	7.5	55
2	After filtration	1.05	

From the result obtained 86% of phosphate is removed after filtration of lake water sample.

V. CONCLUSIONS :

Adsorption is the simplest and most inexpensive technique for phosphate removal, it has several advantages such as longer filtration processes, shorter ripening time, better filtration quality. The only limitation was this method is requirement of back wash water.

When the solution is passed through each filter media separately, Rice husk ash is obtained as the most efficient filter media. The maximum efficiency is 87.57% phosphate removal. The corresponding rate of filtration obtained is 52 ml/min.

Tulsi leaves powder is obtained as the second-bestefficient filter media. The maximum efficiency is 78.24% phosphate removal. The corresponding rate of filtration obtained is 135 ml/min.

Neem leaves powder is obtained as the least efficient filter media among the various material used. The maximum efficiency is 76.45% phosphate removal. The corresponding rate of filtration obtained is 73ml/min.

In rice husk ash rate of filtration decreases and phosphate removal efficiency increases whereas in neem leaves and tulsi leaves phosphate removal efficiency decreases with increase in rate of flow.

About 86% of phosphate is removed from the surface water sample from Vattakayal Lake after filtering through the best efficient filter media.

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