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RESEARCH ARTICLE

EXPERIMENTAL STUDY OF ACTIVATED CARBON DERIVED FROM DRIED WATER HYACINTH AND ITS PERFORMANCE IN PHOSPHATE REMOVAL FROM WASTEWATER

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ABSTRACT

Water of good quality is essential to human life and water of acceptable quality is essential for agricultural, industrial, domestic and commercial uses. Industries produces large amount of wastewater which is needs to be treated before dispose of. The presence of Phosphate in aquatic environment has a direct threat on public health.Wastewater contains phosphate which causes eutrofication. Adsorption is the process of accumulating substances that are in solution on a suitable surface. The carbon is used to remove a portion of the remaining dissolved organic matter, residual amounts of inorganic compounds such as nitrogen, sulfides and heavy metals. Water hyacinth (*Eichhornia crassipes*), has large growth rate in wastewater due to nutrients present in it causes its extremely rapid proliferation and congest growth, presenting serious challenges in navigation, irrigation, and power generation. However, the same plant having ability to absorb and concentrate many toxic metals from aquatic environments. This experiment used water hyacinth as a activated carbon for the removal of phosphate from the wastewater in Pune region. This project work has been patented.

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INTRODUCTION

The use of carbon has been used for many applications. For the preparation of activated carbon Charred wood, bones and coconut charcoal were used. Activated carbon is a material prepared having high degree of porosity and an extended surface area. During water filtration through activated carbon, contaminants adhere to the surface of these carbon granules or become trapped in the small pores of the activated carbon. This process is called adsorption. Activated carbon filters are efficient to remove unwanted taste and odours, micro-pollutants, chlorine, fluorine or radon, from drinking water or wastewater. Activated carbon filtration is commonly used at household level, to produce drinking water and in industries to treat effluents. It is also applied for the removal of micro-pollutants both in drinking water production and for the purification of treated wastewater before disposal. Activated carbon filters are widely used to treat industrial or municipal wastewaters. It is not efficient for disinfection and nitrates removal. Adsorption on activated carbon is a simple technology. It is based on materials such as fossil fuels and even agricultural waste (e.g. coconut shell, wood, etc.). To choose the most applicable type of activated carbon for a given application it is important to analyse the composition of the influent water previously. (http://www.sswm.info/content/ adsorptionactivatedcarbon) Water hyacinth is having good adsorption quality over the nutrient like phosphate. Phosphate has the potential to cause increased algal growth leading to eutrophication in the aquatic environment. Phosphorus is a nutrient which causes to eutrophication when added in excess to water bodies through human sources. Eutrophication is a serious water quality issue facing the nation. Eutrophication is described as human caused acceleration of aquatic plant growth through excess nutrients, like phosphorus, in water bodies due to wastewater discharge. It is a process which leads to a heighten acceleration of primary production or biomass increases within a water body. It causes harmful effects on water bodies, such as detrimental shifts in biological communities, fish kills, and reduction of dissolved oxygen and pH values. (http://www.ct.gov/deep/cwp/view.asp?a=2719 &q=591844) This project works on Activated carbon is prepared from water hyacinth and applied to Phosphate removal from wastewater.

Objectives of study

1. To study and preparation of activated carbon.
2. To study and analyze of wastewater characteristics of a selected industry within Pune region.

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3. To study methods for standardization of water hyacinth.
4. To determine optimum dose of activated carbon through lab scale studies.
5. To setup experimental bench scale arrangements for removal of Phosphate by AC.

Literature review

Mahamadi C studied that, Water hyacinth (*Eichhornia crassipes*), has attracted significant attention due to its extremely rapid proliferation and congest growth, presenting serious challenges in navigation, irrigation, and power generation. Also the same plant having an amazing ability to absorb and concentrate many toxic metals from aquatic environments. Consequently, research activity on utilization of the plant has been registered over the last few decades. This article reviews literature related to the utilization of Water Hyacinth in the biosorption and recovery of metals from aquatic environments. (Water hyacinth as a biosorbent)

P. Santhosh and C. Dhandapani studied that, using activated carbon derived from water hyacinth Cr(VI) is removed from wastewater as an unconventional adsorbent. The physical and chemical characteristics of the activated carbon prepared were studied. The study determines the parameters that influence adsorption process such as pH, initial metal ion concentration, contact time and adsorbent dosage. The suitability of Freundlich and Langmuir models was investigated for each chromium sorbent system. (Adsorption Studies on the Removal of Chromium (VI) from Wastewater Using Activated Carbon Derived)

Azuatalam Godwin A. Joshua studied the adsorptive capacity of activated water hyacinth (AWH) on lead (Pb++) and iron (Fe++). The zinc chloride activated carbons were characterized under pH and iodine number, moisture content, particle size, specific gravity, bulk density, porosity and volume of void. Batch adsorption studies were also carried out under varying experimental conditions of pH of the solutions, contact time of the carbons and metal ions, and initial concentration of Pb++ and Fe++ solutions. The results showed that the highest percentage removal of 99.85 occurred at pH = 8 by AWH on Fe++ and the lowest % removal of 3.03 on the same metal and iodine number of 620mg/g. (Adsorptive Capacity of Water Hyacinth on Heavy Metals Azuatalam Godwin A. Joshua Masters Student, Chemical Engineering, University of Port Harcourt, Rivers State, Nigeria Ugwoke Perpetua Ebere Masters Student, Chemical Engineering, University of Port Harcourt, Rivers State, Nigeria)

Dr. K. Murali, Dr. R. N. Uma studied that dyes are widely used in Indian industries, viz., textile, paper, plastic, leather, printing, food, cosmetics, etc., to colour their final product. Discharge of such coloured effluents causes colour to the receiving water bodies and produces many significant problems such as increasing the toxicity and chemical oxygen demand. It also reduces light penetration which effect on photosynthesis phenomena. The present investigation deals with a series of experiments to assess the suitability of Water Hyacinth (WH) as a biosorbent in removal in removal of Methylene Blue (MB). Methylene Blue (a basic and cationic dye) is the most commonly used substance for dying cotton, wood and silk. (Murali and Uma)

Rezania S, Ponraj M, Talaiekhozani studied that Phyto-remediation is possible method for the removal of pollutants present in wastewater and recognized as a better green remediation technology. Water hyacinth is the technology that has been still used in the modern days. The main objective of this paper is removal of pollutants present in different types of wastewater by using Water hyacinth. In focus to the future aspects of phyto-remediation is the sustainable management technique in treating waste water. (Rezania *et al*.,)

E.Subha, S.Sasikala, G.Muthuraman a study was undertaken to investigate the removal of phosphate from wastewater by using a natural adsorbents. The study was conducted by using different adsorbents like Ficuscarica, Moringaoleifera and Saw dust. The parameters such as pH, contact time and initial phosphate concentration were studied. The influence of the Ph of the phosphate ion solution on the uptake levels of the phosphate ion by different adsorbents used were carried out between pH 3 and pH11. Experiment was done by varying contact time, biosorbent dosage and pH range to get the optimum value. The optimum percentage removal of phosphate was found to be more than 77% in Ficus carica, 75% Moringa oleifera, 70% in Saw dust. The highest percentage removal of phosphate was achieved at Ficuscarica. (Subha *et al*.,)

O. Zanella, I. C. Tessaro and L. A. Féris1 studied that, the efficiency of chemically-modified activated carbon surface was investigated. The purpose of this study was to examine the effect of treatment with $CaCl_2$ solution at a concentration of 2000 mg.L-1 on the sorption of nitrate ions from aqueous solutions in successive sorption/ treatment cycles. The sorbent was initially subjected to chemical treatment with $CaCl_2$ and subsequently to the sorption process. Nine sorption cycles were performed. The concentrations of nitrate ions in the solution were measured by UV-Vis spectrophotometry before and after sorption. The results show that treatment with $CaCl_2$ caused a significant increase in the percentage removal for each treatment step, reaching a removal rate of 80% of nitrate in the solution after nine cycles. (ZanellaI *et al*.,)

T. Haller and D. L. SUTTON studied that, Growth of water hyacinth plants was unaffected by a range of pH values of most natural bodies of water. Maximum growth of water hyacinth occurred in acid pH 4.0 to slightly pH 8.0 water. Maximum growth of water hyacinth occurred in when phosphorus concentration of 20 ppm. Phosphorus absorbed by these plants became more uniformly distributed in the leaves, stems and roots when the phosphorus concentration was increased in the nutrient solution. (Effect of pH and high phosphorus concentration on growth of water hyacinth. William T. Haller and D. L. Sutton graduate research assistant and assistant professor univ. Of florida)

METHODOLOGY

The site selected for wastewater samples where maximum Phosphate contents were present which is previously studied. Site selected for the experimentation at river Mutha. The results shows that Phosphate was present in the wastewater. (Prachi Shelke *et al*.,) The plant used was collected from karve naka, karad. The roots and leaves of the plants were cut off and discarded while the stems were used for the preparation. The stems were chopped into pieces, dried for about 5-7days until they were crispy and ground in a mixer. The activation/carbonization was done at 200^{o}C using a Muffle furnace. The ground sample was then impregnated with a

saturated solution of Calcium chloride and dried before activation/carbonization. The activated sample was then washed with copious amounts of distilled water until the effluent from it was at constant pH, they were then oven- dried at 90-100^{o}C and ground into the particle size for powdered activated carbon.

Application of Adsorbent Dosage

The effect of WHPAC mass on Phosphate removal was investigated by contacting synthetic solution of Phosphate with an initial concentration is 0.866mg/l with different weighed activated carbon 1 gm, 2 gm, 3 gm, 4 gm of WHPAC in a jar. Each Jar was then agitated for 1hrs in Jar Test apparatus. The samples were then filtered through a Whatmann No 42 filter paper and analyzed using using spectrophotometer.

Fig. 1. Stems of Water Hyacinth

Fig.2. Drying of Stems Water Hyacinth

Fig.3. Grinding of dried Stems

Fig.4. Pest of powder water hyacinth by using $CaCl_2$

Fig.5. Washing of carbonized powder

Fig.6. Final Activated Carbon of Stems Water Hyacinth

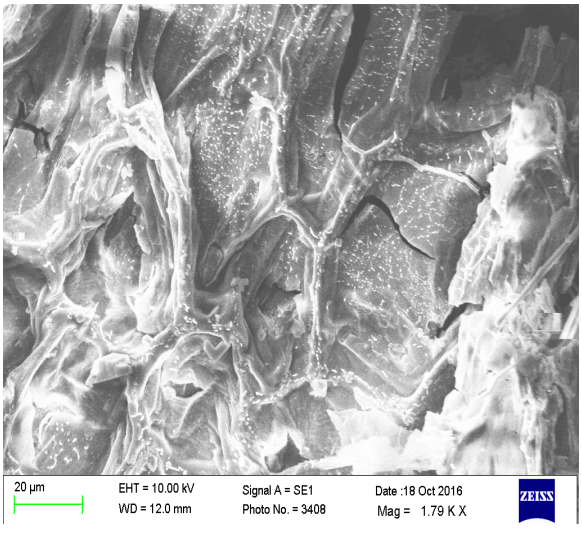


Fig.7. SEM Image of Stem powder at 250^{o}C of Water Hyacinth

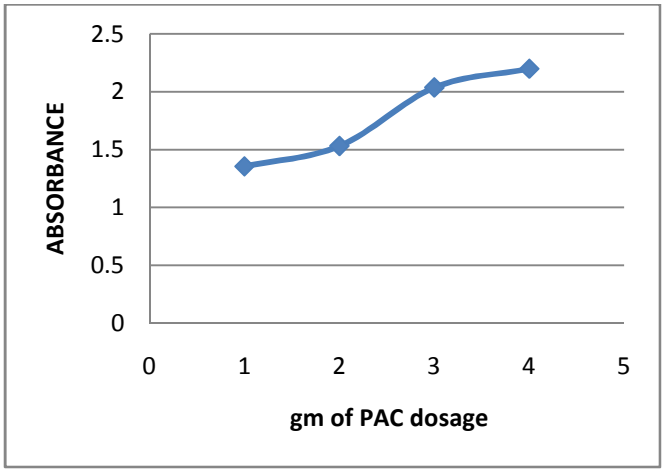
RESULTS AND DISCUSSION

Table 4. Activated carbon applied to synthetic solution of phosphate

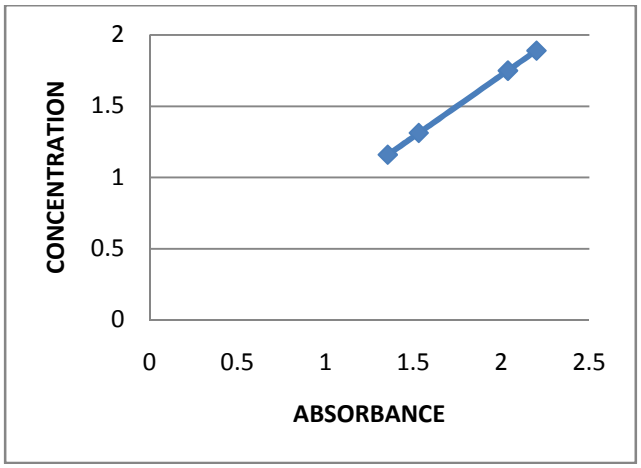
Sr. No.	Applied dosage (gm)	Absorbance	Concentration
1.	1	1.354	1.159
2.	2	1.530	1.3117
3.	3	2.036	1.7490
4.	4	2.198	1.889

Effect of Adsorbent Dosage

It was observed that the adsorption of Phosphate decreasing with the increase in Activated carbon dosage as shown in the table.



Effect of applied dosage of WHPAC



Concentration Vs. Absorbance

Conclusion

Increasing wastewater contaminant in water bodies which degrade life of aquatic system. It is also responsible to growth of aquatic plants in combination with these pollutants. Highly effective aquatic plant is Water Hyacinth. In the vicinity of pune large number of natural water bodies are available on the other side the direct disposal of polluted water in this natural water bodies which integrates the growth and quantity of water hyacinth. The current study was done to utilized the matured water hyacinth in the preparation of powder activated carbon so that it can be utilized for removal of the contaminants from wastewater and specially concentrated for the removal of Phosphate content from wastewater.

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Study of CaCl2 as an agent that modifies the surface of activated carbon used in sorption/treatment cycles for nitrate removal O. ZanellaI,*; I. C. TessaroII; L. A. FérisI ILaboratório de Separação e Operações Unitárias (LASOP), Phone: + (55) (51) 3308 3315, Fax: + (55) (51) (51) 3308 3277, Email: odivan@enq.ufrgs.br IILaboratório de Separação por Membranas (LASEM), Departamento de Engenharia Química, Universidade Federal do Rio Grande do Sul (UFRGS), R. Eng. Luis Englert, s/n. Campus Central, CEP: 90040040, Porto Alegre RS,Brasil

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