

REMOVAL OF HEAVY METAL FROM WATER BY MAGNETIC CARBON NANOSTRUCTURES

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Civil Engineering by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

**SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600119**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work ASHWIN KRISHNA GC (Reg.No.37200009)AQWIN A (Reg.No.37200006) who carried out the project entitled "Removal of heavy metal from water by magnatic carbon nanostructures" under my supervision from October 2020 to April 2021.

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Submitted for Viva voce Examination heldon_____

InternalExaminer

ExternalExaminer

DECLARATION

We, ASHWIN KRISHNA GC (Reg.No.37200009)AQWIN A (Reg.No.37200006) hereby declare that the Project Report entitled "Removal of heavy metal from water by magnatic carbon nanostructures" done by us under the guidance of **Dr.S.Nandhakumar**, M.Sc., Ph.D., at Sathyabama Institute of Science And Technology, Chennai is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in CivilEngineering.

1.

2.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE

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TABLE OF CONTENTS

CHAPTERNO.	TITLE	PAGE NO
	INTRODUCTION	1
2	LITERATURE SURVEY	2
2.1	GENERAL	2
2.2	LITERATURE REVIEW	2
3	AIM AND SCOPE OF THE EXPERIMENTAL WORK	15
3.1	AIM	15
3.2	SCOPE OF WORK	15
4	EXPERIMENTAL WORK	16
4.1	METHODOLOGY	16
4.2	COLLECTION OF WATER SAMPLES	18
4.3	COLLECTION OF RAW WATER SAMPLES	19
4.4	TESTING OF RAW WATER TEST	20
4.4.1	TOTAL HARDNESS OF WATER TEST	21
4.4.2	CALCIUM TEST	22
4.4.3	COPPER TEST	23
4.4.4	CHROMIUM TEST	24
4.4.5	LEAD TEST	25
4.4.6	MANGANESE TEST	25
4.4.7	IRON TEST	26
4.4.8	CHLORIDE TEST	27
4.4.9	CARBONHARDNESS TEST	
	LIST OF ADSORBENTS	30
4.6	MATERIALS USED AND PREPARATION OF ADSORBENT	32
4.6	REGENTS	32

4.6.2 PREPARATION OF WATERMELON PEEL AND ITS CHARACTERISTICS	32
4.6.3 PREPARATION OF NANOCOMPOSITES AND ITS CHARACTERISTICS	33
4.7 ADSORBENT PROCESS	35
4.7.1 REACTION OCCUR ON THE WATER SAMPLE TEST 1	35
4.7.2 REACTION OCCUR ON THE WATER SAMPLE TEST 2	36
4.7.3 REACTION OCCUR ON THE WATER SAMPLE TEST 3	37
4.7.4 REACTION OCCUR ON THE WATER SAMPLE TEST 4	38
5. RESULTS AND DISCUSSION	39
5.1 REMOVAL PERCENTAGE AT LOW CONCENTRATION	39
5.2 REMOVAL PERCENTAGE AT HIGH CONCENTRATION	40
6. SUMMARY AND CONCLUSIONS	45
7. REFERENCES	46

CHAPTER-1

INTRODUCTION

The quality of our surroundings is deteriorating day by day with the most important cities reaching saturation points and unable to deal with the increasing pressure on their infrastructure. Industrial effluents, sewage and farm wastes are the main pollutants contaminating the environment. Most of the industries discharge wastewater and their effluents containing toxic materials into rivers without adequate treatment. Environmental pollution particularly from heavy metals and minerals within the wastewater is the most significant issue in India. Heavy metals are major pollutants in marine, ground, industrial and even treated wastewater. Most of the purpose sources of heavy metal pollutants are industrial wastewater from mining, metal processing, tanneries, pharmaceuticals, pesticides, organic chemicals, rubber and plastics, lumber and wood products. The heavy metals are transported by runoff water and contaminate water sources downstream from the economic site. To avoid health hazards it's essential to get rid of these toxic heavy metals from wastewater before its disposal. Most of the heavy metals discharged into the wastewater are found toxic and carcinogenic and cause a significant threat to human health. (Srivastava et al., 2006). The discharge of huge quantities of hazardous materials into the natural environment has resulted during a number of environmental problems and thanks to their non-biodegradability and persistence, can accumulate within the environment elements like organic phenomenon , and thus may pose a big danger to human health.

The discovery of carbon nanotubes (CNTs) and therefore the prospect of developing novel carbon-based nanomaterials have attracted researchers worldwide. CNTs have great potential as a completely unique sort of adsorbent thanks to their unique properties like chemical stability, mechanical and thermal stability, and therefore the high area , which results in various applications including hydrogen storage, protein purification and water treatment. Removal of heavy metals from industrial wastewater

results in the most important challenge nowadays. to scale back environmental problems, the CNTs are promising candidates for the adsorption of heavy metals. during this study, extremely brief summaries of liquid pollutant purification are reviewed.

The presence of those compounds makes the rind a positive platform for synthesis of activated charcoal materials. The watermelon rind can be an appropriate binding agent for heavy metals thanks to the presence of hydroxyl (cellulose) and carboxyl (pectin) groups.

CHAPTER 2

LITERATURE SURVEY

2.1 GENERAL

In this the review is done about the journals based on groundwater, drinking water and purification processes by using natural adsorbents are discussed.

2.2 LITERATURE REVIEW

Renu, Madhu Agarwal and Singh.K(2017)-The name and year of the journal is "Journal of the water resume and desalination" (07.4.2017). The project work taken for reference is Heavy metal removal from waste water using various adsorbents: a review. The Methodology used in this work is preparation of Graphite, Activated carbon and Carbon nanotubes. The testing performed here is Atomic absorption test. The Knowledge gained through this process is about Absorbents, Capacity, Heavy metal methods. Heavy metal is a serious problem nowadays. These heavy metals are discharged into water from various chemical industries. They are harmful for living organisms and it is necessary to eliminate these heavy metals to minimise risk of uptake by plants, animals and humans. In the previous couple of decades, several methods are developed and extensively investigated for heavy metal removal. There are several methods for heavy metal removal: chemical precipitation, adsorption, natural process, membrane filtration, coagulation-flocculation and floatation. In this paper, an effort is formed to review various methodologies for heavy metal removal from wastewater with their advantages and drawbacks. It is evident from the literature survey that adsorption method is widely used over conventional methods, (i.e., chemical precipitation, natural process, membrane filtration, coagulation-flocculation and floatation) due to its low cost, availability and eco-friendly nature. Keywords: adsorption; heavy metal; methodology; wastewater.

O'mara H.A and Molokhia.H (2008)-The name and year of the journal is "Journal of Hazardous Materials" (15.09.2008). The project work taken for reference is Heavy metal absorption onto agro-based waste materials. The Methodology used in this work are uses of activated carbon. The test being performed here is Atomic absorption test. The Knowledge gained through this process is Method to remove Hazardous metal. Humanity is facing possibly the greatest challenge in its history. Population is expected to reach 9 billion in 2030. At the same time agricultural land is becoming scarcer and poorer in quality. Furthermore, the environmental impact of intensive agriculture and the

effects of climate change are threatening food security in many regions of the globe. Further, shortage of fossil fuels will have dramatic effects on the performance of intensive agriculture. There is an urge to develop more ecological agricultural practices both to meet the need to preserve agroecosystems health and to deal with the reduced availability of “cheap” energy from fossil fuels. This paper reviews a number of studies comparing the performances of conventional and organic agriculture in light of energy use, CO₂ emission and other environmental issues. Organic agriculture, along with other low input agriculture practices, results in less energy demand compared to intensive agriculture and could represent a means to improve energy savings and CO₂ abatement if adopted on a large scale. At the same time it can provide a number of important environmental and social services, such as preserving and improving soil quality, increasing carbon sink, minimizing water use, preserving biodiversity, halting the use of harmful chemicals, thereby guaranteeing healthy food to consumers. We claim that more work should be done in terms of research and investment to explore the potential of organic farming for reducing environmental impact of agricultural practices. However, in the case of organic agriculture, the implications of a reduced productivity for the socioeconomic system should be considered and suitable agricultural policies worked out.

Renu, Madhu Agarwal and K. Singh (2016)-The name and year of the journal is "Article navigation 3. 11.2016. The project work taken for reference is Heavy metal removal from wastewater using Graphite absorbents. The Methodology used here is Absorption of chromium using Graphene. The Testing performed here is Langmuir method. The Knowledge gained through this process is Heavy metal removal using Graphene. There are a number of types of adsorbent that are used for the efficient removal of heavy metal removal from wastewater that are both commercial and/or bio adsorbents. These are described as follows. Commercially available adsorbents for chromium removal Graphene Nanomaterials are efficient adsorbents for the removal of heavy metals from wastewater because of their high surface area, enhanced active sites and the functional groups that are present on their surface (Gopalakrishnan et al. 2015). Graphene is a carbon-based nanomaterial with a two-dimensional structure, high specific area and good chemical stability. It is available in various forms like pristine graphene, graphene oxide and reduced graphene oxide. Graphene may be oxidised to add hydrogen groups for heavy metal removal . Yang et al. adsorbed chromium onto the surface of graphene oxide and therefore the maximum adsorption capacity found was around 92.65 mg/g at an optimum pH of 5. This adsorption of graphene oxide was found to be endothermic and spontaneous. et al. have also oxidised graphene for the addition of –COOH,

–C=O and –OH functional groups onto the surface using a modified Hummer's method (Hummers & Offeman). The novelty of their work is that only 70 mg of graphene oxide has been utilised for 100% removal of chromium from wastewater effectively at an optimum pH of 8. Graphene composite materials are developed by a variety of authors for the removal of heavy metals. Li et al. functionalized graphene oxide with magnetic cyclodextrin chitosan for the removal of chromium since magnetic cyclodextrin chitosan has favourable properties such as high adsorption capacity and magnetic property which assists in the separation process. Guo et al. functionalized graphene with a ferro/ferric oxide composite for chromium removal with a maximum adsorption capacity of 17.29 mg/g which is higher as compared to the adsorption capacity of other magnetic adsorbents, such as Fe@Fe₂O₃ core-shell nanowires (Ai et al.), chitosan-coated MnFe₂O₄ nanoparticles (Xiao et al.) and Fe₃O₄-polyethyleneimine (PEI)-montmorillonite (Larraza et al.), i.e., 7.78 mg/g, 15.4 mg/g, 8.8 mg/g, respectively. Table 1 summarises the graphene-related work that has been reported during this area.

Ma.del Rosario Moreno, Virgen(2018)-The name and year of the journal is "Intechopen"(27.06.2018). The project work taken for reference is Removal of Heavy Metals Using Adsorption process subjected to an external magnetic field. The Methodology used here is Adsorption of heavy metal using raw carbon. The testing performed here is Langmuir method. The Knowledge gained through this process is Steady about the magnetic field. Removal of Heavy Metals Using Adsorption Processes Subject to an External Magnetic Field By Ma. del Rosario Moreno Virgen Adsorption is a broadly used process for the removal of heavy metals and the world trend is directed to the application of new technologies to intensify existing processes. The properties of the magnetic flux (intensity and arrangement) and therefore the refore the intrinsic magnetic properties of the adsorbent and the adsorbate are decisive for satisfactory results. The intensity of the magnetic flux is vital , because this suggests that the greater number of spins present will align with the magnetic flux consistent with the magnetic nature present, allowing the mobility of the adsorbate and generating heterogeneity on the surface of the adsorbent. Similarly, the arrangement of the field will determine the direction of the magnetic field lines. The application of a magnetic flux as an alternate for the intensification of the adsorption process supported the consideration that the magnetic flux is safe, environmentally friendly and economic.

Shuai Liang, a Shengguang Cao, a Changrong Liu, a Yu Cuia and Guoxin Sun(2020)-The name and year of the journal is "RSC Advances (12,2020). The project work taken for reference is Heavy metal absorption using structurally preorganized absorbent. The Methodology used here is Adsorption using heavy metal metal ion solution oscillation. The testing performed here is Langmuir method, Atomic absorption n test. The

Knowledge gained through this process is Heavy metal can be removed by ion solutions. Heavy metal pollution is an essential environmental issue in the world. The current methods present limitations for the low concentration divalent copper metals from wastewater, like high cost, unsatisfactory adsorption capacity, and poor reusability. Herein, we designed and ready a completely unique chelating adsorbent. The adsorbent was prepared using chromium microsphere as a framework material modified by ethylenediaminetetraacetic acid (EDTA) with two types of functional groups and six binding sites in one coordination unit. Each coordination unit of the adsorbent prepared provides two negative charges of two carboxyl groups to balance the 2 positive charges of the divalent heavy metal ion, and forms coordination bonds through its two nitrogen atoms and two amide carbonyl groups. This synergistic adsorption effect produced by electrostatic interaction and chelation significantly improves the adsorption capacity. The adsorption of some copper metals was tested, and high adsorption capacity for Pb(II) was obtained. The saturated adsorption capacity for Pb(II) was as high as 352.1 mg g⁻¹, and therefore the effluent concentration of the column experiment was but 0.20 ppm. Simultaneously, the presence of the amide group shows good anti-interference to alkali metals and alkali soil metals. The result's of considerable significance to the particular

wastewater treatment.

Alexandr Burakov, Evgeny Galunin, Irina Vladimirovna Burakova, Anastasia Memetova(2017)-The name and year of the journal is "ResearchGate" 11,2017. The project work taken for reference is Absorption of heavy metals on conventional and nanostructured materials for waste water treatment purposes. The Methodology used here Biomaterial Adsorption. The testing performed here is Atomic absorption test. The Knowledge gained through this process is Heavy metal can be reduced using Biomaterials. The present paper considers experimental studies carried out to determine the effective kinetic parameters of the adsorption of heavy metal ions (Cu²⁺, Zn²⁺, and Cr³⁺) from aqueous solutions using graphene oxide (GO) and the composite materials on the basis thereof - polyamine cumulene/graphene (PAC/G) and polyquinone/graphene (PQ/G) - under static and ambient temperature conditions. The following results were obtained: GO - adsorption time 20 min (for all the metal ions), and adsorption capacity 60, 26, and 5.5 mg g⁻¹ (for Cu²⁺, Zn²⁺, and Cr³⁺, respectively); PAC/G: adsorption time 30 min, adsorption capacity 26 mg g⁻¹ (for Cu²⁺); and PQ/G: adsorption time 30 min, adsorption capacity - 40 mg g⁻¹ (for Cu²⁺). According to the experimental data, more than 90 % of the adsorption capacity was achieved in the first 20 min of the contact between the GO and the heavy metal solutions. The equilibrium of the system was reached at the same time, regardless of the

extracted component and the degree of adsorption. The PAC/G and PQ/G also exhibited high adsorption capacity values for the heavy metal ions in comparison with the conventional materials. Thus, the graphene-based nanomaterials can be successfully used for removing the heavy metal ions from aqueous media, which is very important from an environmental point of view (e.g., water treatment purposes).

Muhamm ad muneeb Riaz Ullah (2017)-The name and year of the journal is "Removal of heavy metal from drinking water by nanostructures (7/11/2017). The project work taken for reference is Heavy metal adsorbent using nanotubes. The Methodology used in this process is Nano tube absorbent. The testing performed here is Novel adsorbent .The Knowledge gained through this process is Nanotubes and their property. Heavy metals contamination of drinking water has significant adverse effects on human health due to their toxic nature. In this study a new adsorbent, magnetic graphitic nanostructures were prepared from watermelon waste. The adsorbent was characterized by different instrumental techniques (surface area analyzer, FTIR, XRD, EDX, SEM, and TG/DTA) and was used for the removal of heavy metals (As, Cr, Cu, Pb, and Zn) from water. The adsorption parameters were determined for heavy metals adsorption using Freundlich and Langmuir isotherms. The adsorption kinetics and effect of time, pH, and temperature on heavy metal ions were also determined. The best fits were obtained for Freundlich isotherm. The percent adsorption showed a decline at high pH. Best fit was obtained with a second-order kinetics model for the kinetics experiments. The values of n and K were negative while that of q_m was positive. The prepared adsorbent has high adsorption capacities and can be efficiently used for the removal of heavy metals from water.

Rupa Chakraborty, Anupama Asthana (2019)- The name and year of the journal is "International Journal of Environmental Analytical Chemistry (13.12.2019). The project work taken for reference is Absorption of heavy metal ions by various low-cost adsorbent. The Methodology used in this process is Sulphate removal. The testing performed here is Atomic absorption test. The Knowledge gained through this process is Natural material to remove heavy metal. Environmental pollution, particularly from heavy metal ions in the wastewater, is one of the most serious concerns of the world. In the pursuit of remedial action, various conventional methods such as ion exchange, chemical precipitation, coagulation, membrane separation, reverse osmosis, and adsorption methods have so far been used for the removal of heavy metal ions. A good variety of adsorbents have been developed to remove different heavy metal ions from wastewater in particular those which

have been detrimental to living organisms. Adsorption processes have been very demanding for high removal efficiency of heavy metal ions even at trace levels and they are low cost as compared to conventional methods. It has therefore been crucial to develop low cost and readily available adsorbents for the adsorption of heavy metal ions from wastewater. The adsorbents may be collected from agricultural and animal waste and industrial by-products. All adsorbents, by their intrinsic nature, have functional groups to play the key role in metal ion adsorption. Generally, chemically modified adsorbents enhance the surface area of the adsorbent and exhibit higher adsorption capacity than unmodified adsorbents. In this review, a series of natural waste materials and their modified forms have been evaluated for the removal of various metals from potable and wastewater. The major focus has been an accumulation of comprehensive knowledge on the use of the low-cost adsorbents for removal of heavy

Marton Czikkely 1, Eva Neubauer 1, Ilona Fekete Prespa Ymeri(2018)-

The name and year of the journal is MDPI journal on absorption using organic matters (1.10.2018). The project work taken for reference is Heavy Metal Adsorption Processes by Several Organic Matters from Waste water. The Methodology used in this process is Biosorption of Heavy Metals. The Testing performed here is Freundlich and D-R. The Knowledge gained through this process is Heavy Metal removal using watermelon, Orange, Biomass. Heavy metal contamination of natural rivers and wastewaters is a problem for both the environment and human society. The accumulation and adsorption of heavy metals could happen with several organic and inorganic matters, but the most used adsorbents are (biological and chemical) organic compounds. This review article presents the basics of heavy metal adsorption on several organic surfaces. There are many organic matters, which seem to be useful as agents for heavy metal adsorption. All of the cited authors and articles present the adsorption kinetics by the most used isotherm models (such as Langmuir and Freundlich isotherms). By comparing several research results presented by a pre-selected assortment of papers, we would like to give an overview of the microbiological, organic chemical, and other surface adsorption possibilities. We draw conclusions for two new adsorption fields (adsorption with biosorbent and artificial materials). We present an optional possibility to study adsorption kinetics, efficiency and regeneration methods to successfully conclude the heavy metal treatment process, and we make some recommendations about the efficient water usage calculations using the water allowance coefficient (WAC) indicator

Díaz-Robles, L.A.; Ortega, J.C.; Fu, J.S.; Reed, G.D.; Chow, J.C.; Watson, J.G.; (2008)-Moncada-Herrera, J.A. A hybrid ARIMA and artificial neural networks model to forecast particulate matter in urban areas: The case of Temuco, Chile. Atmos. Environ. Air quality time series consists of complex linear and non-linear patterns and are difficult to forecast. Box–Jenkins Time Series (ARIMA) and multilinear regression (MLR) models have been applied to air quality forecasting in urban areas, but they have limited accuracy owing to their inability to predict extreme events. Artificial neural networks (ANN) can recognize non-linear patterns that include extremes. A novel hybrid model combining ARIMA and ANN to improve forecast accuracy for an area with limited air quality and meteorological data was applied to Temuco, Chile, where residential wood burning is a major pollution source during cold winters, using surface meteorological and PM10 measurements. Experimental results indicated that the hybrid model can be an effective tool to improve the PM10 forecasting accuracy obtained by either of the models used separately, and compared with a deterministic MLR. The hybrid model was able to capture 100% and 80% of alert and pre-emergency episodes, respectively. This approach demonstrates the potential to be applied to air quality forecasting in other cities and countries.

Sanhueza, P.A.; Torreblanca, M.A.; Diaz-Robles, L.A.; Schiappacasse, L.N.; Silva, M.P.; Astete, T.D.(2009)-Temuco is one of the most highly wood-smoke-polluted cities in the world. Its population in 2004 was 340,000 inhabitants with 1587 annual deaths, of which 24% were due to cardiovascular and 11% to respiratory causes. For hospital admissions, cardiovascular diseases represented 6% and respiratory diseases 13%. Emergency room visits for acute respiratory infections represented 28%. The objective of the study presented here was to determine the relationship between air pollution from particulate matter less than or equal to 10 microm in aerodynamic diameter (PM10; mostly PM2.5, or particulate matter <2.5 microm in aerodynamic diameter) and health effects measured as the daily number of deaths, hospital admissions, and emergency room visits for cardiovascular, respiratory, and acute respiratory infection (ARI) diseases. The Air Pollution Health Effects European Approach (APHETA 2) protocol was followed, and a multivariate Poisson regression model was fitted, controlling for trend, seasonality, and confounders for Temuco during 1998-2006. The results show that PM10 had a significant association with daily mortality and morbidity, with the elderly (population >65 yr of age) being the group that presented the greatest risk. The relative risk for respiratory causes, with an increase of 100 microg/m³ of PM10, was 1.163 with a 95% confidence interval (CI) of 1.057-1.279 for mortality, 1.137 (CI 1.096-1.178) for hospital admissions, and 1.162 for ARI (CI 1.144-1.181). There is evidence in Temuco

of positive relationships between ambient particulate levels and mortality, hospital admissions, and ARI for cardiovascular and respiratory diseases. These results are consistent with those of comparable studies in other similar cities where wood smoke is the most important air pollution problem.

Song, H.; Starfelt, F.; Daianova, L.; Yan, J.(2012)-One of the by-products from bioethanol production using woody materials is lignin solids, which can be utilized as feedstock for combined heat and power (CHP) production. In this paper, the influence of integrating a drying process into a biomass-based polygeneration system is studied, where the exhaust flue gas is used to dry the lignin solids instead of direct condensation in the flue gas condenser (FGC). The evaporated water vapor from the lignin solids is mixed with the drying medium for consequent condensation. Thus, the exhaust flue gas after the drying still has enough humidity to produce roughly the same amount of condensation heat as direct condensation in the existing configuration. The influence of a drying process and how it interacts with the FGC in CHP production as a part of the polygeneration system is analyzed and evaluated. If a drying process is integrated with the polygeneration system, overall energy efficiency is only increased by 3.1% for CHP plant, though the power output can be increased by 5.5% compared with the simulated system using only FGC.

Miranda, M.T.; Arranz, J.I.; Román, S.; Rojas, S.; Montero, I.; López, M.; Cruz, J.A.(2011)-One possibility for the elimination of the by-products generated in the viticulture industry can be their densification for subsequent use as a solid biofuel. In this work, washed grape pomace has been considered due to its thermal characteristics. Since it could show problems in the densification process, other by-products such as pyrenean oak residues, with good pelleting properties and available in this region, are also used. So, samples of different concentrations from both residues were densified by means of a flat die pelletizer, obtaining pellets of 6 mm diameter. The densified samples were characterized in terms of the proximate and ultimate analyses, heating value and physical characteristics such as durability or bulk density. Also, the combustion profile of the pellets was studied by thermogravimetry and inorganic emissions such as sulphur dioxide and nitric oxide were considered, by means of coupled mass spectrometry (TG-MS). The results obtained showed that both residues show good characteristics for their densification and manufacture in pellets. Also, they show good physical and thermal properties for its use as biofuel, as well as its different blends. Therefore, it is possible to give a more efficient energetic use to both residues.
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Tan, H.; Wang, S(2009)-The influence of acid-washing pretreatment on biomass pyrolysis was experimentally studied in a radiation reactor. The results show that the metal ions content of rice husk treated by acids is reduced markedly. The yield of tar from pyrolysis of rice husk treated by 7% HCl increased from 41.74 to 52.88%, and the yields of gas and char decrease. The influence will be more remarkable with the increase of acid concentration. The gaseous products of pyrolysis of HCl-treated rice husk mainly consist of CO and CO₂ which yields decreased metal ions content when compared with those of the raw sample. The effects of H₂SO₄, HCl, and H₃PO₄ on biomass pyrolysis are different. HCl has the strongest effect on the pyrolysis products distribution because the least amounts of K⁺ remained after HCl treatment. The microstructures of biomass are damaged seriously by H₂SO₄ treatment.

Narayanan, K.V.; Natarajan, E.(2007)-Concerns regarding the potential global environmental impacts of fossil fuels used in power generation and other energy supplies are increasing worldwide. One of the methods of mitigating these environmental impacts is increasing the fraction of renewable and sustainable energy in the national energy usage. A number of techniques and methods have been proposed for reducing gaseous emissions of NO_x, SO₂ and CO₂ from fossil fuel combustion and for reducing costs associated with these mitigation techniques. Some of the control methods are expensive and therefore increase production costs. Among the less expensive alternatives, cofiring has gained popularity with the electric utility producers. This paper discusses the 'gaseous emission characteristics namely NO_x, SO₂, suspended particulate matter and other characteristics like specific fuel consumption, total fuel required, actual and equivalent evaporation, total cost of fuel, etc. from a 18.68MW power plant with a travelling grate boiler, when biomass was cofired with bituminous coal in three proportions of 20%, 40% and 60% by mass. Bagasse, wood chips (Julia flora), sugarcane trash and coconut shell are the biomass fuels conferred with coal in this study.

Chen, W.-H.; Peng, J.; Bi, X.T. (2015)-Torrefaction is a mild pyrolysis, which has been explored for the pretreatment of biomass to increase the heating value and hydrophobicity. Due to its potential applications for making torrefied pellets, which can be used as a high quality feedstock in gasification for high quality syngas production and as a substitute for coal in thermal power plants and metallurgical processes, torrefaction and densification have attracted great interest in recent years from both academia and bioenergy industry. This

paper provides a comprehensive review of research progress in this area, drawing on major contributions from two major research groups of the authors on torrefaction and densification at Canada and Taiwan as well as literature. It is revealed that torrefaction of various biomass species and their major components, lignin, cellulose and hemicelluloses have been extensively studied in thermogravimetric apparatus (TGA) under both inert (N₂) and oxidative (O₂, H₂O) environments to elucidate the weight loss as a function of temperature particle size and time. It was found that the higher heating value and saturated water uptake of torrefied biomass were a strong function of weight loss, which represents the degree of torrefaction. When torrefied sawdust is compressed into torrefied pellets, more mechanical energy is consumed and higher die temperature is required to make torrefied pellets of similar density and hardness as regular pellets. Simple economics analyses based on laboratory scale experimental data showed that because of the potential savings from pellet transport, handling and storage logistics, the overall cost for torrefied pellets can be lower than regular pellets in European market for both European and Canadian pellets. The gasification could be improved in terms of both energy efficiency and syngas quality because of the removal of oxygenated volatile compounds from torrefied biomass.

Acharya, J., Sahu, J. N., Sahoo, B. K., Mohanty, C. R. & Meikap, B. C.(2009)-In this work, the adsorption of chromium(VI) was studied on activated carbon prepared from Tamarind wood with zinc chloride activation. Adsorption studies were conducted in the range of 10–50 mg/l initial chromium(VI) concentration and at temperature in the range of 10–50 °C. The experimental data were analyzed by the Freundlich isotherm and the Langmuir isotherm. Equilibrium data fitted well with the Langmuir model and Freundlich model with maximum adsorption capacity of 28.019 mg/g. The rates of adsorption were found to confirm pseudo-second-order kinetics with good correlation and the overall rate of chromium(VI) uptake was found to be controlled by pore diffusion, film diffusion and particle diffusion, throughout the entire adsorption period. Boyd plot confirmed that external mass transfer was the rate-limiting step in the adsorption process. Different thermodynamic parameters, viz., ΔH° , ΔS° and ΔG° have also been evaluated and it has been found that the adsorption was feasible, spontaneous and endothermic in nature. The results indicate that the Tamarind wood activated could be used to effectively adsorb chromium(VI) from aqueous solutions.

Ai, Z., Cheng, Y., Zhang, L. & Qiu, J.(2008)-The batch removal of Cr(VI) from simulated wastewater with Fe@Fe₂O₃ core-shell nanowires (FCSNs) was investigated in this study. It was found that each gram of the FCSNs

could remove 7.78 mg of Cr(VI) from simulated wastewater containing 8.0 mg L⁻¹ of Cr(VI) with an initial pH of 6.5 at room temperature. The Freundlich adsorption isotherm was applicable to describe the removal processes. Kinetics of the Cr(VI) removal was found to follow a pseudo-second-order rate equation. Furthermore, the as-prepared and Cr(VI)-adsorbed FCSNs were carefully examined by scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX), Fourier transform infrared spectroscopy (FT-IR), and X-ray photoelectron spectroscopic analysis (XPS). The characterization results suggested that the adsorbed Cr(VI) was partially reduced to Cr(III) in Cr₂O₃/Cr(OH)₃ on the FCSNs. The possible mechanism of removal of Cr(VI) on FCSNs was proposed, which involved the dominant Cr(VI) adsorption, followed by the partial reduction of Cr(VI) to Cr(III) (chromium(III) oxyhydroxides) on the surface of FCSNs. These Fe@Fe₂O₃ core-shell nanowires with high specific surface area and strong magnetic property are very attractive for the removal of Cr(VI) from wastewater.

Ajmal, M., Rao, R. A. K., Anwar, S., Ahmad, J. & Ahmad, R(2003)- Adsorption behaviour of Ni(II), Zn(II), Cd(II) and Cr(VI) on untreated and phosphate-treated rice husk (PRH) showed that adsorption of Ni(II) and Cd(II) was greater when PRH was used as an adsorbent. Sorption of Cd(II) was dependent on contact time, concentration, temperature, adsorbent doses and pH of the solution. The Langmuir constants and thermodynamic parameters have been calculated at different temperatures. It was found that recovery of Cd(II) from synthetic wastewater by column operation was better than a batch process.

Akar, S. T., Akar, T., Kaynak, Z., Anilan, B., Cabuk, A., Tabak, Ö.,Demir, T. A. & Gedik Bey. T(2009)-A combination of white rot fungi *Trametes versicolor* and montmorillonite type clay was studied for its ability to remove copper(II) ions from copper contaminated solutions. The effects of process parameters i.e. pH, sorbent dosage, contact time and temperature on the biosorption were examined. Reasonably rapid metal sequester rate was obtained. Maximum copper(II) biosorption capacity was found as 9.89×10^{-4} mol g⁻¹ (62.80 mg g⁻¹) at pH 5.0, 1.2 g L⁻¹ sorbent dosage and 20 °C. Batch biosorption process follows Langmuir, Freundlich and Dubinin-Radushkevich isotherm models. Zeta potential measurements showed that immobilized biosorbent was negatively charged in the pH range of 2.0–8.0. Changes in the texture surface of the biosorbent were screened by using scanning electron microscopy after immobilization and metal sorption processes. Interactions between sorbent and metal ion were examined by FTIR analysis. The proposed immobilized fungal biomass was successfully used to sequester copper ions from real wastewater in continuous mode. These results indicated that montmorillonite immobilized cells of *T. versicolor* were an efficient alternative for the removal of copper(II) ions from synthetic solutions and real wastewater.

CHAPTER-3

AIM AND SCOPE OF THE EXPERIMENTAL WORK

3.1 AIM

To remove the heavy metal in water using the method of magnetic carbon nano-structures and to study its function

3.2 SCOPE OF WORK

- To Study about the magnetic carbon nanostructures
- To determine the concentration of selected heavy metals(Fe,Cu,Pb,Mn,).
- To study about the physico-chemical parameters
- To removal of heavy metal(Fe,Cu,Pb,Mn) from water by biomass, watermelon used as an magnetic carbon composites

CHAPTER 4

EXPERIMENTAL WORK

4.1 METHODOLOGY

The steps involved in the process of removal of heavy metal from water, which has been collected from the villivakkam area, where the Manganese concentration is about 0.03 mg/l and lead concentration is about 0.05 mg/l And copper concentration is about 0.33 mg/l and iron concentration is about 0.13 mg/l using watermelon peel and nanotubes as an absorbent which is discussed in the methodology framework as shown in fig 3.1. The process involved in testing the water for both physical and chemical parameters and the preparation of magnetic carbon nanostructures is discussed. The below flow chart is the diagrammatic representation of the project process in removal of heavy metals from water.

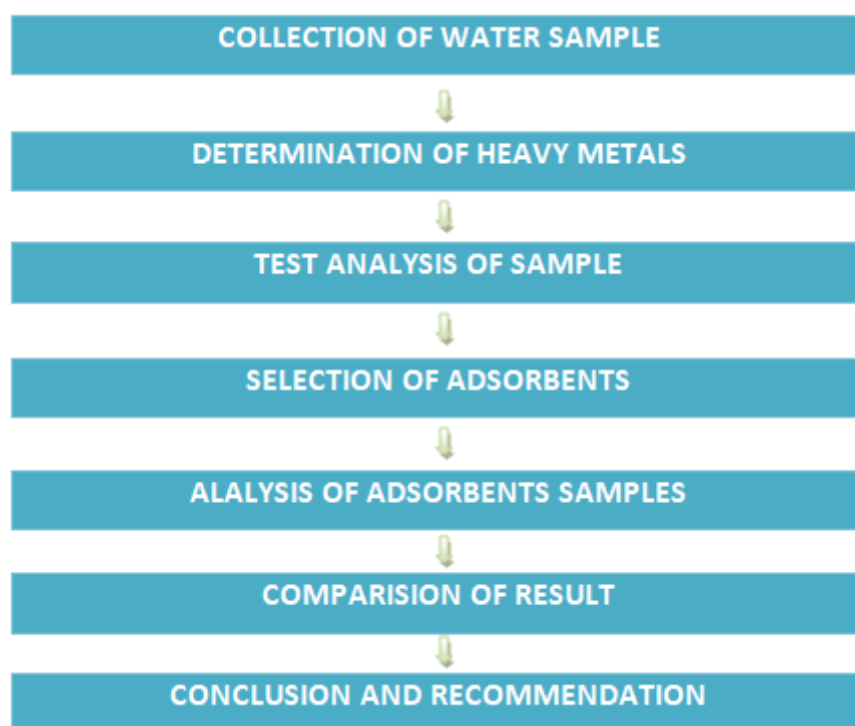


Fig 3.1: Methodological framework

4.2 COLLECTION OF WATER SAMPLES

Water samples have been collected where the iron content is more in Chennai According to the Chennai Corporation.

Samples are collected from villivakkam area

The areas where water samples collected and are given for testing to know the physical parameters of water samples and heavy metals.



Fig 4.1 water samples collected from villivakkam area

4.3 RAW WATER SAMPLES COLLECTION

Villivakkam

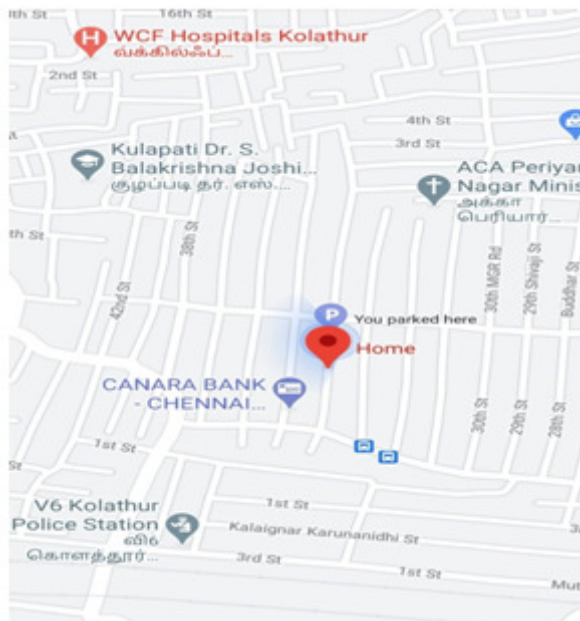


Fig 4.2 location of place where water sample is collected

4.4 TESTING OF RAW WATER SAMPLES

Raw water samples have been tested for the following parameters to know the physical property of the water sample which is collected from the Villivakkam area.

Total hardness test

Calcium test

Copper test

Chromium test

Lead test

Manganese test

Iron test

Chloride test

Carbonate hardness test

4.4.1 Total hardness test

Total hardness is a measurement of the mineral content in a water sample that is irreversible by boiling. Therefore, total hardness can be equivalent to the total calcium and magnesium hardness.

Total hardness is determined by the multivalent cations' concentrations present in water. These cations have a positive charge that is higher than 1+. Typically, cations have a charge of 2+. The most common cations present in hard water are Mg^{2+} and Ca^{2+} .

Hard water is not seriously harmful to human health. However, water with a high level of hardness could cause serious problems in industrial settings wherein water hardness is typically monitored to prevent costly failures in components like cooling towers, boilers and other equipment that contains or processes water.

Total hardness is due to the presence of bicarbonates, chlorides and sulphates of calcium and magnesium ions.

The total hardness of water is estimated by titrating the water sample against EDTA using the Eriochrome Black-T (EBT) indicator.

Initially EBT forms a weak $EBTCa^{2+}/Mg^{2+}$ wine red colored complex with Ca^{2+}/Mg^{2+} ions present in the hard water.

On addition of EDTA solution, Ca^{2+}/Mg^{2+} ions preferably forms a stable $EDTACa^{2+}/Mg^{2+}$ complex with EDTA leaving the free EBT indicator in solution which is steel blue in color in the presence of ammonia buffer (mixture of ammonium chloride and ammonium hydroxide, pH 10).

4.4.2 Calcium test

For the determination of total hardness the sample pH is adjusted to 10 with ammonium chloride - ammonium hydroxide buffer solution and then titrated with EDTA (ethylene diamine tetraacetic acid or its sodium salt) using Eriochrome Black-T as indicator. For calcium hardness determination the sample pH is adjusted to 12 to 13 with Sodium Hydroxide and then titrated with EDTA using ammonium purpurate as indicator. Magnesium is determined by difference.

Total Hardness (Ca plus Mg)

Pipet 50.0 ml of sample into a titration flask and adjust the pH to 7-10 by the dropwise addition of ammonium hydroxide (sp gr 0.90). Add 1 ml of buffer solution. 1.3 Add 4 to 5 drops of Eriochrome Black indicator or approximately 0.2g of powdered indicator

Titrate with EDTA standard solution. The end point will be indicated by colour change from pink to clear blue.

Record the volume of EDTA solution required in the titration. 1.6 Determine a reagent blank correction by similarly titrating 50.0 ml of water including all added reagents.

Calcium Hardness

Pipet 50.0 ml of sample into a titration flask and add 1 ml of sodium hydroxide solution. Add 0.2 g ammonium purpurate indicator and mix.

Titrate with EDTA standard solution. The endpoint will be indicated by colour change from pink to purple. 2.4 Record the volume of EDTA solution required to titrate the calcium.

Determine a reagent blank correction by similarly titrating 50.0 ml of water including all added reagents.F

4.4.3 Copper test

The copper is reduced with hydroxylamine-hydrochloride. The pH of the aqueous phase is adjusted to 4.0-6.0 with sodium acetate buffer. The cuprous ion is then reacted with neocuproine (2,9 - dimethyl --1, 10 - phenanthroline) and the yellow complex extracted either with chloroform or isoamyl alcohol. The intensity of colour, when extracted with chloroform, is measured at 457 nm and at 454 nm when extracted with isoamyl alcohol.

Range

20 to 1,000 micrograms/litre Cu (10 mm cell).

2 to 150 micrograms/litre Cu (50 mm cell).

2 to 100 micrograms/litre Cu (100 mm cell),

Calculation

Calculate the concentration of copper in micrograms per litre in the sample, as follows:

Copper, micrograms/litre, as Cu = $W \times 1000/V$

where

W= micrograms of copper determined in accordance with sections 5.0 and 6.0.

V= millilitres of sample used.

The overall precision of this method may be expressed as follows: $Sr = 0.008X + 0.9$

Where:

Sr=overall precision.

X =determined concentration of copper, micrograms/litre,

4.4.4 Chromium test

Chromium metal (Cr) occurs naturally in the environment and has both beneficial and potential human risks. Cr exists in many oxidation states with Cr(III) and Cr(VI) being the primary existing oxidation states in the environment. Cr(III) is an essential nutrient for maintaining lipid, insulin, and glucose metabolism and its deficiency may lead to diabetes. Of the many Cr species, hexavalent chromium (Cr(VI)) is one of the most toxic, especially when compared to trivalent chromium. Carcinogenic Cr(VI) and other Cr(VI) forms are used in various industries including leather tanning, electroplating, painting, and metallurgy industries. Although determination of total chromium is important, the speciation of metals is much more important for environmental impact studies.

Speciation of chromium usually includes preconcentration or the use of complexing reagent. Various studies have used both spectroscopic and chromatographic techniques for Cr speciation in environmental samples including wastewater, drinking water, and soils. Some of these studies are

cited here below.

Chromatogram of blank sample measured using a Dionex ICS-2100 ion chromatography. The following conditions were used: Dionex IonPac CS5A, 4 × 250 mm column; a Dionex IonPac CG5A, 4 × 50 mm guard column; eluent flow rate: 0.36 mL/min, injection volume: 5000 µL; temperature: 30°C; back pressure: 200–3000 psi; post column reagent system conditions: flow rate: 0.12 mL/min; detection: visible absorbance, 530 nm; noise: 6–8 µAU; runtime: 10 minutes.

4.4.5 Lead test

Lead is regularly measured in municipal water systems and reported to the public in an annual Consumer Confidence Report (CCR). How the lead is measured is defined by procedures in EPA's Lead and Copper Rule (LCR). This rule establishes 15 parts per billion (ppb) as the maximum lead concentration allowed in drinking water and defines procedures that municipal water systems follow to determine whether they are in compliance with this goal. Oddly, using these procedures helps ensure that water companies are in compliance with the LCR but does not ensure that the public is protected from lead exposure in drinking water.

For example, a study funded by a water utility industry found that if the sampling protocol used to determine compliance with LCR were designed to focus on the worst-case lead from lead service lines, over 70% of water utilities with these plumbing fixtures would violate the 15 ppb threshold, legally requiring urgent remedial action.

4.4.6 Manganese test

For the determination of total hardness the sample pH is adjusted to 10 with ammonium chloride - ammonium hydroxide buffer solution and then titrated with EDTA (ethylene diamine tetraacetic acid or its sodium salt) using Eriochrome Black-T as indicator. For calcium hardness determination the sample pH is adjusted to 12 to 13 with Sodium Hydroxide and then titrated with EDTA using ammonium purpurate as indicator. Magnesium is determined by difference.

Total Hardness (Ca plus Mg)

Pipet 50.0 ml of sample into a titration flask and adjust the pH to 7-10 by the dropwise addition of ammonium hydroxide (sp gr 0.90).

Add 1 ml of buffer solution. 1.3 Add 4 to 5 drops of Eriochrome Black

indicator or approximately 0.2g of powdered indicator

Titrate with EDTA standard solution. The end point will be indicated by colour change from pink to clear blue.

Record the volume of EDTA solution required in the titration. 1.6 Determine a reagent blank correction by similarly titrating 50.0 ml of water including all added reagents.

Calcium Hardness

Pipet 50.0 ml of sample into a titration flask and add 1 ml of sodium hydroxide solution. Add 0.2 g ammonium purpurate indicator and mix.

Titrate with EDTA standard solution. The endpoint will be indicated by colour change from pink to purple. 2.4 Record the volume of EDTA solution required to titrate the calcium.

Determine a reagent blank correction by similarly titrating 50.0 ml of water including all added reagents.F

4.4.7 Iron test

Iron is reduced with hydroxylamine hydrochloride and then reacted with bathophenanthroline (4, 7-diphenyl - 1, 10 phenanthroline). The red ferrous complex is extracted with n-hexyl or isoamyl alcohol and the intensity of the colour is measured at 533 nm.

1. Prepare a series of standards (at least five concentrations) to cover the expected range of iron concentrations by diluting appropriate volumes of Iron standard solution (4.7, 1 ml = 1 microgram Fe) as follows Place the required volumes of Iron standard solution (4.7) in 125 ml separatory funnels Add water to make 50 ml

Add 2.0 ml of hydroxylamine hydrochloride solution and mix. 1.4 Add 3.0 ml of bathophenanthroline solution and shake for 30 seconds.

Add ammonium hydroxide (1+1) dropwise with mixing until a distinct turbidity forms. Add hydrochloric acid (1+9) dropwise with mixing until 1 drop clears the solution. Allow to stand for 1 minute.

Proceed in accordance with section 6.0 (6.5 to 6.8). 1.7 Simultaneously carry out a blank determination containing no added iron using 50 ml of water and all reagents.

Calculate the concentration of iron in micrograms per litre in the sample as follows:

Iron micrograms/litre = $W \times 1000 / V$

Where, W = micrograms of iron, read from the calibration curve.

V = millilitres of original sample used.

The single operator and overall precision varies with the determined concentration and may be expressed as follows:

$$S_o = 0.008 X + 0.92$$

$$S_t = 0.039 X + 1.47$$

Where: S_o = single operator precision, micrograms/litre.

S_t = overall precision, micrograms/litre.

X = determined concentration micrograms/litre.

If pH is between 3.3 and 3.7 a 1 mg/litre concentration of the following ions does not interfere with the test copper, manganese, aluminium, zinc, magnesium, sodium, silica, nitrate and orthophosphate.

4.4.8 Chloride test

A chlorinating solution of known concentration is applied in increasing increments of chlorine concentration to a series of portions of the individual sample of water to be tested. The residual chlorine is determined at succeeding intervals of time.

In the absence of iodide ion, free chlorine reacts with para-amino dimethyl aniline (NN-Diethyl-p-PhenyleneDiamine abbreviated as DPD) to produce a red colour. Stepwise colour change is carried out to identify monochloramine, dichloramine, and nitrogen trichloride. The individual fractions are determined by titration with ferrous ammonium sulphate. Upto 4mg/litre with minimum detection limit of 18 micrograms/litre

Place 50 ml of sample into a 125 ml conical flask.

If Sulphite is present, add 0.5 ml of hydrogen peroxide solution and mix for 1 minute.

Adjust the pH to the phenolphthalein endpoint (pH 8.3), using Sulphuric acid solution, or sodium hydroxide solution

Add 1 ml of potassium chromate indicator and mix. Titrate with standard silver nitrate solution to a brick red colour.

Repeat 4.1 to 4.5 using 25 ml of sample diluted to 50 ml with water.

Calculate the chloride ion concentration in the sample, in milligrams per litre, as follows:

$$\text{Chloride, mg/litre as Cl} = \frac{V_1}{V_2} \times N \times 71000 / V$$

Where: V_1 = millilitres of standard silver nitrate solution for the sample

V_2 = millilitres of standard silver nitrate solution for the sample .

N = normality of standard silver nitrate solution.

V = millilitres of sample .

Calculate the chloride concentration in mg/litre as CaCO_3 , as follows: Chloride, mg/litre as CaCO_3 , = $A \times 1.41$

Where: A Chloride concentration, mg/litre as Cl .

The precision of this method may be expressed as follows:

$$S_r = 0.013X + 0.70$$

$$S_o = 0.007X + 0.53$$

Where: S_r = overall precision, mg/litre

S_o = Single operator precision, mg/litre.

X = Concentration of Chloride ion determined, mg/litre.

4.4.9 Carbonate Hardness Test

The hardness is defined as the content of calcium ions, Ca^{2+} , and magnesium ions, Mg^{2+} , ("hardness ions") in a water. The units for the water hardness relate to calcium or its compounds CaO (1 °d = 10 mg/l CaO) or CaCO_3 (1 °e = 14.25 mg/l CaCO_3 ; 1 °f = 10 mg/l CaCO_3), with the magnesium content being expressed as calcium content and include in the calculation accordingly. Carbonate hardness ("temporary hardness") is that proportion of hardness ions for which there is an equivalent amount of anions of carbonic acid (hydrogen carbonate, HCO_3^- , and carbonate, CO_3^{2-}). The concentration ratio between HCO_3^- and CO_3^{2-} is dependent on the pH value. Therefore, in natural waters ($\text{pH} < 8$) the carbonate hardness in mmol/l Ca approximately corresponds to the equivalent concentration of the hydrogen carbonate ions (1 mmol/l Ca = 2 mmol/l HCO_3^-).

Hydrogen carbonate and carbonate ions react with acid. The resultant change in the pH influences the color of a mixed indicator. The carbonate hardness is measured semiquantitatively by visual comparison of the reaction zone of the test strip with the fields of a color scale.

The determination is interfered with when the water sample contains - in addition to the salts of carbonic acid - strong bases or buffering substances such as phosphates and polyphosphates. Flocculating and precipitating agents that bind hydrogen carbonate and carbonate ions produce a false-low carbonate-hardness result.

Immerse the reaction zone of the test strip in the pretreated sample (15 - 30°C) for 1 sec. Shake off excess liquid from the strip and after 1 min determine with which color field on the label the color of the reaction zone coincides most exactly. Read off the corresponding result.

The color of the reaction zone may continue to change after the specified reaction time has elapsed. This must not be considered in the measurement.

The total hardness should also always be determined in addition to the carbonate hardness.

This is because in some cases the value found for the carbonate hardness is apparently higher than that for the total hardness ("hardness inversion"). In this case the value measured for the total hardness must be taken as that for the carbonate hardness actually present.

The "hardness inversion" can be explained by the fact that as a rule - in addition to the hardness ions Ca^{2+} and Mg^{2+} - other cations are also dissolved in the water and hence under certain circumstances more equivalents of carbonic acid anions than of hardness ions are present.

4.5 LISTS OF ADSORBENTS

Following are the lists of adsorbents used for the removal of heavy metals do far from the referred journals:

For Manganese (Mn):

The watermelon and nanotubes have an adsorption capacity of 21.15 and 38.76(mg/g) for the Adsorbent dose of 4.0(g/l) and the contact time is 20 min. The removal percent% is 23%

The coffee beans have an adsorption capacity of 17.9(mg/g) for the adsorbent dose of 10(g/l) and the contact time is (1,440min).The removal percent is 84%

For Lead (Pb)

The watermelon and nanotubes have an adsorption capacity of 1.45(mg/g) for the Adsorbent dose of 3.5(g/l) and the contact time is (90 min). The removal percent is 74%

The pre-treated orange peel has an adsorption capacity of 40.56(mg/g) for the adsorbent dose of 4.0(g/l) and the contact time is (260 min). The removal percent is 93%

For Copper (Cu)

The watermelon and nanotubes have an adsorption capacity of 52.6(mg/g) for the adsorbent dose of 0.25(g/l) and the contact time is (30 min). The removal percent is 94.8%

The *Mucor rouxii* fungal biomass have an adsorption capacity of 15.6(mg/g) for the adsorbent dose of 15(g/l) and the contact time is (12-80 min). The removal percent is 97%

For Iron (Fe)

The watermelon and nanotubes have an adsorption capacity of 133(mg/g) for the adsorbent dose of 20(g/l) and the contact time is (15-140min). The removal percent is 85.3%

The Wheat bran modified with sulphuric acid has an adsorption capacity of 93(mg/g) for the adsorbent dose of 80(g/l) and the contact time is (300 min). The removal percent is 94%.

In this project the The watermelon and nanotubes used to remove the (Fe,Cu,Pb,Mn) Instead of using only natural adsorbent we combined the watermelon with Nanotubes to create Magnetic carbon Nanostructures so that the result may be accurate and to study more about the adsorption capacity of the Nanostructures.

4.6 MATERIALS USED AND PREPARATION OF ADSORBENT MEDIA

Large number of scientists and environmentalists have investigated the possibility and efficiency of utilization of the natural adsorbents for heavy metal adsorption in polluted water. Following materials were used in removal of iron from water discussed below.

4.6.1 Reagents

The chemicals used were Sodium hydroxide (NaOH), Acetic acid (CH₃COOH), Calcium Hydroxide Ca (OH)₂. Sodium Hydroxide (NaOH) and PH buffer solutions were used to adjust PH value of samples. Groundwater samples were collected from villivakkam, Chennai.

4.6.2 Preparation of watermelon pell and Its characteristics:

Watermelon Shells (WS) were collected from The locals in villivakkam. Were washed repeatedly with water so remove dust and soluble impurities and were allowed to dry at sun light in a shade for 48 hours. The shells were then kept in an air oven 313 343 K for 24 hours. The dried shells were then converted into fine powder by grinding in a mechanical grinder. The powder was sieved to get the adsorbent with size ranging 150 to 300 μ m. The powder was sieved After drying for several hours at room temperature, the WS powder was preserved in airtight glass bottles for use as adsorbents.

Conventional chemicals and analytical techniques were employed to ascertain different characteristics of adsorbents Specific gravity of WS was determined using a mercury porosimeter. Size of material selected was 150 to 300 μ m. The loss on ignition (LO) was determined by heating a pre-weighed dry sample (left at 105 C in an oven and then cooled in desiccators) to 600 C over a period of 2 h [28]. The Point of Zero Charge (PZC) was determined using the solid addition method [29] viz a series of 100 ml. conical flasks, 45ml. of 0.1M KNO₃ solution was transferred. The pH, values of the solution were roughly adjusted from 2 to 10 by adding either 0.1N HNO₃, or NaOH The total volume of the solution in each flask was made exactly to 50ml. by adding the KNO₃ solution The pH, of the solutions were then accurately noted. WS (1g) was added to each flask and securely capped, immediately. The suspension was then manually agitated. The pH values of the supernatant liquid were noted. The difference between the initial and final pH (pH_i - pH_f) was plotted against the pH, The point of intersection of the resulting curve at which pH_i = pH_f, gave the PZC The FTIR spectra of WS (before and after sorption of copper) were used to determine the vibrational frequency changes in the functional group in the adsorbents.

Table.4.3physical property of water melon

PROPERTY	VALUES
Moisture content	208%
Specific Gravity	1.23
Loss on Ignition	70.5%
Point of zero charge	6

4.6.3 Preparation of Nanocomposites and Its characteristics:

Preparation of Magnetic Carbon Nanocomposites. For the preparation of magnetic carbon nanocomposites the waste of watermelon was collected from the local market. The peel of watermelon was dried and cut into pieces and transferred to alcoholic solution of $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ (10% w/v) for 24 hrs. The solution and biomass were then separated and dried in open air at room temperature. And then the dried watermelon was then charred and ignited in an electric heater and wire gauze with an inlet for nitrogen and an exhaust outlet for gases, And finally the watermelon is grinded into a fine substance using a grinder.

Characterization of Iron Oxide Magnetic Carbon Nano-composites:

The most significant physical parameter including the utility and quality of materials is surface area and porosity. Variation in these two parameters greatly influences the activity of the materials. After this method is done the Nanotubes (which are brought in the lab) are added to the prepared adsorbent at the quantity required for each test.

Table.4.4 physical property of nanotubes

BET, surface area (m ² /g)	71.35
Langmiur, surface area(m ² /mg)	261.50
Pour volume total (cm ³ /g)	0.63
Micro pores volume (cm ³ /g)	0.27
Pore diameter,average(A,Angstome)	11.5.20

4.7 Adsorbent Process:

The prepared magnetic carbon nanostructures are then tested in a water sample which is collected from the Villivakkam area. The samples are equally separated into 4 different samples and tested in a different level which is mentioned below.

4.7.1 Reaction occur on the water sample test 1

For the first test Watermelon peel (10g) and Nanotubes(20mg) is taken and mixed and kept for 4 hours at room temp, after 4 hours the magnetic carbon nanostructures are mixed with water samples.

For Manganese (Mn):

The watermelon and nanotubes have an adsorption capacity of 21.15 and 38.76(mg/g). for the Adsorbent dose of 4.0(g/l) and the contact time is 20 min. The removal percent% is 0%

For Lead (Pb)

The watermelon and nanotubes have an adsorption capacity of 1.45(mg/g) for the Adsorbent dose of 3.5(g/l) and the contact time is (20 min). The removal percent is 24%

For Copper (Cu)

The watermelon and nanotubes have an adsorption capacity of 52.6(mg/g) for the adsorbent dose of 0.25(g/l) and the contact time is (20 min). The removal percent is 33%

For Iron (Fe)

The watermelon and nanotubes have an adsorption capacity of 133(mg/g) for the adsorbent dose of 20(g/l) and the contact time is (20min). The removal percent is 30%

4.7.2 Reaction Occur on the water sample test 2

For the first second test Watermelon peel (15g) and Nanotubes(20mg) is taken and mixed and kept for 4 hours at room temp, after 4 hours the magnetic carbon nanostructures are mixed with water samples.

For Manganese (Mn):

The watermelon and nanotubes have an adsorption capacity of 21.15 and 38.76(mg/g). for the Adsorbent dose of 4.0(g/l) and the contact time is 20 min. The removal percent% is 0%

For Lead (Pb)

The watermelon and nanotubes have an adsorption capacity of 1.45(mg/g) for the Adsorbent dose of 3.5(g/l) and the contact time is (20 min). The removal percent is 24%

For Copper (Cu)

The watermelon and nanotubes have an adsorption capacity of 52.6(mg/g) for the adsorbent dose of 0.25(g/l) and the contact time is (20 min). The removal percent is 59%

For Iron (Fe)

The watermelon and nanotubes have an adsorption capacity of 133(mg/g) for the adsorbent dose of 20(g/l) and the contact time is (20min). The removal percent is 30%

4.7.3 Reaction Occur on the water sample test 3

For the first third test Watermelon peel (20g) and Nanotubes(20mg) is taken and mixed and kept for 4 hours at room temp, after 4 hours the magnetic carbon nanostructures are mixed with water samples.

For Manganese (Mn):

The watermelon and nanotubes have an adsorption capacity of 21.15 and 38.76(mg/g). for the Adsorbent dose of 4.0(g/l) and the contact time is 20 min. The removal percent% is 23%

For Lead (Pb)

The watermelon and nanotubes have an adsorption capacity of 1.45(mg/g) for the Adsorbent dose of 3.5(g/l) and the contact time is (20 min). The removal percent is 48%

For Copper (Cu)

The watermelon and nanotubes have an adsorption capacity of 52.6(mg/g) for the adsorbent dose of 0.25(g/l) and the contact time is (20 min). The removal percent is 72%

For Iron (Fe)

The watermelon and nanotubes have an adsorption capacity of 133(mg/g) for the adsorbent dose of 20(g/l) and the contact time is (20min). The removal percent is 54%

4.7.4 Reaction Occur on the water sample test

For the first fourth test Watermelon peel (25g) and Nanotubes(20mg) is taken and mixed and kept for 4 hours at room temp, after 4 hours the magnetic carbon nanostructures are mixed with water samples.

For Manganese (Mn):

The watermelon and nanotubes have an adsorption capacity of 21.15 and 38.76(mg/g). for the Adsorbent dose of 4.0(g/l) and the contact time is 20 min. The removal percent% is 23%

For Lead (Pb)

The watermelon and nanotubes have an adsorption capacity of 1.45(mg/g) for the Adsorbent dose of 3.5(g/l) and the contact time is (20 min). The removal percent is 64%

For Copper (Cu)

The watermelon and nanotubes have an adsorption capacity of 52.6(mg/g) for the adsorbent dose of 0.25(g/l) and the contact time is (20 min). The removal percent is 83%

For Iron (Fe) The watermelon and nanotubes have an adsorption capacity of 133(mg/g) for the adsorbent dose of 20(g/l) and the contact time is (20min). The removal percent is 86%

CHAPTER 5

RESULTS AND DISCUSSION

The results are obtained in removal of heavy metals(manganese, lead, copper, iron) by using magnetic carbon nanostructures. The effectiveness in removing heavy metals are tabled here. The initial concentration and the result are shown in the following table.

5.1 Removal percentage at low concentration

Table5.1removal %at low concentration

Maganese (M n)	Lead (Pb)	Copper (Cu)	Iron (Fe)
0.03	0.03	0.18	0.09

5.2 Removal percentage at high concentration

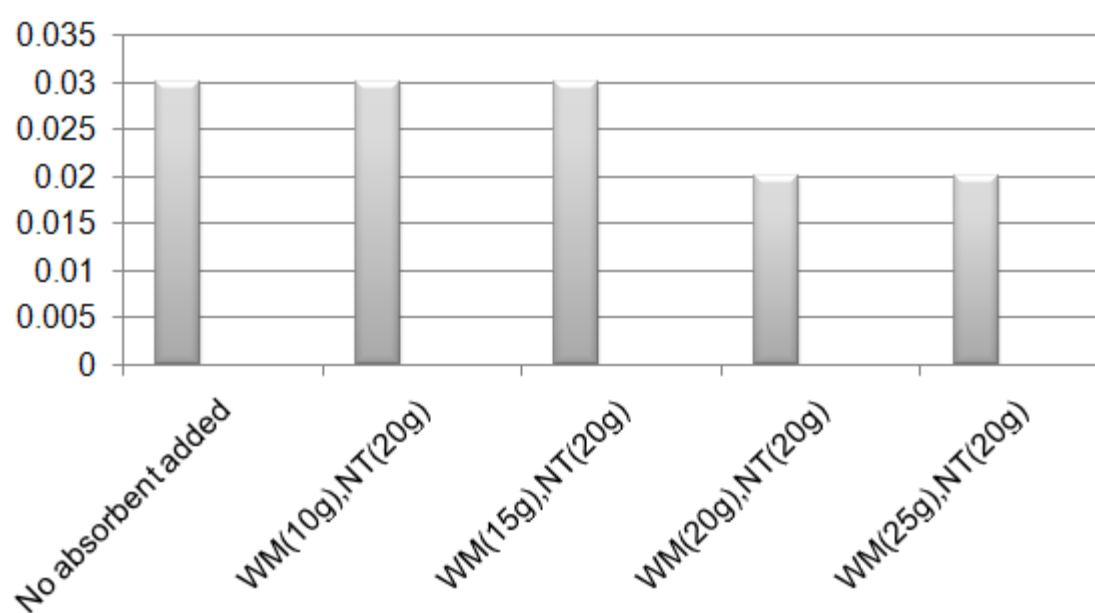
Table5.2removal %at high concentration

Maganese (M n)	Lead (Pb)	Copper (Cu)	Iron (Fe)
0.02	0.01	0.04	0.03

As shown in above table the removal percentage of heavy metal at low concentration is effective only to lead, copper and iron the manganese is not affected much. But in the high concentration all the heavy metal is reduced at a certain rate of above 20%which is shown detail in the table below

Manganese (Mn)

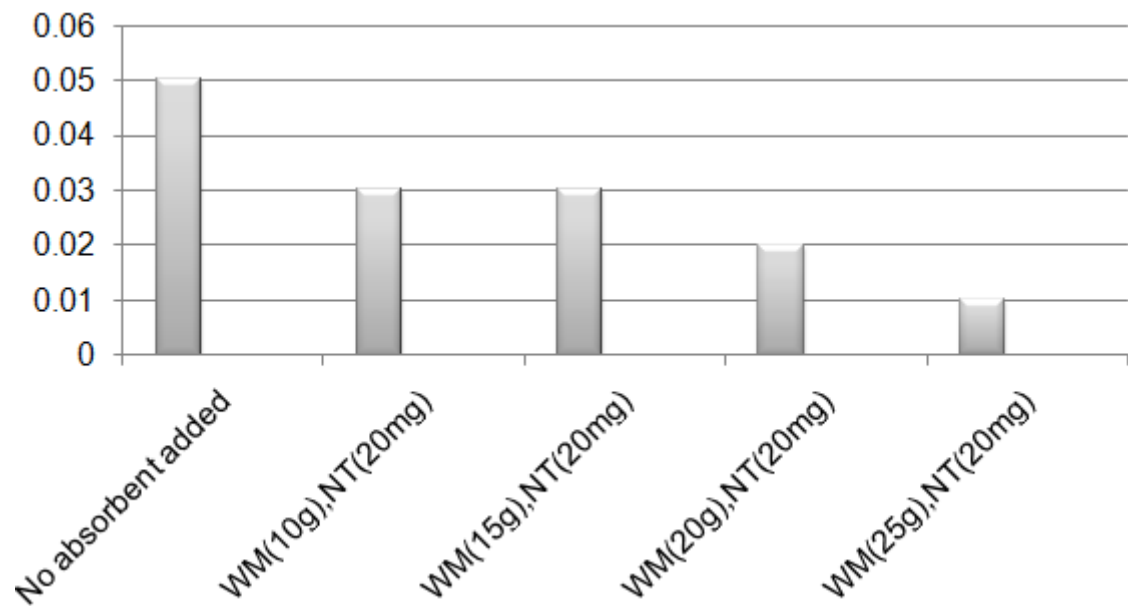
Parameter	1	2	3	4	5
Manganese (Mn)	0.03	0.03	0.03	0.02	0.02



For manganese the removal percentage is not high this is because the watermelon percent in the adsorbent is attracted to manganese only at the higher percentage if we increase the adsorbent percentage the manganese can be removed at higher percentage.

Lead (Pb)

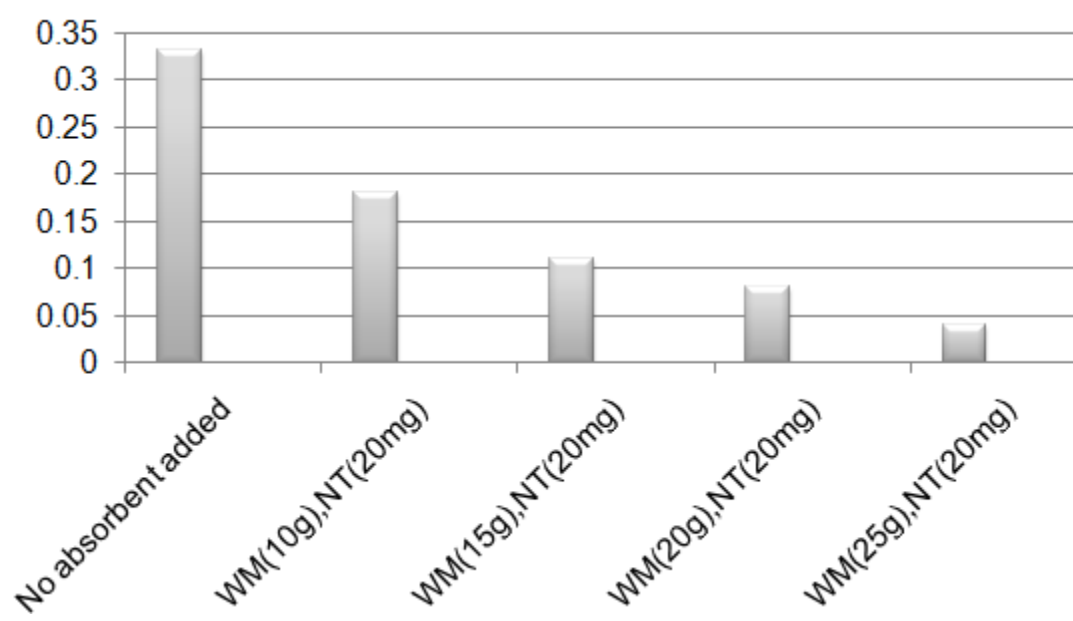
Parameter	1	2	3	4	5
Lead (P b)	0.05	0.03	0.03	0.02	0.01



As the above graph shown that at the first test we can see the change in the lead is decreasing the better result is shown in test 3,4 which has an remove rate of 80%

copper (Cu)

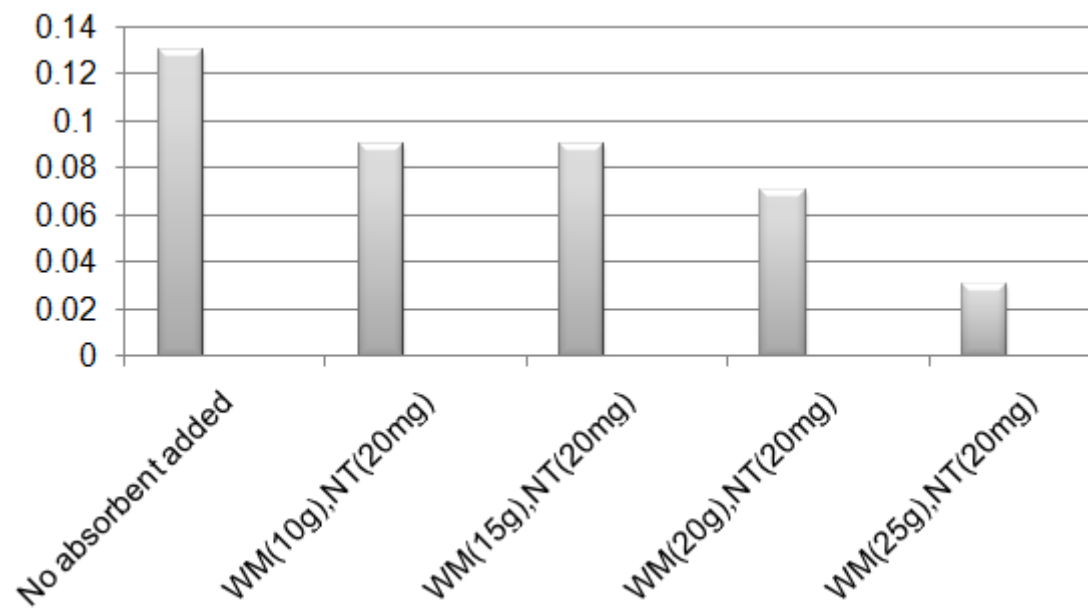
Parameter	1	2	3	4	5
copper (Cu)	0.33	0.18	0.11	0.08	0.04



As the above graph shown that at the first test we can see the change in the copper is decreasing the better result is shown in test 2,3,4 which has an remove rate of 80%

Iron (Fe)

Parameter	1	2	3	4	5
Iron (Fe)	0.13	0.09	0.09	0.07	0.03



As the above graph shown that at the first test we can see the change in the copper is decreasing the better result is shown in test 3,4 which has an remove rate of 80%

CHAPTER 6

SUMMARY AND CONCLUSION

The Magnetic carbon Nanostructures is prepared from the combination of watermelon peel and Nanotubes ,so that it as han high absorption rate even though the amount of Nanotubes we used in very less (20mg) but the watermelon we used is (10,15,20,25 g)

so the watermelon play a major role in it so the removal of copper,Iron and lead is high but the manganese has a low rate of absorption which is because the watermelon is not very attracted to manganese .

If the manganese have to remove at a higher percentage then the amount of Nanotubes has to be increase to (60-80mg) and watermelon has to increase to (190-250) and the contact time has to increase to (80-160min) ,

But by doing so the other heavy metals like copper,iron and lead will be affected majorly because of an increase in adsorbent percentage.

So that we concentrated only in copper,iron,and lead and the removal percentage is also very high

The magnetic carbon Nanostructure we prepared proved to be good result in removal of heavy metals

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