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Design of Advance Constructed Wetland to Purify Domestic Wastewater by Using Activated Carbon

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ABSTRACT

Constructed wetlands (CWs) are affordable and reliable green technologies for the treatment of various types of wastewater. Compared to conventional treatment systems, CWs offer an environmentally friendly approach, are low cost, have fewer operational and maintenance requirements, and have a high potential for being applied in developing countries, particularly in small rural communities. However, the sustainable management and successful application of these systems remain a challenge. Therefore, after briefly providing basic information on wetlands and summarizing the classification and use of current CWs, this study aims to provide and inspire sustainable solutions for the performance and application of CWs by giving a comprehensive review of CWs' application and the recent development of their sustainable design, operation, and optimization for wastewater treatment.Activated carbon has been there with us for centuries. It has wide applications in various industries e.g. in the water-treatment, dye, sugar refining, among others. Constructed wetlands for wastewater treatment have substantially developed in the last decades. As an eco-friendly treatment process, constructed wetlands may enable the effective, economical, and ecological treatment of agricultural, industrial, and municipal wastewater. The present study the recent developments in wetland technology for wastewater treatment from articles published from 2012 to 2022. The papers were searched from Web of Science using the key words constructed wetland and wastewater treatment. Up to 10 articles were selected and a table describes the recent enhancements in wetland treatment technology. Some articles presented notable results, with higher pollutant removal rates or related to some important factors in removal processes. The major enhancement methods for nitrogen, BOD, and COD reduction are hybrid water flow wetland designs and the combination of porous substrates with conventional gravel. Organic substrates, such as coconut shell, wood mulch and rice husk, are a suitable option for the upper porous media. All the activated carbon available in India is imported. Therefore production of activated carbons locally and from locally available materials would be one of the most lucrative and environment-friendly solutions to this as it would transform negative–valued wastes to valuable materials. Thus, the main objective of this research was to prepare activated carbons from coconut shells using a two-step method, and to establish the optimum conditions of production.

KEYWORDS- Coconut shell, Rice husk, Wood mulch, Activated Carbon, BOD, COD, Wastewater

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Increase in population has boosted the growth of different industries leading to discharge of pollutants into the water bodies. Among those industries textile, food, cosmetic and paper industries lead to discharge of dye that needs immediate attention. Color in the water results from various organic chemicals that prevent the sunlight to penetrate affecting the aquatic system. Aquatic organisms and plants are affected due to the release of toxic organic chemicals.Various methods to address this issue has been published by many researchers such as sedimentation with clarification, coagulation and flocculation, chemical oxidation, filtration using membranes, adsorption, biodegradation etc . Among these adsorption is a well-established technology to deal with dye removal. Methylene blue dye has been used in most of the industries and its removal is a matter of great concern. Low cost adsorbents such as coir pith, sawdust, fruit shell, banana pith, pea nut hull, wheat barn etc has been employed [Vadiyelan et al, 2005; Chandran et al, 2002; Bhattacharya et al, 2005; Kumar et al, 2005; Garg et al, 2003; Hamdaoui et al, 2007]. However due to its less adsorption capacity use of activated carbon as an adsorbent is greatly sorted.Activated carbon is a special type of carbonaceous substance. It has highly crystalline form and extensively developed internal pore structure. Due to activation, internal pore network is created which imparts certain surface chemistries (functional groups) inside each particle. Thus carbon gets its unique characteristics leading to high surface area, porosity and greater strength.Theabsorptivity of the adsorbent depends on both the size of the molecule being adsorbed and the pore size of the adsorbent.The organic material which has high carbon content is used as the raw material for the synthesis of activated carbon.

Constructed wetlands (CWs), as a method for wastewater treatment, have developed rapidly in the past two decades (Kadlec, 2008). Compared with conventional wastewater treatment, CWs are a low-cost alternative in terms of construction, operation, and maintenance. Considering the development of treatment wetlands, CWs have become a reasonable option for treating livestock wastewater, farmland leaching water, landfill leachate, and domestic sewage (Lu, 2011). The interaction and application of constructed wetland technology offers more selections and combinations for wastewater treatment systems (Kadlec, 2008).

Several pollutants are removed by CWs. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrogen, phosphorus, trace elements, and some metals like aluminium, copper, mercury, and zinc are common pollutants, which are treated using CWs (Kadlec, 2008). Among these pollutants, N and P, which commonly occur in agriculture, industrial wastewater, domestic sewage, landfill leachate, and storm water, are the main targets of wetland treatment. N occurs in different states in wetland biogeochemical cycles, such as nitrate (NO3) and ammonium (NH4 + -N). The N removal in CWs is based on ammonification, nitrification, and denitrification, plant uptake, and microbial assimilation, as well as ammonia volatilization, filtration, and adsorption (Kadlec, 2008). Phosphorus, as another factor in eutrophication, usually limits the growth of plants and algae in inland waters. Phosphorus removal in wetlands occurs by storing in the sediment and soil via the sedimentation of particulate P, chemical precipitation and adsorption of soluble P, and deposition of suspended organic matter (Kadlec, 2008).

In wastewater treatment, the adsorption process is effective in the removal of organic matters at trace level. Conventional waste treatment methods like coagulation, chemical oxidation have notbeen successful because these methods are stable to organic matters, while adsorption has come out as the cheapest, most profitable and most efficient one. A lot of studies have been done in using the environmental waste as a potential adsorbent in removing organic matters, including studies on converting rice husks to activated carbon as the potential adsorbent. As India is rich with paddy, a thorough study in converting the rice husk to activatedcarbonwill give a lot of advantage to the country.

Activated Carbon is an essential substance for many industrial activities. For instance, bleaching agent (in sugar factory) and for water filtration. Most of the Activated Carbon for industrial activities is being imported from other countries. However, there is no sufficient amount of production to satisfy the need in our country and the demand for Activated Carbon in the market is high. So, to satisfy the demand the Activated Carbon is being produced using solid waste Rice Husk. The purpose of this project is the preparation of Activated Carbon using a suitable rice husk. The

Activated Carbon produced from Pyrolysis of rice husk was chemically activated with activating agent sodium hydroxide (NaOH). The chemically activated carbons were characterized by measuring yield percentage and bulk densities. The activated carbon produced from rice husk at different activating temperature of 650ºC, 700ºC and 800ºC exhibit a yield percentage of 48.2%, 47.65% and 45.95% respectively and corresponding bulk densities were 0.2 g/ml, 0.16 g/ml and 0.117 g/ml respectively. Proximate analysis also performed for precursor selection to choose the appropriate precursor. The quality of activated carbon is highly proportional to the dehydration rate of the sample and also on the process of removal of the volatile substances present in the precursor. According to proximate analysis, rice husk has a volatile matter of 68.06%, ash content 0.952%, fixed carbon content 20.988% and moisture content of 10%. This contributes to a total volatile content (easily escapable components) of about 68.06%. The proximate analysis of rice husk also reveals that the selected rice husk has good carbon content which is 20.988%. Therefore, proximate analysis served as an evidence for choosing rice husk as the precursor. Finally, a preliminary material and energy balance on pyrolysis or carbonization was performed.

2. LITERATURE REVIEW

These activated carbon materials are characterized by their large surface areas and better porosity which was well developed. For these reasons activated carbons are commercially used as adsorbents for the removal of some organic chemicals and metal ions of environmental, potable water, waste water and removal of some gases.Usually the cost of preparation of activated carbon depends on the selection of the precursors.. So from the economical view, to utilize the cheaper raw materials for the production of activated carbon is sorted. Activated carbons are widely used as an economic and stable mass separation agent final or the removal of dye or surfactants and improve the quality of the final product in many industrial processes. Activated carbon is also used for thepurification of liquids and gases, separation of mixtures and catalysis. Adsorption capacity of activated carbon is measured by considering the chemical nature of the aqueous phase, the solid phase and the chemical nature of the adsorbing organic.For the analysis of the surface physical properties of the carbon which includes the determination of the total surface area, extent of micro-porosity and characterization of the pore distribution. The total surface area can be measured by using BET method and pore structure can be shown by SEM test. Pore volume and porosity can be obtained from porosimetry. The adsorbent having large pore volume is used as better adsorbent for the adsorption process.

K Mallick , 2004,used Mahogany sawdust to develop an effective carbon adsorbent. This adsorbent was employed for the removal of dyes from spent textile dyeing wastewater. The experimental data were fitted to Langmuir and Freundlich models of adsorption.

M.M.Nourouzi and T.G.Chuah in 2009, studied the adsorption behavior on Reactive Black 5 and Reactive Red 3 using Palm Kernel Shell Activated carbon. Applications of batch kinetic data to pore and film surface diffusion models were explored.

Jun –jieGao et al., 2013, produced activated carbon from tea seed shells. They obtained activated carbon of BET surface area 1530 m2 /g. The precursor was chemically activated using zinc chloride and pyrolysed in a tubular furnace at 500oC for one hour duration at a heating rate 5oC/min.

Halandemiral et al., 2008, prepared activated carbon from Hazelnut bagasse through chemical activation technique. The surface area developed was significant 1489 m2 /g. It was employed to remove Sandolan blue from the water bodies.

2.1 Activated Carbon

Activated carbon includes a wide range of amorphous carbon-based materials prepared to exhibit a high degree of porosity and an extended interparticulate surface area. It is also a common term used for a group of adsorbing substances of crystalline form, having large developed internal pore structures that make the carbon more adsorbent.

2.2 History of Activated Carbon

The use of carbon extends so far back into history that its origin is impossible to document. The first known use of activated carbon dates back to the Ancient Egyptians as early as 1500 B.C. who utilized its adsorbent properties for purifying oils and medicinal purposes. Charcoal was used for drinking water filtration by ancient Hindus in India. Centuries later, the early ocean-going vessels stored drinking water in wooden barrels, the inside of which had been charred. However, by modern definition the carbon used in these applications could not truly be described as "activated". By the early 19th century both wood and bone charcoal was in largescale use for the decolourization and purification of cane sugar. The first documented use of activated carbon in a large scale water treatment application was in 19thcentury England, where it was used to remove undesirable odours and tastes from drinking water. In recent years, the use of activated carbon for the removal of priority organic pollutants has become very common. Today, hundreds of brands of activated carbon are manufactured for a large variety of purposes. The largest market for activated carbon is currently in the municipal water purification industry, where charcoal beds have been used for the dual purpose of physical filtration and sorption. In fact, activated carbon filters are used today in drinking water treatment to remove the natural organic compounds (i.e. tannins) that produce carcinogenic chlorinated by-products during chlorine disinfection of water. In wastewater treatment, activated carbon is usually used as a filter medium in tertiary (later) treatment processes. In these applications, carbon filters are usually quite effective in removing low concentrations of organic compounds, as well as some inorganic metals. In addition to its drinking water and wastewater treatment applications, activated carbon is used today for many other purposes.Some other common uses are: corn and cane sugar refining, gas adsorption, dry cleaning recovery processes, pharmaceuticals, fat and oil removal, electroplating, alcoholic beverage production, and as nuclear power plant containment systems.

2.3 Structure of Activated Carbon

In order to explain the capabilities of activated carbon, an appreciation of its structure is most useful. Much of the literature quotes a modified graphite-like structure; the modification resulting from the presence of micro crystallites, formed during the carbonization process, which during activation, have their regular bonding disrupted causing free valencies which are very reactive. In addition, the presence of impurities and process conditions influence the formation of interior vacancies, in the microcrystalline structures. Such theory generally explains pores as the result of faults in crystalline structures. However, more recent research studies provide a more feasible explanation of the carbon structure. The generally accepted graphite-like structure theory falls down since the hardness of activated carbon is not in keeping with the layered structure of graphite. Furthermore, the manufacturing conditions are different; in particular the temperature range utilized for activated carbon production is lower than that required for graphitization.Supporters of the graphite-like structure generally only explain the modified microcrystalline structure and ignore photographic and other methods of examining the residual macro structure. High magnification electron scanning microscopy, at 20,000x magnification, has revealed the presence of residual cellular structures. These were previously unseen and unsuspected, except in the case of woodbased activates which have sufficiently open structures visible to the naked eye. Cellular units are built from sugars, the most important being glucose. Sugars ultimately will build to cellulose (the most important single unit in cellular construction) and cellulose polymers cross-link to form the wall of individual plant cells. Glucose units are wound into very tight helical spirals and under polarized light, these exhibit anisotropy - demonstrating the presence of crystalline structures. Although not as yet proven, it has been postulated that in the areas of maximum strain in cellulose chains it is conceivable that smaller crystalline units could be produced. In addition to cellulose, other materials also exist in cell wall structure. Hemi-cellulose, which undergoes degradation more easily than cellulose and Lignin (the structure of which is still unproven) also exists and this is the most resistant to oxidation.Most theories attribute the structure of activated carbon to be aromatic in origin, thus, allowing the carbon structure itself to be described as aromatic in order to explain active centres, etc. Structures of the size of cell dimensions obviously do not influence physical adsorption but illustrate that the only material available for oxidation lies within the cell walls themselves. Final activates consist almost entirely of elemental carbon together with residual ash which, in the case of wood and coconut, originate from minerals within the vessels of living tissues; silica being the only constituent actually incorporated within the cell wall tissue matrix. The ash content of coal is of different composition and due to intrusion of inorganic materials during coalification. Thus, the overall structure consists of a modified cellular-like configuration with varying ash components depending on the particular raw material.The cellular-like structure theory offers a logical explanation for the differences in apparent density between activates of wood, coal and coconut. Wood activates have a very open structure with thin wall cells whereas coconut activates show very thick walls with many pits. It is known that the carbonization and activation processes destroy, to varying degrees, intercellular walls and sieve plates between cells. The end result on wood is a very open, sponge-like macrostructure seriously reducing the probability of adsorbate contact with cell walls. Activation of coconut produces a composition of rod-like cells in very close contact and large surface cavities are formed by destruction of dividing walls but these are shallow and do not extend through the activates granule. The coconut activates thus differ significantly from wood activates in mechanical strength and density. Coconut activates exhibit extensive micro pore volume, whereas wood activates have a definite trend to Mesopores/macro pores and a corresponding change in their basic properties. In the case of coal based carbons, pre-treatment of the raw coal is necessary in order for it to be processed, since raw coal swells during heating to produce coke-like structures. Control of this is achieved by first grinding the raw coal and mixing it with various additives, such as pitch, before it is introduced to the activation furnace.

2.4 Wastewater

"Wastewater" Definition

The term "wastewater" refers any water that has been used or polluted, and contains waste products. Wastewater is approximately 99% water; only 1% is a mixture of suspended and dissolved organic solids, detergent, and cleaning chemicals. "Sewage" is one kind of wastewater. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage treatment, or municipal wastewater treatment, is the process of removing contaminants from wastewater and household sewage. It includes physical, chemical, and biological processes to remove organic, inorganic and biological contaminants.The typical composition of municipal wastewater (after pretreatment) most often treated in CWs contains suspended solids, organic matter, and in some instances, nutrients (especially total nitrogen) and heavy metals, as shown in Table 2 **(Tchobanoglous& Burton, 1991**). Domestic sewage wastewater typically contains 200 mg of suspended solids, 200 mg biochemical oxygen demands, 35 mg nitrogen, and 7 mg phosphorus per liter**(Volodymyr, Sirajuddin, & Viktor, 2007).**

Table 2.1 : Contaminations Concentration in the Typical Untreated Domestic Wastewater

Parameter	Unit	Weak (Concentration)	Medium (Concentration)	Strong (Concentration)
TS	Mg/L	350	720	1200
TDS	Mg/L	250	500	850
TSS	Mg/L	100	220	350
BOD	Mg/L	110	220	400
COD	Mg/L	250	500	1000
TN	Mg/L	20	40	85
TP	Mg/L	4	8	15
Total Coliform	No/100 mL	10^6-10^7	$10^7 \sim 10^8$	$10^7 \sim 10^9$

2.5 Wastewater Reuse and Reclamation

During the last century, the increasing demands for freshwater coupled with environmental concerns about the discharge of wastewater into ecosystems and the high cost and technology requirements of wastewater treatment have spurred processes in water reclamation and reuse. Early development stems from the land application for the disposal of wastewater, following the admonition of Sir Edwin Chadwick—"the rain to the river and the sewage to the soil" **(National Research Council of the National Academies, 1996, p. 17).** Such land disposal schemes were widely adopted by large cities in Europe and the United States in the 1900s.With the development of sewerage systems, domestic wastewater was firstly considered to be reused by farms. California was the pioneer in wastewater reuse and has the most comprehensive regulations pertaining to the public health aspects of reuse. By 1910, 35 California communities were using sewer water for irrigation (Recycled Water Task Force, 2003). In 1918, the California State Board of Public Health promulgated the initial Regulation Governing Use of Sewage for Irrigation Purpose, pertaining to irrigation of crops with sewage effluents. In 1929, the city of Pomona, California, initiated a project using reclaimed wastewater for the domestic irrigation of lawns and gardens **(Ongerth& Harmon, 1959)**. In 1965, the Santee, California recreational lakes, supplied with reused wastewater, were opened for swimming.Today, as more advanced technologies are applied for water reclamation, the quality of reclaimed water can exceed conventional drinking water quality based on most conventional parameters. Water reclamation or water purification processes could technically provide water of almost any quality desired **(Asano, 1998).**

2.6 Conventional Wastewater Treatment

The conventional wastewater treatment process consists of a series of physical, chemical and biological processes. Typically, treatment involves three stages, called primary, secondary and tertiary treatment.

2.6.1 ***Primary treatment*** is used to separate and remove the inorganic materials and suspended solids that would clog or damage the pipes. Primary treatment consists of screening, grit removal, and primary sedimentation. Screening and grit removal may also be called "preliminary treatment." Large debris, such as plastics, rags, branches, and cans are removed by the screens, while smaller coarse solids, such as sand and gravel, are settled by a grit chamber system. Then wastewater is moved into a quiescent basin, with a temporarily retention; the heavy solids settle to the bottom while the lighter solids, grease and oil float to the surface. The settled and floating pollutants are removed by sedimentation and skimming, with the remaining liquid then discharged to undergo secondary treatment. Typically, about 50% of total suspended solids (TSS) and 30% to 40% of BOD are removed in the primary treatment stage **(Nelson, Bishay, Van Roodselaar, Ikonomou, & Law, 2007).**

2.6.2 ***Secondary treatment*** removes dissolved and suspended biological matter. Typically, up to 90% of the organic matter in the wastewater can be removed through secondary treatment by a biological treatment process **(U.S. EPA, 2004b).** The two most common conventional methods used to achieve secondary treatment are attached growth processes and suspended growth processes. In attached growth (or fixed-film) processes, the bacteria, algae and microorganisms grow on a surface and form a biomass. Attached growth process units include trickling filters, biotowers, and rotating biological contactors. In suspended growth processes, the microbial growth is suspended in an aerated water mixture. The most common of this type of process is called "activated sludge." This process grows a biomass of aerobic bacteria and other microorganisms that will breakdown the organic waste.

2.6.3 ***Tertiary treatment*** is sometimes defined as advanced treatment; it produces a higher-quality effluent than do primary and secondary treatment in order to allow discharge into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs, and others). The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality to the desired level. This advanced treatment can be accomplished by a variety of methods such as coagulation sedimentation, filtration, reverse osmosis, and extending secondary biological treatment to further stabilize oxygen-demanding substances or remove nutrients. As wastewater is purified to higher and higher degrees through such advanced treatment processes, the treated effluent can then be safely and appropriately reused.Before the treated wastewater is discharged, ***a disinfection process*** is sometimes required. Water systems add disinfectants to kill pathogenic microorganisms. The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment, and it is almost always the final step in the treatment process regardless of the level or type of treatment used. Common methods of disinfection include chlorine, and ultraviolet light. The treated water can be discharged into a stream, river, lagoon, or wetlands, or it can be used for landscape irrigation. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

2.7 Constructed Wetlands

History of CWs -

The scientific studies on the use of CWs for wastewater treatment began in the middle of the last century. The first experiments were undertaken by Käthe Seidel in Germany in the early 1950s at the Max Planck Institute in Plön**(Seidel, 1955).** In her report, she discussed the possibility "of lessening the overfertilization, pollution and silting up of inland waters through appropriate plants, thereby allowing the contaminated waters to support life once more" **(Seidel, Happel, &Graue, 1978, p. 2).** She opines that macrophytes (e.g., Schoenoplectuslacustris) are capable of removing large quantities of organic and inorganic substances from polluted water. Moreover, Schoenoplectus spp. (bulrush) not only enriches the soil on which it grows in bacteria and humus but apparently exudes antibiotics. Bacteria and heavy metals in the polluted water are eliminated and removed by passing through the macrophytes.Seidel's discoveries gave birth to modern CWs and stimulated the following research and applications of engineered treatment wetlands in the Western world. However, most of her studies focused on the subsurface flow (SSF) CW. The first fullscale CW was built with a FWS system in the Netherlands in 1967 (De Jong, 1976). This treatment facility was designed to clean the wastewater from a camping site with 6000 summer visitors per day.In North American, the experimentation with FWS wetlands started with the observation of assimilative capacity in natural wetlands at the end of the 1960s and beginning of 1970s **(Spangler, Sloey, & Fetter, 1976; Wolverton, 1987).** Between 1967 and 1972, researchers in Chapel Hill, North Carolina began a five year study using a combination of constructed coastal ponds and natural salt marshes for the recycling and reuse of municipal wastewater **(Odum, Ewel, Mitsch, & Ordway, 1977).** In 1973, the first fully CW consisting of a series of constructed marshes, ponds and meadows was built in Brookhaven, New York **(Kadlec& Knight, 1996).** About the same time, an interdisciplinary research team at the University of Michigan began the Houghton Lake project. This is the first application of a treatment wetland in a cold climate area **(Kadlec, Richardson, &Kadlec, 1975; Kadlec& Tilton, 1979)**. Since then, FWS CWs have been broadly used in the United States for various types of wastewater treatment.

ATIF MUSTAFA(2013) conducted treatment performance of a pilot-scale constructed wetland (CW) commissioned in in Karachi, NED University of Engineering & Technology, was evaluated for removal efficiency of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), ammonia-nitrogen (NH_4-N), ortho-phosphate (PO_4-P), total coliforms (TC) and faecal coliforms (FC) from pretreated domestic wastewater. Monitoring of wetland influent and effluent was carried out for a period of 8 months. NED wastewater treatment plant (WWTP) treats wastewater from campus and staff colony. The wastewater contains domestic sewage and low flows from laboratories of various university departments. The constructed wetland is planted with common wetland plant (*Phragmiteskarka*). The key features of this CW are horizontal surface flow. Treatment effectiveness was evaluatedwhich indicated good mean removal efficiencies; BOD (50%),COD (44%), TSS (78%), NH4-N (49%), PO4-P (52%), TC (93%)and FC (98%).

YADAV and **JADHAV (2011)** construct wetland unit combined with surface flow and planted with *Eichhorniacrassipes*was built near Technology Department, Shivaji University, Kolhapur (Latitude 160 40′ N, Longitude 740 15′ S). Maharashtra situated in Western part of India. The campus wastewater was let into the constructed wetland intermittently over 30 days.Thestudy was performed in two sets A and B which were run in the months of December and January respectively. The parameters analysed for the study were pH, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Nitrogen and Phosphorus. Only quality of wastewater was analysed during the study period of 2 months i.e. December and January. The sampling took place daily at both inlet and outlet of constructed wetland system. Treatment effectiveness was evaluatedwhich indicated good mean removal efficiencies; BOD (95%),COD (97%), TSS (82%), NH4-N (43%), PO4-P (49%).

2.8 Wetland Hydrology

Hydrology is probably the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland process **(Mitsch&Gosselink, 2007, p. 108).”** Wetland design is affected by the volume of water, its reliability and extremes, and its movement through the site **(U.S. EPA, 1999).** Wetland hydrology describes the input and output of water in wetland systems. It affects the composition of vegetation and species communities by acting as the main pathway via which energy and nutrients are transported. Water enters wetlands via surface flow, precipitation, and groundwater discharge, while it flows out via surface flow, ground water recharge, and evapotranspiration (ET).

2.9 Pollutant removal

Raw sewage consists of a combination of domestic and commercial wastewaters. The pollutant parameters commonly present are BOD, TSS, organic compounds, pathogens, nutrients (especially nitrogen) and heavy metals. CWs are very efficient in reducing the level of these pollutants in municipal wastewater effluents. In FWS wetlands, the removal mechanisms include flocculation, sedimentation, absorption, oxidation and anaerobic reaction. In a properly operating CW system, the concentration of in the effluent should be less than 30mg/L, TSS are less than 25 mg/L, and fecal coliform bacteria concentration is less than 10,000 colony-forming units (cfu)/100 mL **(David, James, Christopherson, &Axler, 2002)**

Biochemical Oxygen Demand (BOD5) Removal. BOD5 is a measure of the mass of oxygen required by aerobic organisms to decompose organic matter in the water. The standard BOD value is commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20 °C. In FWS wetlands, removal of the soluble BOD5 is due to microbial growth attached to plant roots, stems, and leaf litter that have fallen into the water. Because algae are not present with the complete plant coverage, water surface reaeration provides the major sources of oxygen for these reactions in addition to plant translocation of oxygen from the leaves to the rhizosphere **(U.S. EPA, 1980).** BOD5 removal often approximates first-order kinetics. Based on the First Order–Reaction Kinetics–Plug Flow Approach, Reed´s method is used to estimate BOD removal efficiency. This method is a research-based design method based on the firstorder plug flow assumption for those pollutants that are removed primarily via biological processes (i.e., BOD, ammonia, and nitrate) **(Knight, Ruble, Kadlec, & Reed, 1993).**

TSS Removal.The "total solid" refers to the suspended or dissolved matter. TSS are solids that can be retained by a filter. The removal of TSS from water to the wetland sediment bed is essential for both the improvement of water quality and the function of the wetland ecosystem. TSS are predominantly removed via flocculation/sedimentation and filtration/interception mechanisms **(U.S. EPA, 1999).** Suspended solids can also be produced within the wetland. This occurs due to the death of invertebrates, fragmentation of detritus from plants, production of plankton and microbes within the water column or attached to plant surfaces, and formation of chemical precipitates. TSS removal processes are related to filtration and retention times. The slow flowing water allows the physical separation of TSS.

Nitrogen Removal. Nitrogen is a serious concern in wastewater because of its role in eutrophication and toxicity to aquatic. Numerous biological and physiochemical processes in wetlands are particularly important in the transformations of nitrogen into varying biologically useful forms. Additionally, plants that require nitrogen for their growth play an active role in removing it from the wastewater. Nitrogen removal occurs through nitrification, denitrification, ammonification, volatilization and plant uptake . The removal rate in a wetland is 61% through denitrification and 14% through plant biomass, and the remainder is stored in the soil **(Matheson, Nguyen, Cooper, Burt, & Bull, 2002).** Hence, the nitrification and denitrification processes occurring within the wetland are the major mechanisms for nitrogen removal **(Vymazal, Brix, Cooper, Green, & Haberl, 1998).** Vegetated zones are anaerobic, because oxygen released by hydrophytic plants is trivial compared to the oxygen demands. Therefore, nitrification unlikely to happen in VSB wetlands and highly dense vegetated zones of FWS wetlands, but can be accomplished in open-water zones. To increase the efficiency of nitrification and denitrification, a well aerated condition must be followed by the vegetated zones.

Total Phosphorus Removal. Phosphorus is one of the important nutrients that cause eutrophication in the lakes. Plants uptake phosphorus during the growing season, but the phosphorus is released back into the water during decomposition when plants die. Phosphorus can also be released in varying proportions at different times throughout the year and is cycled throughout the wetland. The predominant form is orthophosphate which can be used by algae and macrophytes. Inorganic phosphorus can also be found as polyphosphates. Municipal wastewaters may contain from 5 to 20 mg/L of total phosphorous, of which 1 to 5 mg/L is organic and the rest is inorganic. The per capita phosphorous contribution per inhabitant per day averages about 0.0048 lb/person/day (Kentucky Department of Environmental Protection, 2012). The removal of phosphorus in wetlands is achieved through physical, chemical, and biological processes **(Debusk,**

1999). The physical process includes sedimentation and entrapment within the emergent macrophyte stems and attachment to plant biofilms. Chemical methods are soil absorption and desorption. This involves soluble inorganic phosphorus moving from the pores in the soil media to the soil surface. The biological mechanism involves uptake of phosphates by microorganisms, including bacteria, fungi, and algae. The biological process is rapid but does not allow for much storage. In FWS wetlands the uptake from free floating macrophytes is more important but these plants must be harvested and replaced to maximize phosphorus removal. Typical phosphorus removal is in the 40% to 60% range **(Vymazal, 2006).**

[1] "Use of Pervious Concrete as Gravity Filter" By:-NinadOke, ParthChoksi, AmeyNaik, Nikita Mahapatra, ASABE Conference Paper, Publishing year :- Nov 2014.

In this study the usage of pervious concrete for filtration purpose is highlighted. It is well known that pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and however not much research has been done on its effectiveness to be used for filtration process. In the water purification process rapid sand filter is provided after sedimentation process. The turbidity of water entering the rapid sand filter is around 25-100 NTU depending on the season of the year. Conventionally, the filter media used is graded sand. This study was conducted to see the feasibility of using pervious concrete as a filtration media. The pervious concrete blocks used had sixteen different combinations in triplicate. The combinations used were having variability in type of cement, water cement ratio and thickness. A reduction of 69.8% turbidity for initial turbidity of 25 NTU and 66% reduction for initial turbidity of 100 NTU was observed. A 97 and 99 % MPN removal for 25 and 100 NTU of initial turbidity was observed.

[2] "Design of Grey Water Treatment Units" By:-M.Seenirajan, S.Sasikumar, Erlin Antony, International Research Journal of Engineering and Technology (IRJET). Publishing Year :- Volume:05 Issue:05 May 2018.

In this paper we have studied about composition and characteristics of grey water and using this information design of treatment units were easy. Treating wastewater will surely reduce the effects of its harm and thus increasing its usability. Once undergone through the procedure of proper treatment, you will no longer receive any bad odours. The water, thus obtained, is clean and safe for use. Grey water can replace drinking water for irrigating gardens or lawns especially during drought periods.

[3] "Efficiency of Slow Sand Filter in Wastewater Treatment" By- Teena Ann Thomas and K. MophinKani, International Journal of Scientific & Engineering Research. Publishing Year- Volume 7, Issue 4, April-2016.

Slow sand filtration is a technology that has been used for potable water filtration for hundreds of years. It is a process well-suited for small, rural communities since it does not require a high degree of operator skill or attention. As its name implies, slow sand filtration is used to filter water at very slow rates. The typical filtration rate is at least fifty times slower than for rapid rate filtration. It was observed that the reduction efficiency of turbidity is about 70% and the reduction in pH and electrical conductivity is also noticeable. Thus it can be concluded that the slow sand filter is efficient in treating wastewater from a particular source.

[4] "A Review on Pervious Concrete" By-Vr.Bharanidharan, K.Ashok Kumar, M. Samuel Thanaraj, International Research Journal of Engineering and Technology (IRJET). Publish year :-Volume-6, Issue-3, March 2019.

Pervious concrete is a cost-effective and environmental friendly solution to support sustainable construction. It's ability to capture storm water and recharge ground water while reducing storm water runoff enables pervious concrete play a significant role. Due to its potential to reduce the runoff, it is commonly used as pavement material. The smaller the size of coarse aggregate should be able to produce a higher compressive strength and at the same time produce a higher permeability rate. The mixtures with higher aggregate/cement ratio 8:1 and 10:1 are considered to be useful for a pavement that requires low compressive strength and high permeability rate. The ideal pervious concrete mix is expected to provide the maximum compressive strength, and the optimal infiltration rate. Pervious concrete is one of the leading materials used by the concrete industry as GREEN industry practices for providing pollution control, storm water management and sustainable design.

3. PROPOSED METHODLOGY

Activated carbon is a amorphous from of carbon which has been treated to produce a highly developed pore structure resulting in a very large internal surface area. It is pore structure which gives the activated carbon its ability to absorb gases and vapours from gaseous phase and dissolved or dispersed substances from liquid phase. Activated carbon can be manufactured from wide variety of raw material such as pinewood, charcoal, coconut shell, rice husk etc. The activated carbon is also used for the purification of air and water, refining of sugar and production of electrodes. The demand is gradually increase with the increase of end users industry.

3.1 Methodology

1. Raw material

For this project the raw materials such as coconut shell activated carbon, activated carbon from rice husk and activated carbon from wood mulch was obtained.

[Fig.3.1: coconut shell]

[Fig.3.2: rice husk]

[Fig.3.3: wood mulch]

2. Chemicals

The various chemicals used during this project were hydrochloric acid, sodiumthiosulphate, iodine solution, starch, 1N sulfuric acid, 1N sodium hydroxide etc.

3. Instrumentation

Muffle furnace, oven, weighing machine,Brunaner Emmett Teller surface area analyzer, pH meter, mercury porosimetry, scanning electronic microscope, hand shaker, UV spectro-photometer.

4. Proximate analysis

According to ASTM D 121, proximate analysis is the determination of moisture, volatile matter, fixed carbon, and ash content by prescribed methods. The proximate analysis of the different type of activated carbon was done using the following procedure.

4.1 Moisture content

Small amount of activated carbon sample (coconut shell) weight was measured and then taken in a petri dish. It was spread nicely on the dish. It was then heated in an oven at a temperature of (105-110)°c for 1.5hr. The petri dish was left open or not covered during heating process. After heating petri dish was removed and cooled in a desicator. After cooling the weight of dried sample was measured.

4. RESULTS AND DISCUSSION

4.1 Activated carbon from coconut shell

A number of studies on converting rice husk to activated carbon have been reported. Rice husk is agricultural waste, accounting for about one-fifth of the annual gross rice, 545 million metric tons of the worlds. As the demand using renewable resource for alternatives is rising rapidly with the decrement of renewable resource, the studies done on the potential of the rice husk is considered to be very essential and important. Before it can be used as an adsorbent, a few methods have been identified to treat this rice husk. These treatment processes include the activation of the rice husk. There is no exact method has been proven to produce a high performance adsorbent from rice husk. The previous studies conducted show that the rice husk needs to be activated with acidic or basic solution. However, there are no studies done to compare between these two types of digestion solution on the rice husk. There are no exact explanations of how the rice husk particles form its binding with its adsorbates. However, the formation of the surface complexes is most likely to be related to the predominant silica content of the samples. This is where the activation process takes place. The digestion process reduces the organic constituents and produced a highly porous cellulose-silica material which has a relatively good adsorptive in removing phenol. In all cases, rice husk is carbonized in an inert atmosphere (nitrogen or argon) in order to remove volatile matter.

Table 4.1: Percent Reduction in Physicochemical Parameters of Grey Water

Physicochemical Parameters	Wastewater Before Treatment	Wastewater After Treatment	Percent Reduction
BOD (mg/L)	148	36.5	75.3
COD (mg/L)	380	160.6	57.7
Ph	7.45	7.2	3.4
Turbidity (NTU)	190	67.10	64.68
Chloride Content (mg/L)	1200	537.4	55.2
Total Hardness (mg/L)	120	115	4.2
Total Solids (mg/L)	780	490	37.2

4.2 Activated carbon from rice husk

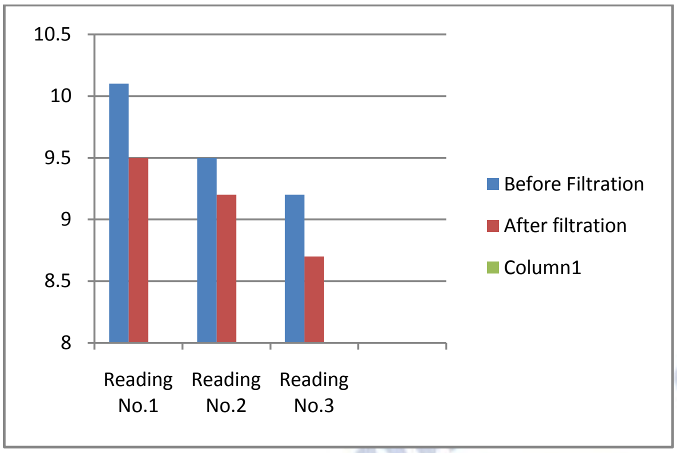
The value-added activated carbon of rice husk can be produced by simple carbonization-chemical activation. Carbonization at 450 °C for 2 hr and using H3PO4 as an activating agent was a suitable process. Under these optimum conditions, BET surface area of the activated carbon of rice husk was 336.35 m2 /g. The adsorption efficiency of activated carbon of rice husk which has the highest gasoline adsorption was obtained when using 0.1 g of ACRH450 as adsorbent at 70 °C adsorption temperature for 30 min of adsorption time. Since the activated carbon of rice husk is high surface area and gasoline adsorption capacity, therefore, it can be employed as noncommercial adsorbent and considered as an alternative one to commercial adsorbent. For further research, these optimum conditions for gasoline adsorption using activated carbon of rice husk as adsorbent will be used for the study of residual gasoline detection in soil samples as duplicated evidence in arson scenes.

4.3 Activated carbon from wood mulch

The production of activated carbon from eucalyptus wood chips by steam activation in a 2000 kg batch intermittent rotary kiln with continuous carbonization–steam activation process conducted at 500 °C to 700 °C was studied. The activated carbon products were characterized by FTIR, SEM–EDS, Raman spectroscopy, and BET analysis. Percent yields, iodine number, and methylene blue number of the produced activated carbon materials were measured as well. It was shown that the percent yields of the activated carbon materials made in the temperature range from 500 to 700 °C are 21.63 ± 1.52%–31.79 ± 0.70% with capacities of 518–737 mg I_2/g and 70.11–96.93 mg methylene blue/g. The BET surface area and micropore volume of the activated carbons are 426.8125–870.4732 m^2/g and 0.102390–0.215473 cm^3/g, respectively. The steam used in the process could create various oxygen containing surface functional groups such as –CO and –COC groups. In addition, it could also increase the amorphous nature of the activated carbon product. These properties of the activated carbon products are increased with increasing steam activation temperature from 500 to 700 °C. As a result, the activated carbon materials produced at activation temperatures of 600 °C and 700 °C exhibit higher adsorption.

Table 4.1: Observation for pH

Reading no.	Before filtration	After filtration	Potable value	Mean value
1	10.1	9.5	6.5-8.5	9.13
2	9.5	9.2		
3	9.2	8.7		

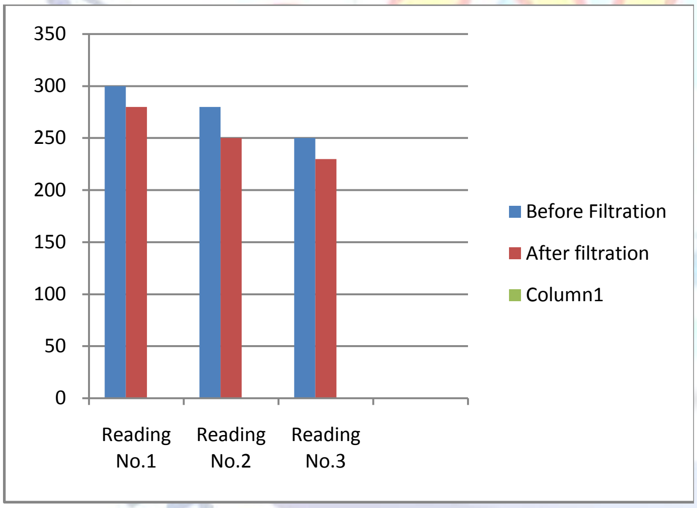


[Fig.4.1: Observation graph for pH]

4.1.2 Observation Table for Turbidity (NTU)

Table 4.2: Observation for Turbidity

Reading no.	Before filtration	After filtration	Potable value	Mean value
1	300	280	0.1 NTU	253.33
2	280	250		
3	250	230		

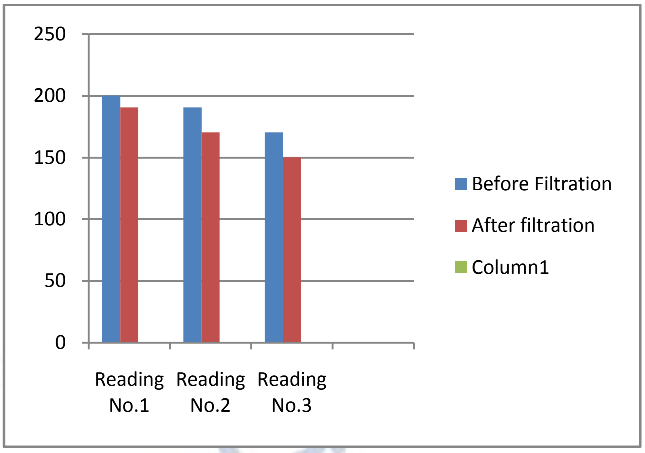


[Fig.4.2: Observation graph for Turbidity]

4.1.3 Observation Table for TSS (mg/l)

Table 4.3: Observation for TSS

Reading no.	Before filtration	After filtration	Potable value	Mean value
1	200.10	190.50	25mg\l	170.3mg\l
2	190.50	170.30		
3	170.30	150.10		



[Fig.4.3: Observation graph for TSS]

5. CONCLUSION

Activated carbon is a non-graphite form of carbon which could be produced from anycarbonaceous material. Activated carbons are increasingly used as the economic and stable mass separation agent for the removal of surfactants to raise the final product quality many industrial processes. Activated carbons also play an important role in many areas of modern science and technology such as purification of liquids and gases, separation of mixtures and catalysis. The main objective of the study is to produce activated carbon from dry coconut shell, rice husk, wood mulch and to treat the domestic waste water and to recycle the treated water for home gardens. The higher purity, negative cost, high rate of production and strong carbonaceous structure of coconut shell proves to be a precursor for carbon production. This research will pave way for the recycle and reuse of waste water that could further reduce the level of water pollution.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Vadivelan V. and Kumar K.V., (2005), Equilibrium, kinetics, mechanism, and process design for the sorption of methylene blue onto rice husk, Journal of Colloid Interf. Sci. 286: 90-100

[2] Chandran, B. and Nigam, P., (2002), Removal of dyes from an artificial textile dye effluent by two agricultural waste residues, corncob and barley husk, Environ. Int 28: 29-33.

[3] Bhattacharyya, K.G. and Sharma, A., (2005), Kinetics and thermodynamics of methylene blue adsorption on Neem (Azadirachtaindica) leaf powder, Dyes and Pigments,65: issue1, 51-59

[4] Kumar,K. V. and Kumaran, A.,(2005), Removal of methylene blue by mango seed kernel powder, Biochemical Engineering Journal, 27: 83-93

[5] Garg, V.K, Gupta, R., Yadav, A.B. and Kumar R., (2003), Dye removal from aqueous solution by adsorption on treated sawdust, Bio resource Technology, 89: 121- 124.

[6] Hamdaoui, O. and Chiha, M., (2007), Removal of Methylene Blue from Aqueous Solutions by Wheat Bran, ActaChim. Slov. 54: 407–418

[7] P.K. Mallick, 2001, "Dye removal from wastewater using activated carbon developed from sawdust: adsorption equilibrium and kinetics" Journal of Hazardous material, Vol 113, September issue, No 1-3, Page no 81-88.

[8] M.M. Nourouzi, T.S G. Chuah, 2009," Adsorption of Reactive Dyes by Palm Kernel Shell Activated Carbon: Application of Film Surface and Film Pore Diffusion models" E-Journal of Chemistry, 6(4), 949-954.Jun-jieGao, Ye-bo Qin, Tao Zhou, Dong-dong Cao, Ping Xu, Danielle Hochstetter

[9] Yue-fei Wang, 2013,"Adsorption of methylene blue onto activated carbon produced from tea (Camellia sinensis L.) seed shells: Kinetics, equilibrium, and thermodynamics studies, Journal Zheijhang University, July 2013, 14(7), 650-658.

[10] HalanDemiral, IIknur Demiral Belgin Karabacakoglu, Fatma Tumsek, 2008, "Adsorption of Textile Dyes onto activated carbon prepared from Industrial Waste by ZnCl2 activation",.J. Ent. Environmental Application & Science, Vol3(5),381-389.