



A Review on Design of Advance Constructed Wetland to Purify Domestic Wastewater by using Activated Carbon

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ABSTRACT

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 reviews 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- Activated Carbon, Domestic Wastewater, Constructed Wetland, BOD, COD

1. INTRODUCTION

1.1 General Introduction

Activated carbon is used as filter media in waste water treatment reactor, then it will be helpful to remove dissolved solids, suspended solids and some dissolved gaseous from a domestic waste water effluent. Large surface area of activated carbon works as an adsorption media to effectively remove or reduce wide range of

dissolved pollutant in domestic waste effluent. Activated carbon is a very important chemical with wide application and employed by numerous industries which require absorption of certain gases and vapors in purification, in catalytic chemical reactions, decolorization of vegetable oil and sugar solutions. Activated carbon manufactured from coconut shell is considered superior to those obtained from other sources mainly because of small

macro pores structure which renders it more effective for the Coconut shell is used for manufacturing a variety of products of commercial importance including activated carbon. Activated carbon is a non graphite form of carbon which could be produced from any carbonaceous material such as coal, lignite, wood, paddy husk, coir pith, coconut shell, etc. adsorption of gas/vapor and for the removal of color and odor of compounds. The activated carbon is extensively used in the refining and bleaching of vegetable oils and chemical solutions, water purification, recovery of solvents and other vapors, recovery of gold, in gas masks for protection against toxic gases, in filters for providing adequate protection against war gases/nuclear fall outs, etc. Product characteristics H value - 6.5-7.5 Adsorption capacity at % by mass - 45 Moisture (max) - 5% Ash - 5% Hardness - 90 Applications

- Granulated activated carbons are used for purification of gases or liquids and are used in a vertical carbon packed column
- Activated carbons have been used as carriers for catalyst in the manufacture of chlorinated hydrocarbons.
- Activated carbon finds application in the preparation of pills and digestive tablets. Its adsorptive properties are utilized in the treatment of ailments of the stomach due to hyper acidity.
- In the laboratory, it is used for the production of high vacuum, purification of gases, determination of vapor content in a carrier gas, etc.

Global demand National Scenario In India activated carbon industry is of recent origin. There were only one or two manufacturing units in early fifties which have now increased to 50 or even more. But now activated carbon industry is widely spreaded in different parts of the country. Most of the units are in small scale sector. However, based upon the enquiries there are more than 50 units manufacturing activated carbon for selling. They are located in different parts of the country. Most of these units have capacity of more than 100 tonnes. Quite a few units have installed capacity of more than 1,000 tonnes also. Only 10 to 12 units cater to the national market, all other units cater by and large to local or regional market. It is learnt that the total installed capacity of present available was about 75,000 tonnes and production was around 65,000 to 70,000 tonnes which includes purified and regenerated carbon too. International scenarios Estimated demand of activated carbon in developing countries like Bangladesh, Sri Lanka and gulf countries, where industrial development is emerging up is around 134580 MT in 2014 to 2015. The

future of beverage industry is very bright. As the demand for activated carbon from this industry is likely to increase rapidly the estimated to be 15 percent annum and accordingly estimated demand are around 12790 in 2010 to 2011. Activated carbon is also being used in nuclear plants and laboratories for containment of many radioisotopes. Since the applications and demand of activated carbon is immense therefore the potential of the product is excellent. It is one of the imperative fields to endeavor.

1.2 Problem Statement

- Issues of accessibility, availability and nature of water.
- Simultaneously we observed generation of waste water is large in amount
- We inspired plan to take care of all above issue by utilizing one technique that is constructed wetland.

1.3 Objectives

- To prepare filter media from recyclable solid waste material such as a coconut shell, rice husk, wood mulch.
- To satisfy the parameters of effluent waste water by using filter media prepared from recyclable solid waste material.
- Design of effective effluent reactor consists of multiple filter media for the treatment of waste water.
- To improve efficiency of traditional filter reactor by making sustainable changes.

1.4 Motivation

There are many cheap, easily available materials such as wheat husk, straw, palm fiber, rubber wood saw dust, bamboo dust, date pits, palm fiber, coconut shell, groundnut shell, oil cake etc which have been used as the source for the synthesis of activated carbon. They are used in the abatement of hazardous contaminants, treatment of municipal and industrial waste water, as catalyst or catalyst support in medicine and the recovery of valuable metals. Thus the aim of this research is to look for a good adsorbent based on their surface characteristics. It also explores the adsorption capacity of the adsorbent for methylene blue dye removal.

2. LITERATURE REVIEW

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 -jie Gao 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 500°C for one hour duration at a heating rate 5°C/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 19th century 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/100mL	10 ⁶ -10 ⁷	10 ⁷ ~ 10 ⁸	10 ⁷ ~ 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., *Schoenoplectus lacustris*) 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 America, 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 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 ($\text{NH}_4\text{-N}$), ortho-phosphate ($\text{PO}_4\text{-P}$), 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 evaluated which indicated good mean removal efficiencies; BOD (50%), COD (44%), TSS (78%), $\text{NH}_4\text{-N}$ (49%), $\text{PO}_4\text{-P}$ (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 16° 40' N, Longitude 74° 15' S). Maharashtra situated in Western part of India. The campus wastewater was let into the constructed wetland intermittently over 30 days. The study 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 evaluated which indicated good mean removal efficiencies; BOD (95%), COD (97%), TSS (82%), $\text{NH}_4\text{-N}$ (43%), $\text{PO}_4\text{-P}$ (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 30 mg/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 first order 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).

3. PROPOSED METHODOLOGY

Activated carbon is a amorphous form 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 activated carbon]



[Fig.3.2: activated carbon from rice husk]



[Fig.3.3: activated carbon from 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, Brunauer 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)^oc 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 desiccator. After cooling the weight of dried sample was measured.

4. CONCLUSION

Activated carbon is a non-graphite form of carbon which could be produced from any carbonaceous 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.

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