Study of Corn cob as an Effective, Eco-Friendly, and Economic Bio-Sorbent For Water Treatment

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Abstract- *This project deals with the filtration of waste water using corncobs which are generally used as fuel which creates air pollution and global warming. Corn cobs are one of the most plentiful and important agricultural wastes in maize cultivation. Thus, a matter of primary concern is the economical and efficient utilization of these corn cobs for a purpose. As they are porous, they can be used as water filtrates. This project discusses about a low cost water filtration system which uses corncobs as filter materials in its various forms. As we know before disposing of waste water from industry, the industrial water has to undergo various chemical process which uses large amount of money, which can be reduced to a large extent when replaced by these filters at the source where industrial waste water is produced. With the increasing industrialization, amount of waste water generated is increasing at alarming rate, so with the help of this cost efficient technology, the waste water generated in the industries can be decreased to a large extent at the source itself.*

I. INTRODUCTION

The world is now running out of water. The real challenge is to provide enough clean water to a rapidly growing global population (and the attendant demands that come with growth: more energy, more food, more industry, and more consumption). Increasingly irregular weather patterns and natural disasters only exacerbate the situation. In the next 40 years, India's population is expected to grow by nearly half a billion. Lack of treatment options lead to two problems: not treating wastewater (i.e., sewage) before discharging it into waterways pollutes the source, often rendering the water unusable for drinking. The water intended for drinking is withdrawn from this same source, and again not adequately treated, creating significant public health problems: 21% of communicable diseases in India stem from unsafe water.

According to India's Central Pollution Control Board, the country has an installed capacity to treat only about 30% of the household waste it generates – the rest is released into open drains or straight into the ground. And just two cities, Delhi and Mumbai, which generate around 17% of the country's sewage, have nearly 40% of its installed capacity. In India, there are 234-Sewage Water Treatment plants (STPs). Most of these were developed under various river action plans (from 1978-79 onwards) and are located in (just 5% of) cities/ towns along the banks of major rivers (CPCB, 2005a). In class-I cities, oxidation pond or Activated sludge process is the most commonly employed technology, covering 26% of total installed capacity. Series of Waste Stabilization Ponds technology is also employed in 28% of the plants, though its combined capacity is only 5.6%. A recent World Bank Report (1986) came out strongly in favor of stabilization ponds as the most suitable wastewater treatment system in developing countries, where land is often available at reasonable opportunity cost and skilled labour is in short supply.

While some of us deal with our home's waste water through grey water systems or other technologies, most of us "flush it and forget it." Once that toilet flushes, or water otherwise runs down the drain, we expect that it'll be taken care of through our municipal sewer system or our septic tank.

We're fortunate in that sense: in the developing world, waste water treatment largely doesn't exist at the residential level, and many industrial operations also don't give it much thought. That means substances ranging from soaps, oils, and dyes, to agricultural fertilizers and pesticides, to heavy metals and industrial compounds, are all meeting up in the same water supplies that people and animals rely on for drinking.

The main objective of our project is to search for a cheap method of cleaning waste water from domestic and industrial sources by utilizing one of the most under-utilized agricultural wastes. The present study is based on the scientific principles of Adsorption by immobilizing the contaminants with the help of corn cobs. Corn is a major crop plant, every part of which is utilized except the cob. In this project, an attempt was made to utilize this less-utilized plant part to clean one of the most precious natural resources, water.

Filtration is one of the stages in water treatment. Under controlled condition in water purification/ treatment plant, it is an indispensable unit process . Filtration is a process in water treatment which removes suspended matter through the use of filters. The removal of suspended solids by filtration plays an important role in both the naturally occurring purification of groundwater and artificial purification of surface water done in treatment plants. During filtration, the water to be treated is passed through a porous substance. The water quality improves by partial removal of suspended solids, colloidal matter and the reduction of number of bacteria, colour, odour etc. some of the various types of filter media used in filtration can be stable material like granular bed of sand, crushed stone, anthracite (hard coal), glass fibers, diatomaceous earth, activated carbon and coconut husk.

In public and large private water supplies, granular beds of sand and activated carbons are almost exclusively used. It is cheap, inert, durable and readily available. Such bed allows penetration of impurities from the raw water without an immediate deterioration of the effluent quality. Activated carbon is a black solid substance resembling granular or powdered charcoal. It is extremely porous with a very large surface area. Certain contaminants accumulate on the surface of the activated charcoal in a process called adsorption. The two main reasons that chemicals adsorb onto activated charcoal are a "dislike" of the water, and attraction to the activated charcoal. many organic compounds, such as chlorinated and non- chlorinated solvents, gasoline, pesticides and tri-halo-methane can be absorbed by activated charcoal. Activated charcoal is effective in removing chlorine and moderately effective in removing some heavy metals. Activated charcoal will also remove metals that are bound to organic molecules. It is important tonote that charcoal is not necessarily the same as activated charcoal. Activated charcoal removes vastly more contaminants from water than ordinary charcoal.

Particle size also affects the rate of removal; smaller activated charcoal particles generally show higher adsorption rates. Activated carbon is an excellent adsorbent and thus is used to purify, decolorize, deodorize, de-toxicant, filter or remove the salts. They are used as catalyst or catalyst supports. The adsorbent properties of activated carbon are essentially attributed to their large surface area, a high degree of surface reactivity, universal adsorption effect and favourable pore size. These unique characteristics are dependent on the type of raw material employed and method of activation. Basically, there are two methods of activation. Physical and chemical activation. Activated carbon can be made from many substances containing high carbon content such as coconut shells, walnut shells, coal, wood, bagasse etc. The raw material has a very large influence on the characteristics and performance of activated carbon and plays a major part in determining its ability to absorb certain molecular species. In the present work corn cobs were used to prepare activated carbon. Corn Cobs is suitable for preparing micro porous activated carbon due to its excellent natural structure and low ash content. Carbonization is the process for the conversion of an organic substance into carbon or a carbon containing residue through pyrolysis or destructive distillation. Activation is a carefully controlled oxidation process to develop a porous carbon structure. The idea behind activation is not only to increase the diameter of the pores that were formed during carbonization process but also to create some new porosity. In the present work Zinc chloride (ZnCl2) is used for this purpose.

Groundwater is an important source of drinking water and it is estimated that more than 200 million people worldwide are drinking groundwater with fluoride concentrations greater than the WHO guideline value of 1.5mg/l. The majority of these cases occur in the developing world. Ground waters are much more vulnerable to fluoride enrichment than surface waters because of the greater impacts of water-rock reactions in aquifers.

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Fluoride is one of the very few chemicals that have shown to cause significant effects in people through drinking water. Fluoride is found in all natural waters at some concentration. Sea water typically contains about 1mg/l while rivers and lakes generally exhibit concentrations less than 0.5mg/l. In groundwater’s, however, low or high concentrations of fluoride can occur, depending on the nature of the rocks and the occurrence of fluoride-bearing minerals. High fluoride concentrations may therefore be expected in groundwater’s from calcium-poor aquifers and in areas where fluoride-bearing minerals are common. Fluoride with inadequacy causes dental carries, while if it is in excess amount (>1mg/l) causes dental fluorosis and skeletal fluorosis which has no cure. Since fluorosis is an irreversible process, prevention of this is the only solution to protect against diseases. This can achieve by adopting defluoridation method by simple techniques.

II. LITERATURE

2.1 Lavanya H et.al (2017) investigates two methods for removal of excess amount of fluoride present in water, namely, flocculation and adsorption. Flocculation technique includes addition of chemical agents to precipitate the excess fluoride content present in water. In adsorption technique involves the adsorption of fluoride ions using activated agents such as activated alumina, activated carbon, bone char etc. Since these active agents are costlier, alternative adsorbents such as corn cobs, crushed tamarind seed, literate soil, moringaolifera etc., can also be used. In this present study corn cob are used as adsorbing agent. Groundwater is an important source of drinking water and it is estimated that more than 200 million people worldwide are drinking groundwater with fluoride concentrations greater than the WHO guideline value of 1.5mg/l. The majority of these cases occur in the developing world. Ground waters are much more vulnerable to fluoride enrichment than surface waters because of the greater impacts of water-rock reactions in aquifers. Fluoride is one of the very few chemicals that have shown to cause significant effects in people through drinking water. Fluoride is found in all natural waters at some concentration. Sea water typically contains about 1mg/l while rivers and lakes generally exhibit concentrations less than 0.5mg/l. In groundwater's, however, low or high concentrations of fluoride can occur, depending on the nature of the rocks and the occurrence of fluoride-bearing minerals. High fluoride concentrations may therefore be expected in groundwater's from calcium-poor aquifers and in areas where fluoride-bearing minerals are common.

2.2 Ms. Pooja P. Malode et.al. (2017) Rapid developments in technology and lifestyle have accelerated the addition of contaminants into air, water and land rendering it unsafe for organisms. Release of pollutants from various sources like domestic, agricultural and industrial sectors has dramatically modified the quality of water thereby causing harm to aquatic organisms. Agricultural activities add excessive fertilizers, pesticides and herbicides into the nearby water bodies. Effluents released from industries release toxic chemicals like heavy metals, chemicals (organic or synthetic) to the aquatic ecosystems. The best solution to water pollution is to prevent it from happening. In addition, the rapid modernization of society has also led to the generation ofhuge amount of materials of little value that have no fruitful use. Such materials are generally considered as waste, and their disposal is a problem. Also, there are some materials that are available in nature that have little or no use. The utilization of all such materials as low-cost adsorbents for the treatment of wastewater may make them of some value. An effort has been made to give a brief idea of an approach to wastewater treatment, particularly discussing and highlighting in brief the low-cost alternative Adsorbents with a view to utilizing these waste/low- cost materials.

2.3 Ashwani Kumar Singh et.al (2015) In India, there are 234-Sewage Water Treatment plants (STPs). Most of these were developed under various river action plans (from 1978-79 onwards) and are located in (just 5% of) cities/ towns along the banks of major rivers (CPCB, 2005a). In class-I cities, oxidation pond or Activated sludge process is the most commonly employed technology, covering 26% of total installed capacity. Series of Waste Stabilization Ponds technology is also employed in 28% of the plants, though its combined capacity is only 5.6%. A recent World Bank Report (1986) came out strongly in favour of stabilization ponds as the most suitable wastewater treatment system in developing countries, where land is often available at reasonable opportunity cost and skilled labour is in short supply. The main objective of our project is to search for a cheap method of cleaning waste water from domestic and industrial sources by utilizing one of the most under-utilized agricultural wastes. The present study is based on the scientific principles of Adsorption by immobilizing the contaminants with the help of corn cobs. Corn is a major crop plant, every part of which is utilized except the cob. In this project, an attempt was made to utilize this less-utilized plant part to clean one of the most precious natural resources, water.

2.4 Daniel Muvengei Mwangangi et.al (2015) Majority of Kenyans lack access to clean water due to increased population growth, high rate of industrialization and poor waste management. The situation may worsen if immediate measures are not taken. Lead and cadmium are the main heavy metals in contaminated water and their harmful effects such as lung cancer, mental retardation and nerve disorder cannot be underestimated. Available methods for removing these metal ions from water such as use of activated carbon are very expensive and unaffordable to low income earners. Maize cobs have minimal use after maize harvesting can be utilized to reduce environmental pollution. The primary aim of this study was to investigate the ability of maize cobs derived products to adsorb both lead (II) and cadmium (II) ions and remove methylene blue and turbidity from contaminated water. Maize cobs charcoal was prepared by heating dry maize cobs in a furnace in limited air. Activation was done by use of 1.0 M sulphuric acid and heating the mixture in a closed vessel. Maize cob ash was generated by heating dry maize cobs in a furnace. Ability of these sorbents to adsorb lead (II) and cadmium (II) ions from the solution was investigated by carrying out batch experiment and varying parameters such as contact time, initial metal ion concentration, adsorbent dose, temperature and shaking speed. The data obtained was fitted into Langmuir and Freundlich models. Activated charcoal gave the best fit in Langmuir for lead ions with maximum adsorption capacity of 13.0 mg/g.

2.5 Daniela Suteu et.al (March, 2010) The potential of corn cob, a natural low-cost lignocelluloses material, was investigated for the removal of reactive dye Orange 16 from an aqueous solution. Sorption isotherms were determined at 3 temperatures (5,18 and 45 °C), in solutions with initial dye concentrations in the 37.05-370.5 mg L-1 range. The equilibrium data were analyzed using Langmuir, Freundlich, Dubinin-Radushkevich and Tempkin isotherm models. The sorption equilibrium process was described well by the Langmuir isotherm model. According to the Langmuir isotherm, the maximum sorption capacity was estimated as 25.25 mg g-1 (18 °C). The values of the mean free energy determined with the Dubinin-Radushkevich equation (9.713 kJ mol-1 at 18 °C, as well as the thermodynamic parameters suggest that the mechanism of reactive dye sorption onto corn cob is a combination of electrostatic interactions and physical sorption. The kinetic data were studied in terms of pseudo-first and pseudo-second order kinetic models. Corn cob, an agricultural waste product obtained from maize or corn, has become more and more important, and new uses, such as the production of activated carbon, manufacture of biofuels20 or as adsorbent for removing some pollutants,20-23 are developed each year. The aim of this paper was to evaluate the potential of corn cob to remove the Orange 16 reactive dye from aqueous media as a function of initial dye concentration, temperature and contact time.

2.6 Abhijeet S.Ghone et al.:(2015) studied on pollution sources, water quality and conservation of lake .In this to evaluate various pollution aspects like water hyacinth, pesticide and heavy metals contamination in lake water, sewage flow into lake and other activities like the submersion of Ganesh idols, cattle washing which are the main pollution causes of Rankala Lake water and steps required for lake conservation. Overall water quality analysis of the Rankala Lake suggested that though the pollution is in moderate condition as main use of Rankala Lake is for recreation purpose but continues supply of sewage is augmenting the severity of water pollution. From the present study, it is found that there are 4 major sewage terminals pouring sewages in the Rankala lake water and thus heavily polluting the lake. In Lake catchment area, insufficient underground drainage system was also observed. Based on water quality index status of the lake was found to be very poor. Eutrophication promotes excessive plant growth and decay, favors certain weedy species over others, and is likely to cause severe reductions in water quality. Washing of animals, clothes, vehicles, bathing activities, immersion of Ganesh idol and Nirmalya, disposal of remains of fast foods at Chaupati in lake, are also contributing pollution in the lake

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III. EXPERIMENTAL PROGRAMME

We concentrate on the main objective of the project i.e. reducing the cost of filtration of water and waste water by utilizing farm waste of corn.

Need of the hour is to clean natural water bodies.

3.1 Materials.

- Water: Sample of water which is use for ordinary work such as drinking, bathing, washing and other work which is transparent, tasteless, odorless, and nearly colorless. This sample of water is to be required for the compare treated waste water results . For this project use domestic tap water.
- Waste Water: Is any water that has been affected by human use. Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and any sewer inflow or sewer infiltration" Therefore, wastewater is a byproduct of domestic, industrial, commercial or agricultural activities. The characteristics of wastewater vary depending on the source. Types of wastewater include: domestic wastewater from households, municipal wastewaterfrom communities (also called sewage) or industrial wastewater from industrial activities. Wastewater can contain physical, chemical and biological pollutants.

Households may produce wastewater from flush toilets, sinks, dishwashers, washing machines, bath tubs, and showers. Households that use dry toilets produce less wastewater than those that use flush toilets. Wastewater may be conveyed in a sanitary sewer which conveys only sewage. Alternatively, it can be transported in a sewer which includes storm water runoff and industrial wastewater. After treatment at a wastewater treatment plant, the treated wastewater (also called effluent) is discharged to a receiving water body. The terms "wastewater reuse" or "water reclamation" apply if the treated waste is used for another purpose. Wastewater that is discharged to the environment without suitable treatment causes water pollution. In developing countries and in rural areas with low population densities, wastewater is often treated by various on-site sanitation systems and not conveyed in sewers. These systems include septic tanks connected to drain fields, on-site sewage systems (OSS),vermin filter systems and many more.

3..2Collection of the data and raw materials:-

- Procurement of raw material: The corn cobs were collected from a nearby local vendors shop and canteens.
- Drying: The corn cobs were spread under the sunlight to remove the moisture content and it was allowed for 1 day to dry and kept in oven for 2 hours for complete removal of moisture.
- Crushing size determination: The corn cobs were crushed into small pieces for a particular size range of less than 1 mm. Crushing was done by using hammer followed by mixer. Sieve analysis was done with the cleaned, dried and powdered sample. The apparatus was set according to the mesh number and then the samples were placed in a shaker for about 30 minutes.
- Treatment with zinc chloride: The reduced product of desired size was treated with zinc chloride for chemical activation. The concentration of zinc chloride used was 50%. The corn cob sample was treated with zinc chloride solution and it was mixed for about half an hour in a mechanical shaker. The sample was filtered and dried.

3.2.3. Preliminary Investigation:-

- A cob was taken whose pith was removed carefully from the top to make a hole at the centre of the cob without piercing the other end for the pilot experiment.
- Then, 50 ml of domestic effluent collected from kitchen drain pipe was allowed to pass slowly through the central hole of the cob and the filtrate was collected.
- The filtrate was subjected to several qualitative tests like the presence and absence of oxides of salts, detergents, oils, colored dyes, suspended particles, etc.

3.2.4. Testing of various samples of waters:-.

- Physical and chemical tests viz., determination of pH, BOD, COD, turbidity, chloride contains performed and results noted.

3.2.5 Preparing filter setup:-

- Corn cobs were washed thoroughly and then dried for one month.
- Then, corn cobs were cut into longitudinal sections, smaller sections, powdered form and charcoal was also prepared.
- Further these different forms of corn cobs were arranged in a sequence in arranged manner.
- The corn cobs were burnt in the presence of oxygen in the can to made a charcoal from it.
- The activated charcoal will purify the contaminants in the water present.
- Also, the sand and pebbles were collected from the VAGHUR TREATMENT PLANT IN**JALGAON** in order to purify the water thoroughly.

3.2.6. Testing of water after passing through filter:-

- The filtrate was subjected to several qualitative tests like the presence and absence of oxides of salts, detergents, oils, colored dyes, suspended particles, etc.
- Test for detergent was done by hand shaking the filtrate to make foam.
- Visual observation was made to find out the presence of colored dyes.
- Chemical tests were conducted in college chemistry laboratory to find out their presence or absence in the test material.

3.3. Stages of filtration:

1. First water passes through the screening process.
2. Then water passes through the layer of vertical corn cobs which have porous structure which helps to absorb large size pollutants.
3. In second layer, small pieces of corn cobs are placed where small size pollutants will absorb.
4. Charcoal present in third layer in which helps to remove chlorine, particles such as sediment, volatile organic compounds (VOCs), taste and odour from water as much as possible.
5. In fourth layer, corn cob powder which helps to remove the fluoride in drinking water as a natural absorbent.
6. In last layer, three different size sand particles arranged in such manner that larger size pebbles place in bottom and on upper side of that coarse sand is place and in upper most layer fine sand particles are place. This layer helps to remove dirt, sand, shale, oxidized particles that are heavy enough to sink to the bottom.
7. At last, filtrated water sample collected at bottom.

IV. RESULT AND DISCUSSIONS

- Test on sample water:

Table 1: Properties of water Sample.

NAME OF THE TEST	SAMPLE OF WATER
BOD	6.2 Mg/l
COD	6.8 Mg/l
SUSPENDED SOLID PARTICLES	4.49 Mg/l
OIL AND GREASE	ABSENT
COLOUR	COLOURLESS
TURBIDITY	4.95 NTU
pH	7.11

- pH of water sample:

Table 2: pH of water Sample.

Sample no.	Temperature of sample	pH
1	27.5	7.19
2	28.5	7.28
3	22.5	6.86

- Total suspended solids:

Table 3: Total suspended solids water Sample.

Sample no.	Description	Wt (gm)
1	Wt. of clean filter paper(g)	1.39gm
2	Wt. of filter reslave (g)	5.79gm
3	Volume of residue (g)	4.49gm
4	Volume of sample (ml)	70ml

- To determine dissolved oxygen:

Table 3: Total dissolved oxygen water Sample.

Sr no	Temperature	Volume of sample	Burette reading		Volume filterrat io n	Dissolved oxygen (mg/l)
Initial			Final			
1	28	203	1.5	9	7.5	7.38
2	27	203	2	7.5	5.5	5.41
3	28	203	2.3	8.2	5.9	5.81

V. CONCLUSION

Corn cob is absorbent material used to absorbed impurities in waste water also it is used to filter waste water to remove waste impurities, solid impurities etc. Corn cob is also known as bio absorbent. Corn cob is a material is acquired from agricultural waste. From above listed literature review it can summarized the expected outcomes are as follows:

1. Corncob reduce impurities in waste water and turbidity of water.
2. To filter solid particle in waste water.
3. To control BOD, COD and pH of waste water.
4. To resolve the solid waste management problem.

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