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Low-Cost Corn Cob Water Purifier for Rural Areas - A Review

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Abstract - *The corn cob water purifier is essentially made for the purification of contaminated water in rural areas. The purifier treats the grey water using corn cob and activated corn cob which checks whether it is suitable for reuse applications like washing, watering, irrigation, etc. For the water filtration body structure, there are different levels of filtration process using corn cobs, grinded corn cobs, charcoal, geotextile cloth, and gravel. This structure is arranged layer by layer for absorbing mainly solid, suspended and gasoline wastewater, etc. Maximum adsorption of gasoline waste is seen in the powdered corn cob layer & suspended particles are collected by the section of corn cob pieces. As the sources of grey water include sinks, showers, washing machines, or dishwashers and grey water contains fewer pathogens than domestic wastewater. Quantities of pollutants ranging from detergents to gasoline to salts and heavy metals are adsorbed by the corncob. From this work, the common methods utilized for making a corn cob water purifier are reviewed and analyzed, focusing on some important methods and summarizing all the researches that dealt with different layers of corn cobs along with charcoal, sand and gravel.*

***Key Words*: *Corn cobs, Activated corn cob charcoal, Geotextile cloth filter, Gravel, Fine sand*.**

1. INTRODUCTION:

Greywater, also known as sullage, is wastewater that is generated in homes and factories which does not include wastewater from toilets. The domestic greywater comes from the kitchen, bathrooms, and laundry[1]. Greywater has a lower proportion of hazardous microorganisms than industrial sewage, making it easier to handle and treat. This greywater could be used for flushing, landscaping, irrigation of crops and other non-potable purposes. For irrigation purpose when water is used again, it is best to use low-sodium products. Greywater recycling and reuse lessen the enormous demand for freshwater[2]. It also alleviates the strain on wastewater treatment systems. Filters avoid pollutants from water such as sediment, taste, odour and germs, which increases the quality of water. Corn cobs are a by-product of the maize crop and constitute the center core of a corn ear. They are the little yellow seeds that sprout on the long-rounded portions of the maize stalk. The interior Corn cobs are readily available and inexpensive, making them a viable water purifying option, hence sustainable in rural areas. The maize cob is a bio-adsorbent material that may successfully filter the numerous pollutants found in water in terms of efficacy. The white corn cob has a foam plastic-like consistency. During the filtration, the impure water passes through the different layers consisting of corn cobs, longitudinal sections of corn cobs, activated charcoal of corn cob, and powdered corn cob. In addition, there is sand and gravel which is for the base support as a filter. Purification of wastewater (farm wastewater, household wastewater etc.,) is always an issue in rural areas. They cannot install high-cost water purifying machines as in seen in cities. So for this in rural areas corn cob is used as water purifier, since in many farms these corn cobs are thrown away after taking the corn and these corn cobs can be burned and activated charcoal can be produced or it can be used as a purifier as it is a good adsorbent and purifies the waste or grey water in an efficient way[4]. Detergents, coloured dyes, salts, oil and heavy metals was observed to be adsorbed on corn cobs surface. Activated charcoal can be converted from corn cob, thereby advancing utilization of biomass and bio resource recycling [8]. Powdered corn cobs did not exhibit remarkable adsorption, but aluminum-treated corn cobs did. Contact time, concentration, temperature, and pH are among the parameters investigated. The optimal medium condition was determined to be near neutral pH, and the best contact time for maximum fluoride adsorption was determined to be 90 to 120 minutes. The Freundlich isotherm was discovered to govern the adsorption process. The aim is to study the filtration process of water by building a corn cob water filter system and using different forms of corn cob to filter water which can be from lakes, rivers, wells etc. To solve the problem of lack of water availability in water scarce areas by the use of the recycled water from the filter process to make an eco-friendly water purification method of water[5].

2. DESIGN:

1)Ali et., 2016 dried maize cobs in an oven before being sliced into same sized pieces with length of 7.97 cm and diameter of 2.54 cm respectively. Corn cobs are properly cleansed after being prepared in distilled water. The maize cob shells which are cleaned are then dried for 5 hours at 105°C. After that, they were sterilized for 30 minutes at 16 psi. For calculating the area and volume of maize cobs the following formulas were used, A = 2r (r + h) and V = r2 h, respectively. The parameters like 'r' and 'h' was seen to be reflecting the radius and height of the maize cobs during observation. The average particular area and volume were discovered. The MCTF-WWT system's body was made using a gauge 22 = 0.64 mm Zn alloy-based metallic sheet in a circular shape with a diameter of 76.2 cm and a height of 152.4 cm in the university's departmental workshop. The designed MCTF-WWT system is depicted schematically in

Figure 2. 30.2639°N and 71.5101°E are the latitude and longitude of the installed MCTF-WWT system. On the bottom of the reactor body, a drainage layer with a depth of 30.48 cm was deposited, as indicated in Fig. 2. In the MCTF-WWT system, the drainage layer is made up of slotted rocks that allow the WW to pass through while supporting the media. It served three purposes: (i) transmitting wastewater through the filter, (ii) sloughing solids out of the filter, (iii) to keep same aerobic condition by providing air circulation to the filter. The MCTF-WWT system was filled with maize cob filter for the biofilm to be intact. The packaging material, corn cobs, were delicately put together to ensure that no or minimal breakage occurred during installation. A circular steel grid supported the media at a height of 30.48 cm[6].

2)T. Janani used the methodology described below

For a long time, as a filter media sand is used in factories where water is treated. The creation of a gelatin like biological layer on top of the fine layer of sand is crucial in slow sand filters. Schmutzdecke is another name for this biofilm. This layer comprises of a diverse biodiversity of fungi, bacteria, larvae, and protozoa, all of which help with wastewater treatment. The Schmutzdecke is usually forms after 10 days of filter operation. The particle matter is trapped in the biofilm as the incoming wastewater passes through it. Contaminants will be degraded by the organisms that thrive on the biofilm, resulting in the production of water that is safe to drink.

The layers are as follows,

1) Gravel as the first layer of support: A base support is required for any filter, 20 mm of gravel was used as a filter material here 1 kilogram of pebbles were weighed, and thoroughly cleansed to avoid dirt which was later dried. On top of a geotextile cloth, clean gravel was placed into the filter. The gravel layer must be spread evenly.

2) Fine sand as the second layer: It is used in sewage treating plants to treat highly contaminated water. Water impurities get stuck in the gaps between the oil particles. This layer feeds small organisms that treat the wastewater components biologically. A geotextile filter cloth is draped on the gravel layer. 1 kilogram of fine sand is spread on the geotextile cloth and thoroughly tamped.

3)Third layer as Powdered corn cobs: The corn cobs which were dried were made into tiny pieces. Before layering, the corn cobs which are powdered must be thoroughly cleaned and dried.1 kilogram of powdered corn cob is weighed and then the corn should be placed uniformly one above other by avoiding being tamped constantly. Cover the layer with a geotextile cloth.

4) Activated Carbon is the fourth layer: Any water filter would be incomplete without activated carbon, which is a well-known adsorbent. Granular activated carbon was chosen from the several types of activated carbon available. To remove the carbon, it must be thoroughly washed. It was then allowed to dry once the ash was removed. kilogram of ash-free activated carbon is placed in the reactor dispersed evenly across the geotextile material in all directions. It is covered with a geotextile material.

5) Corn cobs-small chunks as fifth layer: Long size corn cobs are cut into small pieces of 5 to 8 cm in length. The shattered pieces are cleaned and kept for drying, and 1 kilogram of corn is weighed and set aside. A geotextile material is laid over the broken maize cobs. It's important to make sure there are no gaps between two pieces of corn.

6) Cob longitudinal sections are the sixth layer:

Corn cobs are sliced longitudinally into long segments. The dried corn cobs are longitudinally sectioned with a hammer. Water must also be used to clean and dry the longitudinal sections. One kilogram of this is weighed and placed over a layer of broken cobs on a geotextile cloth. Geotextile cloth is used to help with consistent filtration by acting as a divider between different layers of filtering media.

After the corn cob filter has been correctly stacked and tamped, it must be examined for efficiency. 5 liters of water from the kitchen sink, plus another 5 liters from bathing and washing. This pale orange liquid was then poured at a consistent rate through the top of the filter. The inflow water was collected in the bottom tank after a 10-minute detention time was maintained. The entire filtration process took 15 minutes. Filtrate obtained was transparent. This water was then collected in a container which is cleaned and thoroughly sealed before being evaluated for its properties. The filtrate collected after filtering through the filter must be examined for all of the parameters that were seen in the raw water sample.[1]

3. CORN COBS:

Corn cobs are the least used portion of the maize plant. Corn cob is an absorbent with great mechanical strength, stiffness, and porosity. The central core of a maize ear is known as a corn cob. It is the area of the ear where the kernels grow[7] . The pH, mud density, and specific gravity of the corn cob made by mud formulating had higher cellulose than the standard mud, but the deformation or flow of matter in the prepared mud was seen to be lower[8]. Contaminants such as salt oxides, suspended particles, coloured dyes and some heavy metals can be absorbed on corn cobs surface as a result of this. If household drainpipe is linked to a chamber with different layers of corn cobs in partition layers then pollutants such as suspended particles will be separated from the waste water. Corn cobs have abrasive and absorbing characteristics. The chaff and plinth absorb moisture, but the wooden ring is extremely abrasive. It is a silica-free, 100% environmentally friendly product. It regulates the pace at which water evaporates. The pH is of

5.42, and the electrical conductivity is 382 S-cm-1, indicating that it can absorb a lot of water. I collected the corn cobs, washed them, and dried them for a month for doing the experiment. I preserved the corn cob bits after filtering the water to see how long they could be utilized. It should be stored in the sun after each experiment so that it can be used again [9].

Fig.1:Corn cobs[1]

4. ADSORPTION:

Adsorption is the process of a particle accumulating at the connection between two phases, such as solid and liquid or solid and gas. Adsorption is the most commonly used heavy metal waste treatment process due to the ease of manufacturing and the availability of materials that can be used to adsorb heavy metal from wastewater. Heavy metal adsorption can use microorganisms as adsorbent, such as microalgae, bacteria, and fungi [10]. One of the main adsorbents used is activated carbon. It is used as an adsorbent as it is having more specific surface area and good pore size distribution.[11] Although certain adsorption phenomena were recognized in the past, C.W. Scheele reported the first quantitative investigations on the absorption of gases by charcoal and clays in 1773. The observations of Lowitz, who used charcoal to decolorize tartaric acid solutions, followed. Larvitz in 1792 and Kehl in 1793 reported same type of phenomena with vegetable and animal charcoals, respectively. While Bois-Reymond proposed the term "adsorption," Kayser was the first to use it in the literature. The adsorption technique has been widely utilized to remove solutes from solutions. Adsorption is caused by uneven attraction forces at the surface of materials. Physical adsorption occurs when the adsorption is caused by weak van der Waals forces. On the other hand, chemisorption occurs when there is a chemical bond between the adsorbent and the adsorbate molecule[12]. Treating of wastewater by using activated carbon by the process of adsorption was seen to be good and it is seen to be a good environmental control technologies and it has also been cited by EPA.[13]

5. ACTIVATED CHARCOAL:

It is a porous, soft, black substance created by heating carbon-containing materials in a controlled environment. Hardwood trees and coconut shells are the most common sources. Charcoal may absorb 100 to 200 times its weight in water. Heating activates the charcoal, which increases its adsorption capability. Activated charcoal in powdered form is composed of extremely minute carbon particles with a strong accord for organic compounds like insecticides. Organic molecules can bind to it because of its vast surface area. When pesticide molecules are attracted to activated charcoal particles and come into contact with them, the pesticide molecules bind. Inorganic pesticides like arsenates, lead compounds, Sodium Chlorate, Sulphur, Borax, and water-soluble organic pesticides like MSMA and DSMA are not affected by activated charcoal. Organic insecticides, some petroleum compounds, and hydraulic fluid spills can all be mitigated with activated charcoal. Pesticide levels in soils can be fairly high at some places where pesticides have been combined and loaded for years. Pesticide residues are shown by the lack of vegetation on certain areas. Unfortunately, there is no way to know for sure how much pesticide residue is still present in the soil of such a location. If activated charcoal will be used to treat the site, planting a seed several weeks after the treatment will reveal whether residues are still there. If the seeds germinate and the seedlings look to be healthy, the pesticides' effects have been inactivated.[14]

Fig.2:Activated corn cob[15]

6. DEFLUORIDATION USING CORN COBS POWDER:

Fluoride ions are absorbed by activated agents such as 1) Activated alumina,2) Activated carbon, 3) Bone char because these active agents which are more expensive and alternative adsorbents such as corn cobs, crushed tamarind seed, laterite soil, moringa olifera, and others can be used. Corn cob is used as an adsorbing agent in this investigation. The aim of this experiment was to find out the best way to remove fluoride from corn cobs powder, and the findings were compared to Bureau of Indian Standards: 10500-2012. Before filtration, the physical and chemical characteristics are checked. The results revealed that the fluoride content of the 3 samples, Uppinahally, Doddagatta, and Yadapura, above the desired limit (1 mg/l), necessitating treatment. As a result, the water samples were processed through corn cob powder, and the fluoride content was lowered to less than 1 mg/l, making it safe to drink.[7]

7. RESULTS & DISCUSSIONS:

The volume of oxygen needed for bacteria to breakdown some organic components in wastewater is measured by BOD. It is an extremely significant feature of water. It has a direct impact on water quality. When the BOD levels are high, the dissolved oxygen (DO) levels drop automatically because the oxygen in the wastewater is rapidly devoured by the bacteria. As a result, the amount of DO available in the water decreases, and as a result, fish and other aquatic species in the water body may perish. Untreated sewage has a concentration of 200 to 600 mg/l. COD is a complete measurement of all chemicals in wastewater, including organics and inorganics. The fundamental distinction between the BOD and the COD is this. BOD exclusively decomposes organic materials, whereas COD decomposes both organic and inorganic stuff. Furthermore, BOD is always equal to or less than COD, and vice versa. The same thing happens if COD value is too high like the BOD. If good efforts are made in the appropriate direction, the water can easily be reused. Because this easy technique does not include any space science, anyone can readily operate this treatment system for his or her home or property. The papillae present on the activated charcoal's surface absorb the most pollutants. The larger the surface area, the more porous the structure. Furthermore, because no electricity is required, no power transmission is required. It's entirely natural. Agricultural waste can once again be used without causing pollution. This purified water can now be simply discharged into a river or used for farming or gardening. If we can effectively treat it again, it can be used for a variety of applications.[15]

The parameters of the grey water when collected were determined by testing. Raw water had 7.82 mg/L as pH reading, 0.91 mg/L of anionic surfactants, 745 mg/L of chlorides, 31 mg/L of nitrogen, 1509 mg/L of TDS , 138 mg/L of BOD, and 667 mg/L of COD. The grey water which is treated had a pH of 9.03 mg/L, 0.62 mg/L of anionic surfactants, 489 mg/L of chlorides, 20 mg/L of nitrogen, 907 mg/L of TDS,87 mg/L of BOD, and 220 mg/L of COD. The filtrate which they got from the vertical packed corn cob filter had a starting reduction effectiveness of 40% for BOD, 70% for COD, 40% for TDS, 40% for SS, and 35% for Surfactants, with 53 percent for Chlorides, TDS of 907 mg/L , BOD of 87 mg/L, and COD of 220 mg/L, Nitrogen of 20 mg/L ,907 mg/L of TDS , 18 mg/L of , BOD with a detainment period of 10 minutes, the filtrate got through the vertically arranged corn cob filter showed an initial reduction efficiency of 40 percent of BOD, 70 percent of COD, 40 percent of TDS, 35 percent of Surfactants, 53 percent of Chlorides, and 36 percent of Nitrogen. The filtrate can be used to recharge groundwater and for various indoor uses. It is feasible to gain more efficiency by extending the detention term.[1]

8. CONCLUSIONS:

This research review demonstrates the adsorption efficiency of pollutants from the wastewater. We made a method to recycle excess corncob debris by treating and reusing grey water generated by homeowners. Effluent from the vertically kept corn cob filter can be used for groundwater recharge, gardening, flushing, and other indoor applications. By extending the detention time, it is easier to create an effluent that can also be made use for drinking. As a result of the preceding discussion, wastewater re-use can be regarded as a best method of lowering municipal point consumption as well as water expenditures while not lowering total water use in a residence. In order to conserve the world's most valuable resource, water, the government has supported such reuse systems that contribute to sustainable water management by giving Green Certification. This is a baby step toward long-term growth. The goal is to focus on recent breakthroughs in removing the toxins of water and wastewater using adsorbents of low-cost derived from agricultural, industrial, and municipal wastes. The use of waste corn cobs as low-cost adsorbents for extracting various contaminants from wastewater has a number of appealing features, most notably its contribution to waste disposal cost reduction and thus environmental protection. Further research could be carried out by using these environmentally acceptable materials as adsorbents or for extracting metal ions from water.

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