Greywater Treatment using Corncob
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Abstract— Corncob which is a biopolymer waste which represent an interesting alternative as a low cost adsorbent because of its abundant, renewable and biodegradable raw resource and properties such as its chemical stability, oil absorption, surface area, iodine value and high reactivity, resulting from the presence of chemically reactive hydroxyl groups. 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. This project discusses about low cost water filtration by bio-sorption mechanism using corncobs as filter material in its various forms. The different layers of corncob are separated, granulated and surface activated by suitable treatment with 0.5 N phosphoric acid and citric acid. Also activated carbon is prepared from the corncobs and impregnated in 1N NaOH to increase the pore size and free covalent bonds by removing the organic adsorbates and unwanted impurities. Diatomaceous earth which is a naturally occurring soft, siliceous sedimentary rock that is easily crumbled into fine off–white powder is used as a filtration aid to filter very fine particles and bacteria that would otherwise pass through. The outcome of the project shows satisfactory removal of solids, hardness, chlorides, turbidity, BOD with an average efficiency of 75% and excellent removal of heavy metal concentration especially 90% of Chromium (VI). However the performance over COD is unsatisfactory and change in pH is negligible as it remains in acidic range as the influent.

Key words: Greywater Treatment, Corncob

I. INTRODUCTION

Corn which is naturally occurring material and also it is easily available in plenty in the world. All the corn manufactures in the world used corn starches for several applications except corn cob. Corn cobs contain a considerable reservoir of carbohydrates, most of which are of a polysaccharide nature. These polysaccharides consist principally of cell-wall cellulose and hemicellulose. The term hemicellulose denotes those polysaccharides extractable from plants by aqueous alkali. They are characterized by the type of sugar residue present; thus, D-xylan is a polymer of xylose residues. D-mannan of D-mannose residues, etc. However, the natural occurrence of homoglycans considerably less than that of heteroglycans in present day corn cobs. The heteroglycans usually contain two to four different types of sugar residues, for example, L-arabino-D-xylans and L-arabino-D-glucuronos-D-xylans, and have branched structures. The hemicelluloses of corn cobs are mainly heteroxylans. The cell walls of the corn cob contain cellulose bundles which are embedded in an amorphous mass of lignin and polysaccharide material, thus giving a strong and rigid structure.

Activated carbon is carbon produced from carbonaceous source materials such as nutshells, peat, wood, coir, lignite, coal, petroleum pitch and maize cob. It can be produced by one of the following processes i.e., physical or chemical activation. Before carbonization, the raw material is impregnated with certain chemicals. The chemical is typically an acid, strong base, or a salt. Chemical activation is always preferred over physical activation due to the lower temperature and shorter time needed to obtain activated carbon. The adsorbent properties are essentially attributed to their large surface area, high degree of surface activity, universal adsorption effect and favourable pore size.

Diatomite refers to the light coloured sedimentary rock that is composed of the remains of one-celled algae known as diatoms. Diatomite is highly siliceous, has a low specific gravity, and is very porous. These properties are what make diatomite useful as a filter, as an absorbent, and as a filter for rubber, paint, and plastics. When diatomite is crushed into a powder, it is normally referred to as diatomaceous earth, sometimes abbreviated as DE.

II. METHODOLOGY

RAW MATERIAL AND SAMPLE COLLECTION

PRE-TREATMENT ANALYSIS OF GREYWATER SAMPLE

PREPARATION OF ADSORBENTS

FILTRATION

POST TREATMENT ANALYSIS OF TREATED GREYWATER

RESULTS AND DISCUSSION

III. RAW MATERIAL AND SAMPLE COLLECTION

The sites selected to collect sample for analysis and treatment is commercial sewage (Greywater) from one of the car showrooms in Chrompet. The greywater sample contains waste water from pantry, floor wash, wash basins and car service unit. The corn cobs were collected from a de-kernelling mill, salem.
IV. PREPARATION OF CORNCOB ADSORBENTS

The raw corncobs obtained from de-kernelling mill are sun dried to remove the moisture. Then the layers are separated and chemical activation is done to prepare the adsorbent as per the following procedure.

- The corncobs were sundried for 3 days
- The corncobs were then broken and the pith layer was separated.
- The remainder of the cob is ground in the grinding mill.
- Then the coarsely ground material is sieved to separate the chaff from woody ring.
- Pith was ground and sieved separately.
- Then they are rinsed using a mixture of 0.5 N Citric acid and 0.5 N Phosphoric acid for chemical activation.
- Finally oven dried at 80°C till it reaches constant humidity (90 minutes).

V. PREPARATION OF CORNCOB BASED ACTIVATED CARBON

Since the corncobs are available in plenty and exhibits very good porosity, they are used to prepare activated carbon. The activated carbon obtained by carbonization was chemically activated using Sodium hydroxide solution and thermally activated by the following procedure.

- Corncobs were washed and sun dried for 2 days.
- Carbonized in controlled burning to prepare activated carbon.
- Mixed with 1M NaOH solution at the ratio of 3:1 (by weight) and impregnated for 2 hours.
- Then, washed to take off excess chemicals and dried at 110°C in hot air oven for 24 hours.
- They are coarsely ground to particle ranging between 2.36mm to 425µm.

VI. FILTER SETUP

The filter is setup in a glass container of cross section 200 mm x 200 mm as shown in the figure.

A. Chaff Layer

The chaff layer is the outer most layer which holds the kernel. It can adsorb oil, grease and suspended particulate matter to a great extent. Coarse chaff’s particle size ranges from
1.18 mm to 710 μm and the fine chaff’s particle size ranges from 710 μm to 425 μm.

**B. Woody Ring Layer**
The woody ring layer constitutes the major portion of the corncob by volume and has excellent adsorption capacity for pulling in dissolved solids like detergents, lignosulphates and fatty acids. Woody rings particle size ranges from 425 μm to 150 μm.

**C. Pith Layer**
The pith layer is the most porous layer in the corn cob. It can absorb hardness causing salts to a great extent and can also remove odour in untreated form. Piths particle size range from 425 μm to 300 μm.

**D. Diatomaceous Earth**
Diatomaceous earth is highly siliceous, has a low specific gravity, and is very porous. These properties are what make DE useful as a filter, as an absorbent, and as a filter for rubber, paint, and plastics. It has electromagnetic properties that actually attract and trap toxins, fungus, yeast, bacteria and some viruses in a honeycomb like structure (frustules). The packing of the particles is irregular and creates a complex matrix with very high porosity.

**E. Corncob Based Activated Carbon**
Thermo chemically activated corncob based carbon is granulated and the particle size ranges from 710 μm to 150 μm. This layer efficiently absorbs all heavy metal and specifically Chromium(VI) and also removes dyes.

**VII. LABORATORY ANALYSIS OF SAMPLES**
Both the untreated and treated samples are tested in the laboratory to determine their characteristics. The test for pH, turbidity, chlorides, ammonia nitrogen, total solids, dissolved oxygen, BOD, COD, hardness, chromium and lead were conducted as follows.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>UNTREATED SAMPLE</th>
<th>TREATED EFFLUENT</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>1.36</td>
<td>1.67</td>
<td>-</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>95</td>
<td>-</td>
<td>99</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>3300</td>
<td>180</td>
<td>94.54</td>
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<tr>
<td>BOD (mg/l)</td>
<td>600</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>3405</td>
<td>1362</td>
<td>60</td>
</tr>
<tr>
<td>Hardness (mg/l)</td>
<td>500</td>
<td>130</td>
<td>74</td>
</tr>
<tr>
<td>Total solids (ppm)</td>
<td>1200</td>
<td>2000</td>
<td>83.33</td>
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<tr>
<td>Suspended solids (ppm)</td>
<td>8000</td>
<td>1000</td>
<td>87.5</td>
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<tr>
<td>Dissolved solids (ppm)</td>
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<td>1000</td>
<td>75</td>
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<tr>
<td>Chlorides (mg/l)</td>
<td>459.03</td>
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<td>Ammonia nitrogen (mg/l)</td>
<td>104.72</td>
<td>10.08</td>
<td>90.37</td>
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<tr>
<td>Chromium (mg/l)</td>
<td>0.85</td>
<td>&lt;0.1</td>
<td>&gt;90</td>
</tr>
<tr>
<td>Lead (mg/l)</td>
<td>1.67</td>
<td>0.653</td>
<td>62.27</td>
</tr>
</tbody>
</table>

**VIII. RESULTS AND DISCUSSION**
The overall performance of the filter was good, but the change in pH was negligible, the sample being very acidic is an undesirable trait. Also the BOD and COD of the filtrate was above the permissible limit of 30 mg/l according to irrigation standards. The diatomaceous earth layer was seeded with sodium bicarbonate (food grade) to reduce the acidity. Also it must be noted that sodium salts do not produce any hardness and more of all the reason to be chosen as the additive. Upon filtering the sample through altered filter medium, the filtrate obtained has a pH of 8.47 without affecting other parameters. However the problem of BOD and COD can be taken care of by diluting with normal water suitable.

Even though the filter has certain drawbacks (which can be rectified with few modifications), it has removed hardness causing salts, detergents, odour and heavy metals considerably. Hence this method can be effectively used as a natural pre-disposal treatment.

**IX. CONCLUSION**
The greywater discharged in the sewage from commercial source was analyzed to determine the characteristics. Granulated corncob with chemical and thermal surface activation were used to build a filtration system on lab scale to treat the commercial greywater. And the treated sample is analysed and compared with untreated sample where TSS, TDS, BOD, COD, hardness and heavy metal concentration shows a large temporal variation. Although there was no considerable change in the pH of samples. Hence considerable measures were taken to neutralize the acidity without affecting the other parameters. The material has high potential for adsorbing heavy metals and can even be used profitably for industrial uses with suitable modifications.

This system has proved that “use of natural resources” to treat onsite wastewater. It is the dynamic option which can directly connect the masses of general public. The Treated water has a wide range of applications as a replacement of freshwater resources for non-consumptive uses. It is very helpful for people to use this technique to recycle greywater since it is economical and simple in
construction. And the recycled water can be used for gardening, toilet flushing, power plant coolant, laundries, vehicle wash, etc. This method is eco-friendly without use of special equipments and electricity, with minimum operational and maintenance cost.

REFERENCES


