Removal of organics in crepe cotton wastewater using aerobic biodegradation

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Abstract: Industrial wastewater contains various types of organic and inorganic compounds. Textile wastewater is one of the major holders of organic pollutants, discharging them without any prior treatment affects aquatic, surface organisms as well as human beings. In this study, the Crepe Cotton processing wastewater is collected from the cotton mills of Rajapalayam city and checked for its pH, Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) by treating them using Activated Sludge aerobically. Two batch studies were made by varying concentration of wastewater and removal efficiency was checked. It is found that the COD value decreases over time and achieved 100% removal on the 7th day while the TSS increases because of the growth of microbes. This shows that activated sludge microbes readily accept the organics present in Crepe cotton wastewater and can be effectively used for its treatment, though further studies are required to conform the removal of nutrients and other organic pollutants.

1. INTRODUCTION

Crepe cotton bandage is made from cotton which is known for its light weight, high absorbing capacity and is widely used in medical field. A bandage from Crepe cotton is manufactured from various processes starting from ginning, spinning, weaving, bleaching, rinsing, drying and stitching.

Among these processes, a large quantity of wastewater comes out from the bleaching and rinsing section which is done to brighten the fabric using certain chemicals (NaOH flakes, H₂O₂ aqueous solution, Polypropylene twine, Silicate) and rinsing off the excess chemicals present in the bleached fabric in normal water [1]. The wastewater is found to be highly basic, turbid and has high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels, if the wastewater are left untreated into water bodies they can cause harm to the public and aquatic organisms. Hence there is a need to implement effective technology to remove chemicals to purify and conserve water [2].

During the manufacturing of the fabric several kinds of dyes are added to give colour and better appearance and when it is left untreated, it causes harm to the environment. Direct dyes are toxic and Adsorption method is recommended which treats the wastewater effectively and is less expensive [3]. Nowadays many advanced treatment methods are available to treat the wastewater effectively and to promote safe discharge. Iyagba et.al [1] mentioned that since ages Hypochlorite is used as one of the bleaching agents that can be replaced by Peracetic acid and is found to be biodegradable. Some of the effluent treatment methods include Adsorption on powdered activated carbon, Electrochemical
process, Ozone treatment and Nanofiltration. Salzar et al. [4] Indicated that using Membrane bioreactor (MBR), the COD removal was about 89-92% compared to the conventional Activated Sludge (AS) process which was about 54-70% and shows that the MBR has more efficiency and also expensive than the conventional method for treating the textile wastewater. According to Carmen et al. [5], the MBR technique is used to treat Industrial and Municipal wastewater with the help of membrane filtration unit which provides greater effluent quality and longer solid retention time but Biological treatment is always reversible and is less expensive compared to the physical and chemical treatment. Prabha et al. [6] reported that the bacteria and fungus found in river water have the capacity to remove the colour from dyes present in the effluent.

In this study a simple approach is made to determine the biodegradation of organic pollutants in crepe cotton wastewater using activated sludge from domestic sewage from nearby treatment plant.

1.1. Manufacturing Process of Crepe Cotton Bandage

The Figure 1 shows the schematic flow chart diagram involving the process of the manufacture of crepe cotton bandage.

![Flow Chart of the manufacturing process of Crepe Cotton Bandage.](image)

The manufacturing process starts with the Ginning, where the Seed is separated from cotton. Then the raw cotton is spun into yarns. The yarns are weaved into a cloth in the Weaving process and are stacked into bundles in a Godown to be sent for bleaching. The original fabric which is pale yellow in colour which is sent to the Bleaching section and is bleached into bright white using Caustic Soda (NaOH) and aqueous H₂O₂ as bleaching agent in a steamer for 3 and ½ hours at 500°C. In Rinsing, the chemicals are removed by rinsing in normal water and the wet bleached cloth is left to dry under sunlight. In stitching section, the dried cloth is stitched according to required shape and size. For the final process, the cloth is stitched with X-ray thread which is in blue colour that helps in detecting the cloth by scanning if it is accidently stitched within the body.
2. METHODOLOGY

2.1. Wastewater Collection
The Crepe cotton wastewater needed for the experiment was collected from a cotton mill in Rajapalayam and stored in the cold storage to prevent the changes to take place in the properties of wastewater.

2.2. Biodegradation Studies
To check the degradation of the organics from Crepe cotton wastewater using activated sludge microbes, two batch scale setup was described. The sample was taken with 200 ml Wastewater + 50 ml MSM + 10 ml Sludge as Batch 1 and 100 ml of Wastewater + 150 ml Minimal Salt Media (MSM) + 10 ml Sludge as Batch 2. MSM is the nutrient composition which enhances the growth of microbes. The COD and Total Suspended Solids (TSS) were checked on all consecutive days with the pH adjusted to 7 and the batches are taken in conical flasks with constant shaking using the mechanical shaker. The process is repeated on the above mentioned days by checking its pH, COD and TSS till the COD value becomes asymptotic with time. The Table 1 shows the composition of the names of the chemicals present in MSM and its composition.

| S.No | Name                                      | g/l   |
|------|-------------------------------------------|-------|
| 1    | Ammonium Sulphate                         | 0.3125|
| 2    | Manganese Sulphate Hydrate                | 0.00394|
| 3    | Calcium Chloride dehydrate                | 0.1191|
| 4    | Manganese Sulphate Heptahydrate           | 0.1329|
| 5    | Dipotassium phosphate                     | 2.627 |
| 6    | Monopotassium phosphate                   | 1.436 |
|      | Trace Elements                            |       |
| 1    | FeCl₂·4H₂O                                | 1.22  |
| 2    | MnCl₂·4H₂O                                | 4.09  |
| 3    | CoCl₂·4H₂O                                | 0.927 |
| 4    | ZnCl₂                                     | 0.37  |
| 5    | CuCl₂                                     | 0.61  |
| 6    | NaMoO₄·2H₂O                               | 0.579 |
| 7    | H₃BO₃                                     | 0.16  |
| 8    | KI                                        | 0.148 |
| 9    | NiCl₂·6H₂O                                | 0.067 |
| 10   | EDTANa₂·4H₂O                              | 6.5   |

2.3. Chemical Analysis
2.3.1. Chemical Oxygen Demand
The COD experiment for the two batches was done using HACH COD Reactor using APHA (2008). The sample and other two reagents namely Potassium Dichromate and Sulphuric acid that were taken in the ratio of 1:2:3 in a COD test tube and placed at 150°C for two hours. The solution was then titrated against Ferrous Ammonium Sulphate (FAS) reagent till the colour changes from bluish green to reddish brown. The final value is measured in milligrams per litre (mg/l).

\[
\text{COD} = \frac{(A - B)ml \times N \times 8\text{g/eq} \times 1000\text{ml}}{\text{Volume of sample}}
\]
where A is the volume of Blank, B is the volume of Sample in burette measured in ml.

2.3.2 Total Suspended Solids

The experiment was done to quantify the Suspended particles present in the batches. The filter paper (Whattman, 42 μm) was wetted and kept in the hot air oven (Technico Laboratory products pvt.ltd, Chennai) for 1 hour at 50°C. It is then brought to normal room temperature using dessicator. The initial weight was noted. After the sample was completely filtered the process was repeated for hot air oven followed by dessicator to get the final weight. The weight is measured in grams and the final value is measured in (mg/l).

\[
\text{Final Weight} - \text{Initial Weight} \times \frac{\text{Volume of Sample}}{10^6 \text{ mg/l}}
\]

3. RESULTS AND DISCUSSION

The Figure 2 shows the decrease in the COD level in Batch 1 and 2 due to the changes in the pH, organic content and suspended particles that were measured each day with different dilution of wastewater. Figure 3 shows the changes in the Total suspended solids concentration as the microbial growth in increasing trend.

In Batch 1 and Batch 2, the removal efficiencies of organic pollutants with time are expressed in percentage and are shown in Table 2. It is observed in Batch 2, that 100% COD removal takes place in the 4th day itself where as in Batch 1, the maximum removal is obtained on 7th day only. This may be due to vary in dilution for the two batches as the microbes took more organic pollutants in Batch 2 than Batch 1. Higher concentration of wastewater may take additional time for degradation of organic pollutants.

| Day | COD Removal |
|-----|-------------|
|     | Batch 1 (%) | Batch 2 (%) |
| 1   | 16.7        | 16.7        |
| 2   | 50          | 50          |
| 3   | 66.7        | 75          |
| 4   | 83          | 100         |
| 7   | 100         | 100         |
4. CONCLUSION

The biodegradation of organic pollutants is checked in Crepe wastewater using Activated Sludge and the parameters namely pH, COD and TSS were tested. The COD was constantly decreasing which shows the increase in the oxygen content supplied with constant shaking using mechanical shaker. 100% removal was found on 7th for both the batches. Initially the TSS was found to be constantly increasing to the growth of microbes and then found to be asymptotic with time.

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