Biological Treatment of Industrial Starch Wastewater From Cardboard Packaging Industry

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Abstract- *The biological treatment of starch wastewater which typically produced from cardboard packaging industry. Starch wastewater generated due to process of machine washing. Both suspended and dissolved solids concentration present in wastewater was very high. In present study, the treatment of starch wastewater by using solid and liquid separation with the help of gravity settling in primary sedimentation tank and supernatant wastewater treated by biological process in batch reactor. After gravity settling chemical oxygen demand reduced up to 45-50%. Then supernatant wastewater treated in batch reactor to reduce the organic pollutant maintained up to permissible limits.*

Keywords- Starch, Wastewater, Supernatant, Sludge, treatment, cardboard.

I. INTRODUCTION

The cardboard manufacturing industry related to packaging and printing sector are currently the fastest developing industries in the world [1]. The Corrugate cardboard Packaging industry is continuously growing on a surging trend in the global scenario. The production of a simple foldable carton incorporates technologies that make use of large amounts of water and energy [1]. The production of cartons a lot of water is consumed for washing of machines, maintaining clean the area where printed packaging is manufactured. According to publisher results, most paper cardboard plants consume from 20- 60 m^3 of water per tones of paper [2]. Daily demand for water used for the paper heating steam is approx. 5 to 7 m3/d. Further amount of water is used for the purpose of washing machines and is estimated in the range from 10-24 m^3/d [2]. The wastewater, which the plant is draining into the collection system consists a mixture of sanitary and industrial wastewater. The wastewater from this industry contains large amounts of pigments derived from printing inks, starch adhesive, paper pollen, etc. The most dangerous is the technological wastewater formed during washing equipment and facilities. Water-based coatings and water-based glues have become popular because of their environmental friendly and non-harmful properties. However, they caused wastewater from machine washing to be treated before discharge [3].

This study presents information on production technology at cardboard packaging industry manufacturing cardboard and cartons, located at MIDC Butibori, Nagpur. This plant served as example to discuss the most important issues in the field of wastewater management. As a result, we have managed to propose new technological solutions in the context of sustainable development. This study aims to recommendations for industrial practice, with regard to environmental aspects of wastewater management by improving the quality of post-production wastewater from industry. The objectives of this research were to survey the sources of influent in a cardboard packaging plant and to find the proper technique of wastewater treatment. In this study, the focus is on the treatment of wastewater from a cardboard manufacturing plant by gravitational sedimentation followed by biological batch reactor method.

II. METHODOLOGY

2.1 Sampling

The cardboard manufacturing industrial wastewater samples collected include influent from industrial outlet and influent from the wastewater collection tank. Composite sampling method was adopted for sampling of starch wastewater. Composite sampling consists of a collection of samples taken at regular interval over a period of 24 hours (sampling every 2 hrs). The volume of each sample was taken 1 liter. The samples were collected in glass bottles, transported immediately to the laboratory.

2.2 Physicochemical Analysis

The physicochemical parameters were chosen following the regulatory requirements with respect to pollution control board discharge limits The study was limited to the following parameters: pH, TSS, TDS, COD and $BOD_{3,27°C.}$ All physicochemical parameters of wastewater were determined by the wastewater analytical standard methods. The content of suspended solids (TSS) was determined by the gravimetric method. The chemical oxygen demand (COD) was analyzed using reflux dichromate method and biological oxygen demand ($BOD_{3,27°C}$) was measured using an Dilution Method Incubate at 27ºC for 3 days.

2.3 Method of Optimization

2.3.1 Primary treatment by gravity settling

Cardboard industry wastewater has low pH, high suspended solids, and high COD (Table 1). Wastewater sample from industrial outlet is collected in 1000ml measuring cylinder (Fig.2.1). The detention period is given 3-4 hours for primary sedimentation for removing heavy suspended solids. After primary sedimentation process sludge is settled down at the bottom of the measuring cylinder (Fig.2.2).

Fig. 2.1 Starch Wastewater Sample

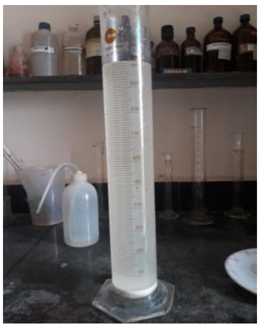

Fig. 2.2 Starch wastewater after After Gravity settling

Primary treatments on wastewater by gravity settling process sedimentation that receive starch wastewater prior to biological treatment are called primary sedimentation. The objective of the primary sedimentation tank is to remove organic solids and floating material and thus reduce the suspended solid content. The supernatant wastewater after the gravity settling used in the investigation, sample after gravitational settling indicated as shown in the fig.2.2 a remarkable discoloration is obtained had lower total SS (TSS), as approximately 90% of the solids were removed. The supernatant wastewater from the jar enters into batch reactor tank.

2.3.2 Secondary treatment by using biological Batch reactor

The batch reactor works on the principle of activated sludge process for the treatment of wastewater. The starch wastewater feed into the batch reactor for the aerobic biological treatment. Batch reactor contain active sludge and Continues aeration was provided by using air pumps The Batch reactor treats starch wastewater in batches. Oxygen is bubbled through the mixing of wastewater and activated sludge to reduce the organic matter. The carbonaceous BOD removal occurs in the react phase. Further nitrification occurs by allowing the mixing and aeration to continue the majority of de-nitrification takes place in the mixed-fill phase. The treated effluent may be suitable for discharge to surface water or possibly for used on land.

2.4 Reactor operation

Volume of laboratory batch reactor is 1000ml and reactor contains 250-300ml biologically active sludge. Supernatant starch wastewater enters into the reactor which is 700-750ml [Fig. 2.3(a)]. Continues aeration was provided by using air pumps. The active bacteria present in the reactor stabilized the wastewater. After 6 hrs aeration was stopped and sludge was settled down at the bottom of the tank. Supernatant treated water was decanted. Then determine the physicochemical properties of treated water. Reactor includes fill, react, decant and idle.

Fig.2.3 a) Fill and React

Fig.2.3 b) Settled

Fig 2.3: Laboratory Batch reactor

Biological treatment processes have the primary purpose of removing organic materials from the effluent. Biological treatment process is expected to remove only biodegradable fraction of the organic materials present. Aeration devices in biological treatment reactors should be designed as that they can transfer oxygen at a sufficient rate to satisfy the demand of the biomass is maintain.

III. RESULTS AND DISCUSSION

The sample was collected from the cardboard packaging industry and analyzed in the Enviro Techno Consult Pvt. Ltd. The analysis of starch wastewater sample and sludge sample was done to determine the strength and characteristics. In the laboratory analysis for starch wastewater sample pH, TSS, TDS, BOD and COD these are the operating parameters to optimize.

3.1 Analysis of starch wastewater

Table 3.1 Characteristics of cardboard industrial wastewater

Parameters	Unit	Permissible Standards	Sample I	Sample II	Sample III	Sample IV
pH	-	5.5-9	5.2	5.1	5.0	5.2
Total Suspended Solids (TSS)	mg/l	100	52630	49246	50964	54240
Total Dissolve Solids (TDS)	mg/l	2100	30890	31470	29960	30480
Biochemical Oxygen Demand ($BOD_{3,27}$°C)	mg/l	30	1760	1680	1660	1720
Chemical Oxygen Demand (COD)	mg/l	250	4400	4220	4280	4400
BOD/COD		--	0.4	0.39	0.38	0.39

Table 3.1 shows that the analysis starch wastewater samples contain high amount of TSS and TDS. Accordingly, TSS, TDS, BOD and COD are 52630 mg/l, 30890 mg/l, 1760mg/l, and 4400 mg/l respectively. The pH of wastewater is found that 5-5.5.

Table 3.2: Sampling analysis of starch wastewater after gravity settling

Parameters	Unit	Permissible standards	Sample I	Sample II	Sample III	Sample IV
pH	-	5.5-9	5.6	5.5	5.4	5.2
Total Suspended Solids (TSS)	mg/l	100	4934	4658	4710	4830
Total Dissolve Solids (TDS)	mg/l	2100	3838	3569	3369	3620
Biochemical Oxygen Demand ($BOD_{3,27}$°C)	mg/l	30	960	940	980	920
Chemical Oxygen Demand (COD)	mg/l	250	2400	2304	2256	2448
BOD/COD		--	0.35	0.36	0.34	0.33

Table 3.2 shows that after gravity settling the suspended solids settled down at the bottom of the tank. Primary sedimentation should remove 80 to 90% of the suspended solids and 45 to 50% of the **BOD** and **COD.** pH of starch wastewater remains same after sedimentation process. From BOD/COD ratio we conclude that the supernatant wastewater is 0.35 which is biodegradable. After sedimentation process supernatant starch wastewater treated by biologically in batch reactor. Wastewater sample after gravitational settling samples following indicated on Table 2. As shown in the results, a remarkable discoloration is obtained using gravity settling Previous studies have shown the effectiveness of the gravity settling in the context of synthetic discoloration. Due to primary sedimentation it gives interesting results which obtained a significant improvement in especially for TSS reduced up to 90% and wastewater become colorless.

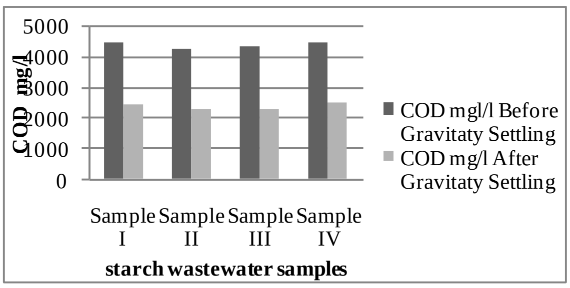

Fig.3.1 COD Reduction after Primary sedimentation

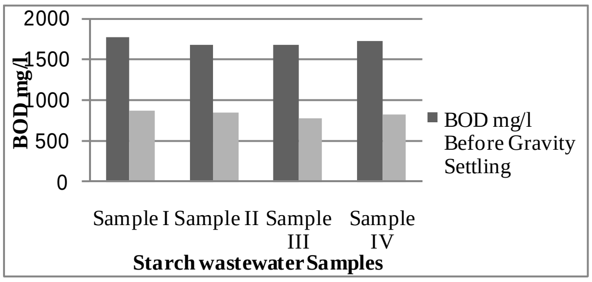

Fig.3.2 BOD Reduction after Primary sedimentation

3.2 Treatment on supernatant wastewater by using Batch reactor

Biological treatment processes have the primary purpose of removing organic materials from the effluent. Biological treatment process is expected to remove only biodegradable fraction of the organic materials present. Aeration devices in biological treatment reactors should be designed as that they can transfer oxygen at a sufficient rate to satisfy the demand of the biomass and maintain the dissolved oxygen concentration above kg/m^3.

Table 3.3: Analysis of BOD and COD of starch wastewater during react phase in batch reactor

Sr. No.	Time duration in react phase (Aeration phase)	Biochemical oxygen demand (BOD) mg/l	Chemical oxygen demand (COD) mg/l
1.	At the time feed	860	2400
2.	After 1 hours	740	2030
3.	After 2 hours	580	1660
4.	After 3 hours	440	1290
5	After 4 hours	280	920
6.	After 5 hours	130	560
7.	After 6 hours	20	190

Table 3.3 shows that the react phase in batch reactor, the reduction of BOD and COD of starch wastewater was reduced with respect to time. In react phase allows for further reduction or "polishing" of wastewater parameters.

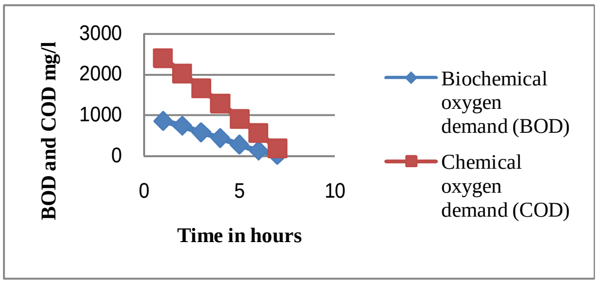

Fig.3.3 Reduction of BOD and COD with respect to time in Batch reactor

Fig. 3.3 shows that drastically reduction of BOD and COD in react phase of batch reactor. After 6 hours of aeration organic matter gets stabilized. In batch reactor the rate of organic loading decreased dramatically. The carbonaceous BOD removal occurs in the react phase and physicochemical parameters including color, odor, pH, TSS, TDS, COD and BOD is to be maintained up to permissible standards

3.3 Evaluation of Overall Treatment Processes

The good functioning of the overall treatment process appears in the result of the final effluent quantity as illustrated in (Table 3.4) Characteristics of Final Effluent.

Table 3.4: Characteristics of treated effluent

Sr. No.	Parameters	Unit	Influent after gravitational settling	Effluent after (BR) treatment	CPCB Standard
1	pH	-	5.5	7.3	5.5-9
2	Total Suspended Solids (TSS)	mg/l	4934	10	100
3	Total Dissolve Solids (TDS)	mg/l	3838	250	2100
4	Biochemical Oxygen Demand ($BOD_{3,27^{\circ}}$ C)	mg/l	860	20	30
5	Chemical Oxygen Demand (COD)	mg/l	2400	190	250
6	BOD/COD	-	0.35	-	-

Table 3.4 shows that the supernatant wastewater treated in batch reactor gives good results. Batch reactor provides highest efficiency possible in a single step biological process. The removal efficiency of BOD, COD, TSS and TDS was very high. The pH of the final effluent is 7.3. Results indicated that the recommended treatment of starch wastewater using biological batch reactor COD removal >90% was obtained. The specifications of treated water fulfill the requirements of governmental regulations to discharge in land or sewer network system.

3.3.1 Abatement of COD

The starch wastewater treatment by primary sedimentation shows that reduction of COD with an average reduction rate of 45% and after biological batch reactor process cod reduce to 190mg/l (Table 3.4).

3.3.2 Abatement of Suspended Matter

Analysis of the suspended matter present in starch wastewater the amount of un-dissolved material (colloid) settled down by gravity settling and remaining solids removed in secondary treatment process. Wastewater studied is highly charged with suspended matter 52630 mg/L. This treatment can achieve an average reduction rate of 98% with a minimum TSS content of 100 mg/L (Table 3.4).

3.3.3Abatement of BOD_3

The wastewater treated by the gravity settling test shows that BOD has an average reduction rate of 45-50% and after batch reactor process $BOD_{3,27°C}$ estimated 20mg/l that compared with current regulations (30 mg/L) (Table 3.4).

IV. CONCLUSION

1. This study demonstrated the feasibility of biological batch reactor process for the treatment of cardboard industry starch wastewater after removal of suspended solids by simple gravity settling.

2. Results indicated that removal of starch solids from starch wastewater by simple gravity settling reduced organic loading up to 45-50% was sufficient to obtain good performance of the batch reactor treatment process.
3. The recommended treatment of starch wastewater using biological batch reactor BOD and COD removal >90% was obtained.
4. The specifications of treated water fulfill the requirements of governmental regulations to discharge in land or sewer network system.

V. ACKNOWLEDGMENT

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