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Performance Evaluation of Floating Treatment Wetlands Integrated with Microbial Fuel cell for the Treatment of Dairy Wastewater

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Abstract – *The objective of the study was to develop laboratory scale model of Floating Treatment Wetlands Integrated with microbial cell. The Canna Indica plants were used for the Floating Wetland (FW). The 9-volt current were supplied to the microbial cell. The treated wastewater was collected at 4 different time cycle (30min, 1hr., 2hr. and 4hr.). Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and PH tests were conducted on the treated water. The result after 4th hour is good. At 4 hour the Biological Oxygen Demand (BOD) was 314mg/lit also Chemical Oxygen Demand (COD) was 314 mg/lit. After 2 hour we found the pH in below 7.7. The study concludes that as the reaction time increases the BOD and COD were sufficiently removed and the pH is in between 5.5 to 7.5.*

Key Words: BOD, COD, pH, Floating Treatment Wetlands, Microbial cell, Wastewater.

1. INTRODUCTION

India is a global powerhouse of agriculture and related products. Milk is one among these products. India produced large amount of milk and milk product. From the dairy industry we achieving food security, generation of employment opportunity for women and regular source of income. Dairy is most important and fast-growing industries [1]. Nearly 160 million children around the world receiving benefits from the milk. Dairy industry is equally important in developing economics in countries like India, for providing nutrition support, employment opportunities for women, economical support to rural area for development. In 1998 India become largest country for milk production than US. 22% of the global milk production in 2018. Nearly 183 million tons of milk produced in India per day. From that milk variety of products are produced in India. Such as yogurt, paneer, butter, cheese, dried milk, ghee, etc. Amul, Mother Dairy, Nestle, Gokul, Chitale, etc. are the famous dairy companies in India.

But the dairy industry produces large amount of water pollution. For 1 liter production of milk 3 liters of water are used. This water comes from various stages from dairy industry such as cleaning system, technological process, cooling system, steam generation. Those waters contain organic matter, fats, carbohydrates, proteins and phosphate and nitrate concentration. Because of this water can't be use for any purpose. That's why we have to treat wastewater and then reuse the water.

For treating wastewater, we have some treatment that are used in dairy. For treating wastewater, we used Electrocoagulation Process, Reverse Osmosis (RO) and Nano Filtration (NF), Natural Coagulants, Up flow Anaerobic Sludge Blanket, Constructed Wetland, activated sludge process, aerated lagoons, aerobic bioreactor, trickling filters, sequencing batch reactor (SBR), up flow anaerobic filters, and bio coagulation. Most of the dairy choose aerobic process for the wastewater treatment. But because of aerobic process we lose lots of energy. To conduct aerobic process, we need to give continuous supply of oxygen to aeriation tank for 12 -14 hours and for that we need electric pump. Electric pump needs energy to supply oxygen. For aerobic process we lost lot of energy and money. But instead of aerobic process we use microbial cell then we conserve energy.

Constructed wetland also new technique to treat the wastewater. Floating wetland is most economical method to treat the wastewater. In floating wetland, the aquatic plants allow to grow on artificial platform in which the roots of the plants are inside the water. Floating treatment technique properly remove solid particles, suspended particles, pigments, harmful dyes from textile industries [3]. Floating treatment wetland was used for treatment of wastewater generated from the municipal. It removed BOD, COD also harmful bacteria, chloride from the wastewater [4]. It is very easy to maintain also very economic. It can't produce harmful product [5]. Phragmites australis, Glyceria maxima, Iris pseudacorus, Canna indica, Typha angustifolia, Wachendorfia thyrsiflora, Typha latifolia, etc. plants are used in the Floating treatment wetlands [6].

The objective of this study was to develop the laboratory scale model of Floating treatment wetland integrated with microbial cell. For the wetland select appropriate plant. Evaluating the laboratory scale model at 9-volt current at specific time interval such as 30 min., 1hr, 2hr and 4 hr. The analyzing BOD, COD and pH of the treated water at specific time interval.

2. Method and Methodology

2.1 FTW with Microbial cell Setup:

In this study, the laboratory scale model was used and the characteristics of tank was follows. The cylindrical shaped model was used with height 30 cm and the radius of that tank was 20 cm. The volume of the tank was around 35 litters. For the experiments 30 litters water were used. Firstly, the wastewater coming from the dairy industry goes for the first step, which was screening. Large size particles like plastic bottle, bags, large size garbage were separated form wastewater. At the same time, the fats containing the wastewater were removed from that. After screening and removing the fats, the water was collected for the experiment.

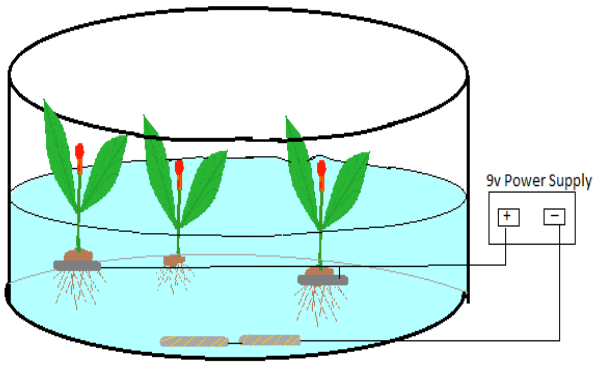


Fig -1: FTW with microbial cell setup diagram

In floating treatment wetland unit, we used one ornamental plant of specie Canna Indica (Indian Shot). The Canna Indica remove 74.9% COD from wastewater [7]. These plants were placed in that tank with 3 plants in a row. The plant density is 7 plants/sq.m. Plants were initially kept in wastewater for 1 week. The surface of the water tank is covered with insect screen to prevent misquotes proliferation. The FTW was composed of lightweight materials like plastic bottles. The roots of the plants were completely immerged in the water. The FWT need 10 plants/m2 [2]. For the Microbial Cell, the Graphite electrodes were used. For cathode only 99.99% pure graphite rod were used and for anode, graphite rod with wounded copper wire was used. The graphite is good conductor of electricity and also used in electrocoagulation process to treat the wastewater. The cathode electrodes were placed at the bottom of the tank in wastewater. The anode electrodes were tied with the plants root. the distance between the cathode and anode was kept constant at 20 cm. The 9 volts current are externally provided to anode and cathode. The continuous current supply was provided to the electrode for 0.5, 1, 2 and 4 hours. The experiment was connected for 2 weeks with three cycles for specific time interval.

Fig -2: Graphite electrodes with copper wire as anode

Fig -3: Graphite electrodes tied with roots as cathode

2.2 Site description and Wastewater characteristics:

The water was collected from the near dairy industry. The collected wastewater contains COD, BOD, pH, suspended particles, dissolved particles, chloride, oil and fats, etc. The current dairy used the Aerobic process for the treatment of wastewater. For aeration process the dairy industry used diffused aeration. Wastewater from each stage in dairy industry collected at the end and then transfer to the ETP process. The water firstly passed through the screening process also suspended fats and oils are removed. After that wastewater were used for treatment floating wetland with microbial cell.

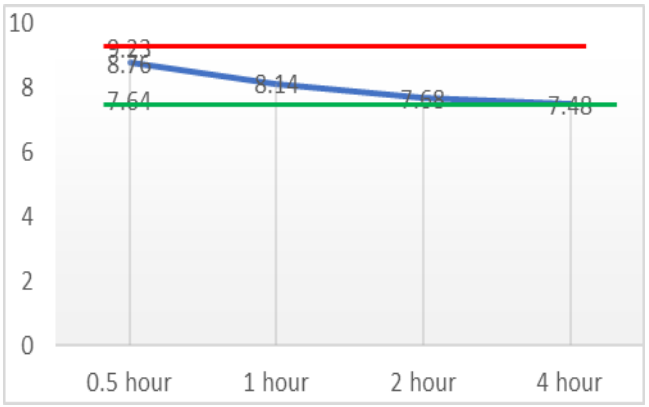
These are the properties of treated water and untreated from dairy industry.

Table -1: Properties of Untreated and treated wastewater collected from dairy industry

Parameters	Properties of Untreated wastewater	Properties of Untreated wastewater
pH	9.2	7.3
COD (mg/l)	652.0	29.2
BOD (mg/l)	248.0	8.0
Chlorides (mg/l)	98.0	29.09
Sulphate (mg/l)	78.90	21.70

2.3 Result and Discussion

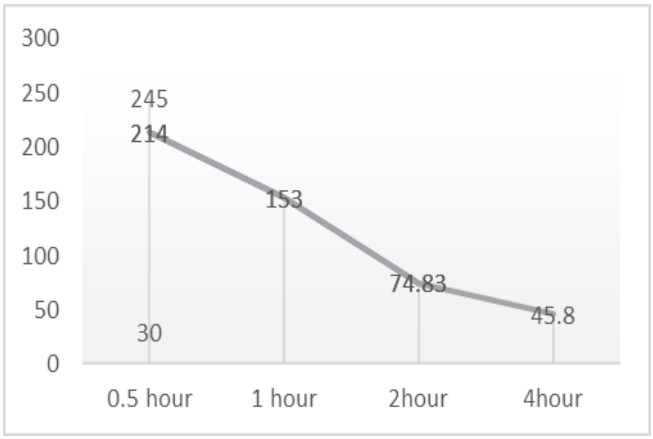
The 9-volt current was supplied to the electrodes after specific time interval the treated water was collected. The pH of untreated water was 9.23 the after 30 min, 1hr, 2hr and 4 hr. the pH of the water 8.76, 8.48, 7.88 and 7.66 respectively. That shows that After time passes the pH of the water decreases. The following graph shows the difference of pH at specific time interval.



Graph -1 -: pH of treated Wastewater

The BOD of the wastewater was 245.6 mg/lit. The BOD Of Treated Wastewater from ETP present in the dairy industry is 30 mg/lit. when the electric supply was provided to the microbial cell then after 30 min the BOD decreases up to 214. Again, after 1hr, 2hr and 4hr the BOD was 153, 74.83 and 45.8 mg/lit resp.

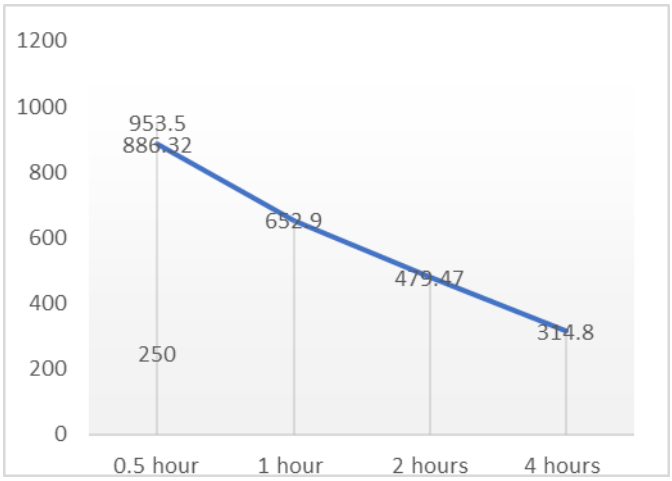
The following graph shows the difference of BOD at specific time interval



Graph -2 -: BOD of treated Wastewater

The COD of the wastewater was 953.5 mg/lit. The BOD Of Treated Wastewater from ETP present in the dairy industry is 250 mg/lit. The COD after 30 min, 1hr, 2hr and 4hr were 886.32, 652.9, 479.47 and 314.8 mg/lit resp.

The following graph shows the difference of COD at specific time interval:



Graph -3 -: COD of treated Wastewater

3. CONCLUSIONS

By using FTW with microbial cell with Graphite electrodes, the pH of the wastewater decreases as time passes. As well as the BOD of the wastewater was changes from 245mg/lit to 45.8 mg/lit. It clearly shows that after 4 hr. the best result is found. Exactly for the COD, after 4 hr. the COD of the wastewater decreases up to 314.8 mg/lit. that means the overall result shows that pH, BOD, COD are decreases as time passes and after 4 hr. we got good result for wastewater by sing FTW with microbial cell.

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