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Algal Bioreactor For The Removal Of Residual Pollution Various Parameter From Secondary Biologically Treated Waste Water

Banu priya.S[1], Sudha.N[2], Reetha Devi.R[3], Sharmila Devi.S[4], Sri Nivashini.U[5]
[1, 2] Assistant professor, Dept. of Civil Engineering, Vivekananda college of Technology for women, Tamilnadu, India
[3, 4 ,5] UG Students, Dept. of Civil Engineering, Vivekananda college of Technology for women, Tamilnadu, India

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Abstract:
The waste water generated from various sources like agriculture, industry normally consist of organic and inorganic waste. The main objective of this project is to reduce the both organic and inorganic solids by treating it with the unicellular organism algae. Though many treatment methods were available to reduce the pollutants, based upon the recent researches treatment with algae produces greater results when compared to other microorganisms involved in the treatment process. Algae are preferred because of its attitude of in taking the inorganic substances for their growth and releasing enormous amount of oxygen than the other microorganisms. The species like chlorella pyrenoidosa, cynobacteria, scenedesmus species are the most frequently used algae in waste water treatment. We have taken two waste water samples namely institutional wastewater and sugar mill effluent. The process requires a small retention time and minimum facilities. The effluent obtained after primary treatment generally loaded with inorganic nitrogen and phosphorous due to their presence in water it leads to eutrophication and the process of eutrophication is also stimulated with considerable amounts of heavy metals. The process is applicable in both aerobic and anaerobic situations. Though open systems are also available for the treatment closed systems provide significant results as they are prevented from atmospheric contact. By proceeding with algae in waste water samples of secondary treated waste water and sugar mill effluent the reduction in residual pollutants has to be analyzed. The various parameters like DO, chloride, sulfate and pH contents are continuously monitored and the results will be clear in the reduction of residual pollutants.

Keywords*: Algae, Residual Pollutants, Waste Water treatment, institutional wastewater, sugar mill effluent.*

Introduction:

Water on the earth present today is the same water that was there when the earth began. This process is applicable in the case when it is recycled. The earth usually reuses its water naturally. But with the present population it is not beneficial or clever to wait for the water to get recycled in its own way and thus we use advanced technologies to overcome such situations and emergency needs. The recycled water is used for the purposes such as irrigation, for flushing, watering a lawn and even to charge the underground aquifers. Benefits of recycled water not only includes the removal of offensive, volatile materials from the water it also prevents the environment from harmful impacts. Water recycling is always performed in the sewage water because it is the source where large quantity of waste water is

generated and it also saves the life of aquatic animals that survive in the water bodies.

Water treatment is a process in which the offensive or harmful contaminants are eliminated from the water for the purpose of direct usage of water in case of water demand or for the purpose of discharging the effluent with permitted standards in to the neighboring water bodies .The wastewater treatment processing units are termed as waste water treatment plants (WWTP), or water resource recovery facility (WRRF). Pollutants in municipal waste water can be removed or broken down with the use of advanced water treatment facilities. The treatment of waste water is included as a part of sanitation.

2. STUDY AREA

2.1 SCOPE

The method of treating waste water with the addition of algae has evolved through the history including the changes occurred in culture, technology development and environment. Today waste water treatment with the inoculation of algae is well planned along with the needed infrastructure and implemented in urban areas on the basis of sanitation related activities.

Identifying the initial parameters of water collected from different origin and thereby inoculating algae in the secondary treated waste water to reduce its pollutants.

2.2 OBJECTIVES

Waste water systems always takes the water polluted by both human as well as industrial activities and makes it safe enough to be discharged into the aquatic systems and terrestrial land. Reducing the BOD content is the vital role of the treatment process.BOD is the quantity of oxygen required by the microbes for the decomposition of organic and inorganic compounds into carbon dioxide. The main objective is to reduce the cost required to construct or maintain a treatment unit for secondary treatment of the respective waste water. Not only reducing the BOD content it simultaneously also reduces all the toxic parameters that are present in excess than the permissible limits.it also reduces the time required to treat a wastewater when compared to the conventional method.

2.3 BIOREMEDIATION

Bioremediation is a process in which the subjected media (including water, soil and subsurface materials) with contaminants must be treated in order to remove the targeted contaminants by altering the environmental conditions favoring the growth of microorganisms.

Recent trends in bioremediation are divided into two main categories:

<u>In situ bioremediation</u>

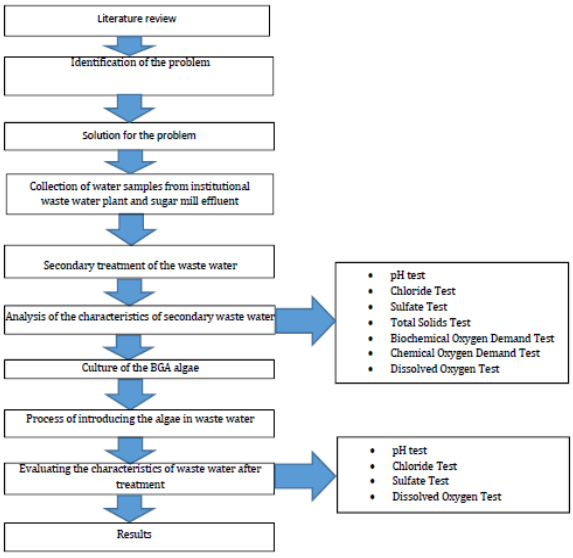
- ✓ Bioventing
- ✓ Bio stimulation
- ✓ Air sparging
- ✓ Bio augmentation
- ✓ Natural attenuation
- ✓ Bio surfactants
- ✓ Microbes assisted phytoremediation
- ✓ Genetically engineered plants
- ✓ Phytoremediation

<u>Ex situ bioremediation</u>

- ✓ Land farming
- ✓ Composting
- ✓ Controlled solid phase treatment
- ✓ Slurry phase biological treatment

3. MATERIALS AND METHODOLOGY

3.1METHODOLOGY



3.2 BIOREACTOR

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Bioreactor is defined as the vessel in which biological reaction takes place. The most commonly used bioreactors are HRAP(high rate algal pond), photo bioreactor, fluidized bed, packed bed, bubble column, airlift and stirred tank. Bioreactor should accompany closed upper cover with perforations to maintain aerobic condition and the cover protects the entire setup contact with the environment and the sample remains as the same without any unwanted reactions. The bioreactor used here is stirred tank as it requires stirring with sufficient intervals and not continuously. The paddles are not fixed to the reactor as it is stirred manually and not mechanically agitated. The reactor is made up of glass and it is fully water tighten to prevent the leakage of water.

3.3 AEROBIC CONDITION

An aerobe is an organism which can survive only in the presence oxygen. The bioreactors in practice is generally pressurized; this increases the solubility of oxygen in water. In an aerobic process the microorganism takes oxygen for the breakdown of organic compounds.

3.4 ANAEROBIC CONDITION

The environment which lacks oxygen is termed as anaerobic environment but it consists of atomic oxygen with the presence of nitrate, nitrite and sulfites. Anaerobic digestion can be termed as a process in which the organic compounds are broken down to simpler compounds in the absence of oxygen.

4. WASTE WATER CHARACTERISTICS

4.1 INSTITUTIONAL WASTEWATER EFFLUENT

Conventional waste water treatment processes were developed to release effluents suitable to the environment. The vital role of wastewater treatment process is to reduce BOD content and to remove the suspended solids. Primary, secondary and tertiary are the three main stages of water treatment process and in some cases quaternary is also included. There are various types of processes available for secondary treatment namely oxidizing beds, oxidation ponds, activated sludge blanket and aerated digestion tanks. The sample is collected from a waste treatment plant located in a reputed institution after primary treatment as the study deals with the overall treatment of treating secondary waste water. The sample generally consist of pH, alkalinity, chloride, and sulfate. The reaction with algae with the secondary water leads to the reduction in the amount of chloride, sulfate present in that stage of waste water. Algae replaces the coagulant and mechanically operated equipment needed for the secondary treatment of water.

4.2 SUGAR MILL WASTE EFFLUENT

The type of waste which affects the environment is from sugar mill industry. The effluent when untreated is released into the environment the impacts will be severe. The manufacturing process of sugar produces waste products such as molasses, filter press cakes, wastewater, bagasse, and bagasse ash. Among the waste products mentioned above molasses and bagasse are the most valuable by-products nowadays. The sample is collected from a reputed sugar mill industry and the effluent is taken after primary treatment as the whole study takes place in the secondary treated waste water. Taking in account about the constituents of the effluent the treatment method should be finalised.The effluent generally consist of bicarbonate, carbonate, oil and grease, phosphate, nitrite in addition to the volatile and suspended solids. The above mentioned pollutants can bring changes in both temperature and humidity. . Since the effluent from sugar mill consists of richer organic matters it is not advised to release the effluent without proper treatment as if untreated effluent is released it simultaneously leads to depletion or caution to the environment. Though many treatment methods are available for treating sugar mill effluent, algae plays a major role in depleting or reducing the residual pollutants present after the primary treatment without the addition of coagulants.

5. ALGAE

Generally there are different species of microorganisms available for the treatment of different wastes. This study of treating institutional waste water and sugar mill effluent waste water

deals with algae. Obviously specific algae are efficient in removing specific inorganic matter from the desired effluent. The research takes place by introducing the same algae in two different samples by comparing the results we can conclude that which effluent's parameter is greatly reduced.

Algae can grow sufficiently in clean and brackish water. They are capable of growing in different environmental situations. There are algae which can grow in the snow of American mountains, lichens in bare rocks, and they can even sustain in hot springs and in dessert soils. .algae are the primary producers of food chain as they produce organic material with carbon dioxide, sunlight and water. Besides their function as primary producers they also produces oxygen necessary for the consumers. But consumers like humans won't directly take algae for their food but they harvest the producers which are in higher level than the algae (shellfish, edible fishes).some algae are used as thickening agents and they can be harvested as eatable vegetables.

5.1 CHARACTERISTICS OF BLUE GREEN ALGAE

Cyanobacteria is also known as "blue – green algae" and it is familiarly known as pond scum. As the name indicates the algae is mostly blue-green in color and in some cases reddish brown, green and blue. These algae bloom in slow moving streams, ponds and lakes where the nutrients like phosphorous and nitrogen are in enormous amount. A species from blue green algae *Chlorella salina* is inoculated in both institutional waste water and sugar mill effluent for study their reactions in waste water.

Instant multiplication of blue green algae is possible when the environmental conditions are favorable. The species of blue green algae will mostly float on the surface and they form scum layers or floating mats. And this process is termed as "blue-green algae bloom".

Blue green algae are associated with toxin production, discolored water, offensive taste and odour. There is also depletion of dissolved oxygen in the case when it dies. Aesthetic appearance of the water gets affected by blooming of algae and thus it reduces light penetration and affects the aquatic animals directly and indirectly. Directly in the sense it affects the growth of aquatic plants and indirect in the sense it affects the fish and water depended animals that depends on the plants that grow in under water. .after blue green algae blooming the water exhibits offensive smell and it also affects the taste of the subjected water and the public are very conscious that the raw water inoculated with algae should not be used for drinking purposes. The cells of the blue green algae are broken down by the microbes after its life ends. Thus creates biological oxygen demand as it requires oxygen for the breakdown process. When the biological oxygen demand is increased it simultaneously results in the depletion of oxygen concentration in water and it leads to a situation in which the aquatic animals cannot survive.

Toxins or chemical compounds are internally processed inside the cells of blue green algae. There is no exact analysis available about at which time the chemical compounds are produced and at which situation they are not produced. The toxins are discharged after the breakdown of cells. In some cases the toxins are also released after the death of algae and the process is quite nature. The cells can also be broken open when they are treated with chemicals , or it may open up when the cell is swallowed in the digestive acids which is secreted in the stomachs of people and animals.

6. DECOMPOSITION OF ORGANIC MATTER

When organic materials decompose in the presence of oxygen, the process is called "aerobic". The aerobic process is most common in nature. For example, if it takes place on ground surfaces such as the forest floor, where droppings from trees and animals are converted into relatively stable humus. There is no accompanying bad smell when there is adequate oxygen is present.

In aerobic decomposition, living organisms, which use oxygen, feed upon the organic matter. They use the nitrogen, phosphorous, some of the carbon and

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other required nutrients. Much of the carbon serves as a source of energy for the organisms and is burned up and respired as carbon dioxide (CO_2). Since carbon serves both as a source of energy and as an element in the cell protoplasm much more carbon than nitrogen is needed. Generally about two-thirds of carbon is respired as CO_2 while the other third is combined with nitrogen in the living cells.

Oxidation at hemophilic temperatures takes place more rapidly than at mesophilic temperatures and hence, a shorter time is required for decomposition (stabilization). The high temperature will destroy pathogenic bacteria, protozoa, algae (microscopic one celled animals) and weed seeds, which are detrimental to health or agriculture when the final compost is used. Aerobic decomposition of organic matter does not produce any objectionable odor.

6.1 PROCESS

The samples collected from different origin are first tested to study about its characteristics and the contents present in it. Then the open bio reactor is filled with effluent collected after the primary treatment and the cultured blue green algae *Chlorella salina* of about 100 ml is added to the effluent at room temperature at 20 – 21 degree Celsius to test if the algae can bloom in the specified effluent. The blue green algae added is a matured culture and it existed in active state. The retention time needed to absorb the results takes place to about 5-7 days. The time taken by the algae to grow is about 9- 14 days. The algae oxidize the organic matter present in the effluent and reduce the residual pollutants when compared to the primary results that we obtained.

6.2 OBSERVATION OF INSTITUTIONAL WASTEWATER AFTER INOCULATION OF BLUE GREEN ALGAE

After adding 100 ml of blue green algae *Chlorella salina* to the institutional wastewater there is no mat formation occurred in the amount of sample taken. After adding another 100ml of algae there is no considerable reaction changes occurred. Due to the presence of excess heavy metals and organic loading the effluent obstructed the growth of algae. The process stopped after the addition of algae and the further process is dropped due to inactive algae.

6.3 OBSERVATION OF SUGARMILL EFFLUENT AFTER INOCULATION OF BLUE GREEN ALGAE

After adding 100ml of blue green algae *Chlorella salina* to the sugar mill effluent there is sufficient amount of mat formation occurred on glowing the effluent. The test is further proceeded as the added algae showed activity. The study is carried for 5 days after the inoculation of blue green algae.

7. EXPERIMENTAL METHODS

7.1 Determination of pH

The pH is obtained by using pH paper or pH meter. pH is defined as the negative logarithmic hydrogen ion concentration. **pH= -log [H+]**. The actual pH of industrial effluent is 6.5-8.5.

7.2 Determination of sulfate

Sulfate is determined by igniting barium chloride solution with hydrochloric acid till the quantity of solution is reduced to half of its initial quantity. Then the solution is filtered with a filter paper and the residue is dried and weighted .the difference between the initial and final amount is taken as sulfate content. The sulfate contents are taken into consideration while the water is supplied for domestic purposes.

7.3 Determination of chloride

Chloride ion is determined by Mohr's method. The silver nitrate solution is titrated against the respected wastewater sample and the indicator used is potassium chromate. The end point of the titration is identified by the formation of red precipitate due to the reaction between silver nitrate and potassium chromate.

$Ag\,NO_3 + Cl^- \text{------} > AgCl + NO_3^-$

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$2Ag\ NO_3 + K_2CrO_4$------> $Ag_2CrO4 + 2\ KNO_3$

7.4 Determination of dissolved oxygen

Filling the Sample in a glass-stopper bottle whose volume is determined previously. Mainly the bottle should not consist of any trapped air bubbles. Add 1-2ml of conc. H_2SO_4 and shake the bottle well to dissolve the precipitate. Sample from the solution and titrate it against Sodium thio Sulfate using starch as indicator. End point is change of color from blue to colorless solution.

8. RESULT AND DISSCUSSION

8.1GENERAL

From the analysis of the waste water it is concluded that some of the parameters like chloride, sulfate, PH, DO is higher and they are reduced compared to the initially obtained values.

8.2 CHARACTERISTICS OF WASTE WATER

Table-1: characteristics of institutional wastewater before the addition of *Chlorella salina*

PARAMETERS	OBTAINED VALUES	UNITS
pH	6.69	-
TOTAL SOLIDS	10	ppm
CHLORIDE	1174.6	ppm
SULFATE	730	ppm
DO	NA	ppm
BOD	30	ppm
COD	175	ppm

Table -2: characteristics of sugar mill effluent before the addition of *Chlorella salina*

PARAMETERS	OBTAINED VALUES	UNITS
pH	4.4	-
TOTAL SOLIDS	4.73	ppm
CHLORIDE	984	ppm
SULFATE	825	ppm
DO	425	ppm
BOD	25	ppm
COD	43	ppm

Table -3: characteristics of sugar mill effluent after adding *Chlorella salina* and the results of 5 days analysis.

PARAMETERS OF SUGARMILL EFFLUENT	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
pH	4.6	4.75	4.8	4.81	4.86
SULFATE	780	756	730	700	681
CHLORIDE	975	830	750	662	652
DO	380	350	340	290	274

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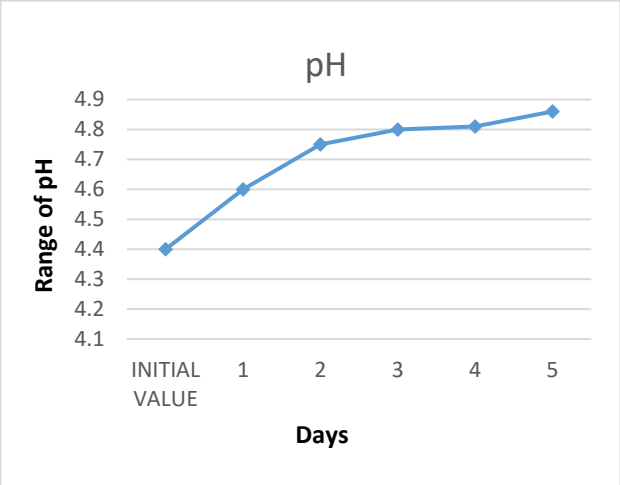

Chart -1: PH rating (with *Chlorella salina*)

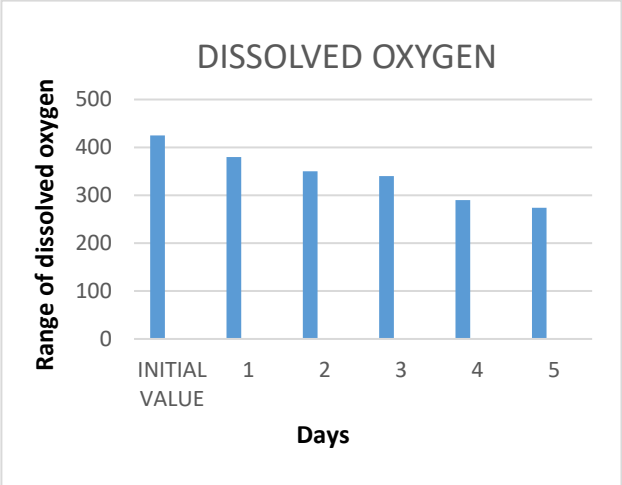

Chart -4: dissolved oxygen rating (with *Chlorella salina*)

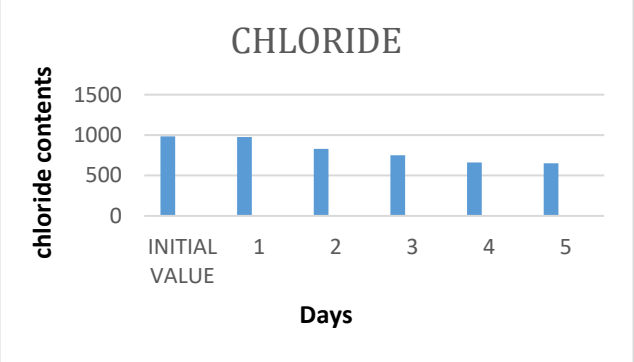

Chart -2: chloride rating (with *Chlorella salina*)

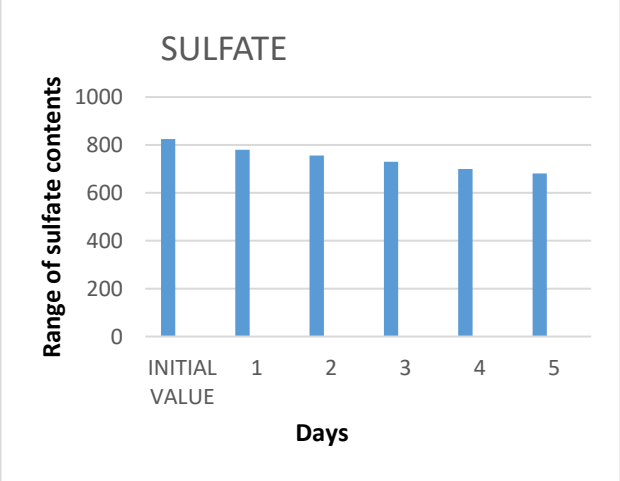

Chart -3: sulfate rating (with *Chlorella salina*)

CONCLUSION

The knowledge gained on algae- based water treatment is a promising alternative for conventional wastewater treatment and it is a cost-effective and sustainable technology. The parameters like pH, chloride, sulfate and DO have been studied and reduced when compared to the initial obtained values in sugar mill effluent.

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