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Observational Study of Wastewater Treatment by the Use of Microalgae

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Abstract: Organic and inorganic substances which were released into the environment as a result of domestic, agricultural and industrial water activities lead to organic and inorganic pollution. The normal primary and secondary treatment processes of these wastewaters have been introduced in a growing number of places, in order to eliminate the easily settled materials and to oxidize the organic material present in wastewater. The final result is a clear, apparently clean effluent which is discharged into natural water bodies. Treatments of wastewater with Microalgae based system have the ability to remove nutrients. (Nitrogen, Phosphorus and other nutrients), BOD, COD and other impurities present in the wastewater by using the sunlight, CO2, and impurities like nutrients present in the wastewater. The microalgae also have the ability to fix the excess. Carbon dioxide presents in the environment and release the oxygen and solve the problem of Global warming. According to the various study, the nutrients removal efficiency of microalgae based wastewater treatment system is very high as it removes 78-99% of Nitrogen and Phosphorus. Microalgae culture offers an interesting step for wastewater treatments because they provide a tertiary bio treatment coupled with the production of potentially valuable biomass, which can be used for several purposes. And also, for their capacity to remove heavy metals, as well some toxic organic compounds, therefore, it does not lead to secondary pollution. In the research, we will highlight on the role of micro-algae in the treatment of wastewater.

Keywords: inorganic pollution; treatment; impurities; microalgae; wastewater

I.INTRODUCTION

In developing country, due to the increasing population and rapid industrialization, the amount of wastewater generated every day is very huge. Due to this, water pollution is one of the most critical environmental problems. For wastewater treatment various conventional methods are used in the development country but they are costly and not economical. Nowadays, some new green technical methods of wastewater treatment are being introduced to resolve the problems related to the conventional methods.

Environment laws are given general applicability and their enforcement has been increasingly sticker. So, in terms of health, environment and economy, the fight against pollution has become a major issue. Today, although the strategic importance of fresh water is universally recognized more than ever before, and although issues concerning sustainable water management can be found almost in every scientific, social, or political agenda all over the world, water resources seem to face severe risks to availability and quality of water resources, in many areas worldwide.

Cultivation of Microalgae in wastewater for wastewater treatment, pollution control and production of energy from microbial biomass is nowadays common treatment method. Microalgae have become significant organisms for biological treatment of wastewater. Microalgae based treatment system is one of good solutions to solving the environmental problems such as global warming, the increase of ozone hole and climate changed due to its ability to consume high quantity of carbon dioxide in Photosynthesis process to produce oxygen and glucose.

The problems of water shortage in the Middle East and North Africa (MENA) regions are well documented. Most countries in this region are arid or semi-arid. They have low rainfall, mostly with seasonal and erratic distribution. The MENA region, home up to 5% of the world's people contains less than 1% of the world's annual renewable freshwater. On the other hand, water demand in arid and semi-arid countries is growing fast.

Algae also release a large amount of simpler organic compounds that can be assimilated in aqueous system. The bacteria, in turn constitute an essential source of CO_2 required for algal growth, stimulate the release of vitamins & organic growth factor s and change the pH of the supporting medium for algal growth.

One of the major sources of water pollution is the uncontrolled discharge of human wastes while some countries have made massive investment in water supply projects there has been an overall under-investment in appropriate sanitation systems, which has resulted in harmful contamination of water resources, increased flooding and reduced health benefits from water investments. Finding a solution for the treatment and safe discharge of the wastewater is a difficult challenge because it entails integrated processes in which technical, economic and financial consideration come in play. The uniqueness of each situation makes it difficult to define a universal method for selecting the most adequate type of waste treatment plant. However, it is important to ensure that appropriate treatment standards are selected to meet local conditions, and alternative innovative technologies for treating wastewater are considered. Both conventional and innovative methods should be evaluated.

Determination of Algae Growth Potential is based on the relation of a maximum biomass yield concerning the biologically used nutrients for microalgae growth. In a water body, nutrients could be consumed, partially or totally, depending on the nutritional present in the water. Furthermore, a nutrient-rich discharge like, effluent from the anaerobic digestion process is generally recycled to the head of the wastewater treatment plant and can increase the cost and destabilized the overall treatment process due to the accumulation pf phosphorus.

The microalgae system can treat various types of wastewater like, domestic sewage, industrial waste water etc and reduce the nutrients (Nitrogen, phosphate and other minerals) from the waste water. Removal of Nutrient is an important part of wastewater treatment because rich nutrient effluent discharged into water bodies can result in eutrophication in water bodies. The increased atmospheric CO_2 level is now worldwide accepted to be a major contributor to global warming; its various potential effects are only beginning to be understood. Microalgae use carbon dioxide and sunlight in photosynthesis activity and release the Oxygen in the environment.

Microalgae based treatments have a number of unique benefits. As an aquatic species they do not require arable land for cultivation. It means the cultivation of microalgae does not need to complete with agricultural commodities for growing space. In fact, microalgae cultivation facilities can be built on minimal land that has few other uses.

II.COMPOSITION OF TYPICAL WASTE WATER

Watercourses receive pollution from many different sources, which vary both in strength and volume. The composition of wastewater is a reflection of the life styles and technologies practiced in the producing society. It is a complex mixture of natural organic and inorganic materials as well as man-made compounds. Three quarters of organic carbon in sewage are present as carbohydrates, fats, proteins, amino acids, and volatile acids. The inorganic constituents include large concentrations of sodium, calcium, potassium, magnesium, chlorine, sulphur, phosphate, bicarbonate, ammonium salts and heavy metals.

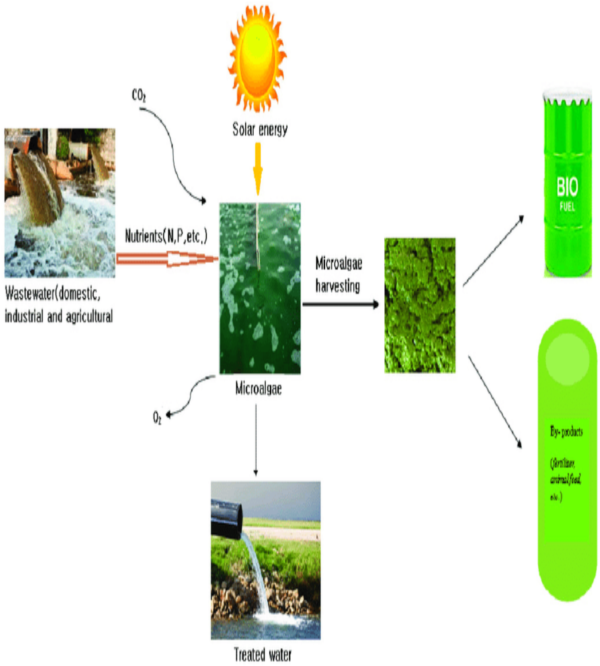

Fig.1.Process of wastewatertreatment with microagale

1. Microbiological Composition of Sewage

Wastewater environment is an ideal media for a wide range of microorganisms specially bacteria, viruses and protozoa. The majority is harmless and can be used in biological sewage treatment, but sewage also contains pathogenic microorganisms, which are excreted in large numbers by sick individuals and a symptomic carrier. Bacteria which cause cholera, typhoid and tuberculosis; viruses which cause infectious hepatitis; protozoa which cause dysentery and the eggs of parasitic worms are all found in sewage. The efficiency of disinfecting sewage is generally estimated by the extent of removal of total coliform organisms.

Fig2. Algae for wastewater treatment

Fig.3.Improving of microagale

2. Factor Affecting for the Growth of Microalgae

(a) Sunlight

Microalgae are unicellular, photosynthetic microorganisms and they use sunlight in photosynthesis process. Photosynthesis is the process of converting light energy into organic molecules, which are mainly composed of carbohydrates, CH2O. Sunlight is important to the growth of microalgae and without sunlight microalgae growth has been reduces.

(b) Carbon Dioxide

The increased atmospheric CO_2 level is now worldwide accepted to be a major contributor to global warming; its various potential effects are only beginning to be understood. Microalgae use Carbon dioxide and sunlight in photosynthesis activity and release the Oxygen in the environment. During the photosynthetic process, microalgae utilized CO_2 from the atmosphere as a carbon source to grow and release oxygen. According to the studies microalgae cells contain approximately 50% carbon, in which 1.8 kg CO_2 are fixed by producing 1 kg of micro algal biomass. For the fixing of CO_2 microalgae are considered as more efficient than terrestrial plants.

(c) Carbon Dioxide

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(d) PH

Microalgal growth rate and treatment of waste water may also be affected by pH of the waste water. Availability of inorganic carbon also affected by pH, even if pH is high for other reasons than photosynthetic CO_2-exhaustion, the pH regulates what species of inorganic carbon that is available. Increasing dissolved oxygen concentration and pH cause for phosphorus sedimentation and also ammonia and hydrogen sulphur removal. High pH in algal ponds also leads to pathogen disinfection.

(e) Temperature

Temperature is proportional to the availability of sunlight and has little effect when light is limiting. When light availability is not limiting, increase in temperature can increase the rate of photosynthesis, growth/doubling rates are consequently. However, even though light is most often limiting the growth of microalgae too much light may also cause lowered photosynthetic effectively, which is known as photo inhibition. Increased temperature enhances algal growth until an optimum temperature is reached. Further increase in temperature leads to a rapid reducing in algal growth rate. Temperature ranges generally within 20 to 30'C for the maximum growth of microalgae.

Table I. Summary major nutrient removal efficiencies by algal cultivation [Wang et al., 2010]

Algae species	Wastewater Characteristics	Carbon	P(%)	N(%)	Retention timrn
Cyanobacteria	Secondarily treated domestic effluent+ settled swine wastewater	NA	60	94	2 Days
Chlorealla pyrenoidosa	Settled domestic sewage	NA	78.8	92.3	15 Days
Chlorella vulgaris	Diluted pig slurry (suspended solids content to 0.2%)	BOD_5 98%	42-89	52-86	3.5Days
Algal –bacterial symbiosis (Chlorella+Nitchia)	Settled domestic sewage	73	91	95%BOD, 80%COD	9hours
Mixed culture of Chlorella and diatom species	Wood-based pulp and paper industry wastewater	40%			45Days
Chlorella pyrenoidosa	Domestic sewage and wastewaters from a pig farm and a palm oil mill	70-78% of BOD, 60-72% COD	40-50	50-60	17 Days

III. REVIEW OF VARIOUS STUDY RELATED TO WASTE WATER TREATMENT WITH THE HELP OF MICROALGAE

The reduction of anthropogenic nutrient inputs (from agricultural practices, urban wastewater and various industries) in the system is required to protect water supplies and to decrease eutrophication process. Their removal efficiencies depend on several factors: (1) microalgae culture, (2) Nutrients initial concentrations, (3) Ration of Nitrogen and Phosphorus (N/P), (4) microalgal strain, (5) microalgae growth conditions, (6) nutrients source, and (7) characteristics.

Microalgae can be used to treat both of municipal and industrial wastewater. However, microalgae can be grown in wastewater to removal all pollutants and chemical toxic substances from wastewater such as nitrogen, phosphorus, nitrite, silica, iron, magnesium and other harmful chemicals. Microalgae have huge capacity to accumulate the heavy metals and heavy toxic compounds to form microalgae biomass (2). The various study conducted to identify the treatment of wastewater using microalgae discussed below.

The work conducted by Dalrymple et al., (2013) showed that there are important benefits to be derived from integrating algal production systems with nutrient-rich waste streams. The energy resulting from algae will play a significant role in providing energy security while important services such as waste treatment can be significantly achieved by these systems. It also shows that by the end of 14-day batch culture was removed 94% ammonia, 89% TN and 81% TP with the help of algae (5).

Mahapatra et al., (2013) investigate the treatment efficiencies of the Algae based sewage treatment plant located in Mysore. The study showed moderate treatment levels with 60% total COD removal, 50% of filterable COD removal, 82% of total BOD removal, and 70% of filterable BOD removal. The nitrogen removal efficiency was less. However, a rapid reduction in the suspended solids after a high euglenoid growth indicates particulate carbon removal by algal ingestion (13). **Sekaran et al (2013).,** studied on Integrated Bacillus sp. immobilized cell reactor ad Synechocystis sp. algal reactor for the treatment of tannery wastewater with CAACO reactior. **Wang et al (2010)** conducted a study to evaluate the growth of green algae Chlorella sp. on wastewaters sampled from four different points of the treatment process flow of a local municipal wastewater treatment plant and how well the algal growth removed nitrogen, phosphorus, chemical oxygen demand (COD), and metal ions from the wastewaters. The study showed average specific growth rates in the exponential period were 0.412 , 0.429, 0.343, and 0.948 day -1 and removal rates of NH_4 –N were 74-82 % phosphorus 83-90% and 50-78% COD were removed four different types of wastewater. It was also found that metal ions, especially Al, Ca, Fe, Mg, and Mn in centrate, were removed very efficiently. Indeed, the HRAP produced an effluent with a low concentration of dissolved COD (about 60 mg/ml), but the total COD may be high due to algal biomass. The major NHJ-N removal mechanism was the stripping of ammonia in the range between 52%-66%. It was possible to achieve nitrification at all SRTs and corresponding COD/TKN ratios. The COD removal was found to average between 89.5%-97.7% for the organic loadings between 0.5 g/L –day to 0.68 g/L –day.

IV.CONCLUSIONS

Algae can be used in wastewater treatment for a range of purposes, including;

1. Reduction of BOD
2. Removal of N and P,
3. Inhibition of coliforms,
4. Removal of heavy metals

The various studies conducted to treat the wastewater using microalgae shows that the microalgae reactor has a significance reduction in nutrients, BOD and COD and other toxic chemicals but increase in Total solids due to the growth of microalgae, so it is recommended before discharging the treated wastewater in the stream, it is necessary to remove microalgae from the treated effluent to meet general standards of wastewater discharge. The nutrients removal efficiency of microalgae based wastewater treatment system is very high. The system has a removal efficiency of 78-99% of Nitrogen and Phosphorus. The treatment system also succeeds to remove 40-65% of BOD, COD and other impurities present in wastewater.

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