BIOFUEL PRODUCTION AND BIOSORPTION IN INDUSTRIAL WASTE WATER USING MICROALGE

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Abstract: The removal of heavy metals from the waste water is necessary because it starts accumulating in the food web. Many techniques have been emerged to remove heavy metals. The biomass has huge advantageous over conventional methods. The biomass is further directed into transesterification to produce biofuel. Algal biomass is higly productive feedstock with great potential in biofuel industry.

***IndexTerms* - Biofuel,Biosorption,Transesterification,Biomass**

1. INTRODUCTION

1.1 ALGAE DESCRIPTION

Algae Living or dead algal cells are being increasingly used as biosorbents to remove heavy metals from aqueous solutions due to their high sorption uptake and their availability in practically unlimited quantities in the seas and ocean. Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms. Seaweeds are the largest and most complex marine forms. They are photosynthetic, like plants, and "simple" because they lack the many of the distinct organs found in land plants The various sorts of algae play significant roles in aquatic ecology. Microscopic forms that live suspended in the water column(phytoplankton) provide the food base for most marine food chains. Some are used as human food or harvested for useful substances such as agar, carrageen an, or fertilizer. [1]

1.2 TOXIC HEAVY METALS

Most of the heavy metals are well-known toxic and carcinogenic agents and represent a serious threat to the human population and the fauna and flora of the receiving water bodies. Heavy metals have a great tendency to bio-accumulate and end up as permanent additions to the environment. When wastewater is discharged to receiving water bodies without removal of heavy metals, heavy metals may be harmful to both human and aquatic life as they are non-degradable and persistent. Industrial wastewater containing heavy metal should be treated before discharge to the water stream but its treatment is very costly. There are several techniques to remove heavy metals from wastewater such as filtration, electro coagulation etc but there is some limitation such as long treatment time. Various biological treatments, both aerobic and anaerobic can be used for heavy metal removal **[7]**

1.3 MICROALGAE FOR WASTEWATER TREATMENT

Conventional methods of heavy metal removal such as ion exchange or lime precipitation are often ineffective or very expensive when used for the reduction of heavy metals at very low concentrations of 10– 100 mg/L. As an alternative adsorption medium, heavy metal removal by microalgae is very efficient and economical. While microalgae is a versatile and economic option for the treatment of effluent and create a valuable byproduct, the suitability to serve these many purposes must be judged in part on the ability to remove heavy metals from effluent.

Wastewater treatment in combination with algae cultivation as a way to enhance the environmental and economic performances of the process. Algae cultivations serve two purposes by improving water qualities and producing biomasses for further utilization as e.g. biofuel. [3]

1.4 BIOFUELS

Biofuels are a wide range of fuels which are derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price hikes and the need for increased energy security. Studies have shown that some species of algae can produce 60% or more of their dry weight in the form of oil. Because the cells grow in aqueous suspension, where they have more efficient access to water, CO_2 and dissolved nutrients, microalgae are capable of producing large amounts of biomass and usable oil in either high rate algal ponds or photo-bioreactors. [2]

1.5 TRANS-ESTERIFICATION

Trans-esterification is the chemical reaction in which oils or animal fats are reacted with alcohols (methanol/ethanol) in the presence of catalyst to produce methyl esters of long chain fatty acid i.e., Biodiesel. Trans-esterification by chemical methods is widely used as it is high conversion rate and low time of production. However, chemical method has drawbacks like energy intensive process, harmful for the environment and complex recovery of catalyst, product. [4]

1.5.1 ENZYME TRANS-ESTERIFICATION

It is the process of conversion of triglycerides into methyl esters in the presence of enzymes as a catalyst. Enzyme trans-esterification has advantages like (a) Temperature conditions close to room temperature (b) Process of recovery of catalyst, product separation and waste water treatment is eliminated. (c)Environment friendly and biodegradable commonly used enzyme is lipase [4]

2. METHODOLOGY

2.1 COLLECTION OF WASTE WATER:

Industrial waste water is collected from nearby industry in Davangere district and it is used for the growth of selected Microalgae. The waste water is collected before passing on to effluent treatment plant and it has been tested for heavy metals contamination using atomic absorption spectrophotometer. We found that water contains lead and zinc heavy metals.

2.2 SELECTION OF MICROALGAE:

Algal species selected on the basis of lipid productivity, growth conditions and other characteristics. Based on availability we have chosen *Chlorella sorokiniana* which has high lipid content of 28-36%. The selected species are isolated and subcultured by providing nutrient media continuously.

2.3 CULTIVATION OF MICROALGAE:

A Photobioreactor is a closed system that contain biologically active environment which is sustained with light, energy, heat and nutrients. It allows the better control of conditions surrounding the cultivation of microorganisms. Microalgae are inoculated into Bold's basal media of appropriate concentration which contains macronutrients and micronutrients.

2.4 BIOSORPTION OF HEAVY METALS:

Industrial waste water contains many heavy metals. As these toxic chemicals may enter to food chain will cause severe disasters to human beings, aquatic and non-aquatic species. This present work aimed to reduce the effect of biosorption of locally available heavy metals released by industrial waste water using algae culture. The water sample contains lead and zinc metals. When microalgae are put into the water it started absorbing the heavy metals and finally after 15 days the concentrations of heavy metals become negligible. It has shown good biosorption ability of microalgae. [7]

2.5 PRODUCTION OF BIOFUEL:

2.5.1. Oil extraction from algae:

In the current study, solvent extraction method was used because solvent used was recycled, reducing processing cost. Three hundred milliliters of n-hexane was used for 40 to 60 g of dried algae for the oil extraction. The extraction was carried out in a Soxhlet extractor for 4 h in order to determine the algae oil contents. All the experiments were conducted using a 0.5L round-bottomed glass flask. The resultant solution was separated from solvent by simple distillation. The solvent was reused in the next batch of extraction.

2.5.2. Transesterification of algal oil

The extracted oil was transesterified to methyl ester (biodiesel) by sodium methoxide. The mixture was heated at 62°C and methanol (10 wt% dry basis) having sodium metal (0.1 wt% dry basis) previously dissolved was added to the container. Reaction was conducted at the same temperature for 1 h with constant stirring. The reaction mixture was cooled to room temperature after this process. Then, the solid phase was separated using a separating funnel. Finally, the bottom layer of glycerin was separated from the mixture biodiesel and hexane layer (top layer), which was then washed with water to remove the methanol excess and the traces of catalyst. In order to obtain the crude biodiesel, it was necessary to remove the solvent by distillation.

2.6. BIOFUEL CHARACTERISATION:

The final product of methyl ester identified with the help of thin layer chromatography (TLC) and analyzed for kinematic viscosity, specific gravity, carbon residue. In thin layer chromatography, thin layer chromatogram (0.25 mm of thick) having length of 20 cm and width of 20 cm was prepared by using water and silica gel. The plate was air dried and activated through heating at 105°C in an oven for one hour. Diethyl ether and n-hexane (20:80) were used as solvent system, biodiesel was dissolved in a solvent and 2,7-dichlorofluorescein was used as non-destructive locating agent to see color bands (purple-yellow) under ultra violet light of 366 nm wavelength. [6]

3. RESULTS AND DISCUSSION

3.1 Biosorption

Industrial waste water contains many heavy metals. As these toxic chemicals may enter to food chain will cause severe disasters to human beings, aquatic and non-aquatic species. The present work aimed to reduce the effect of biosorption of locally available heavy metals released by industrial waste water using algae culture. The water sample contains lead and zinc metals. When microalgae are put into the water it started absorbing the heavy metals and finally after 15 days the concentrations of heavy metals become negligible. It has shown good biosorption ability of microalg

Table 1: Biosorption of Lead Sample

TableHead	Biosorption of Lead Sample	
Sl.no	**No. of Days**	**Concentration MG/I**
1	0	1.84
2	5	1.53
3	8	1.30
4	15	0.8
5	20	0.44

Table 2: Biosorption of ZINC Sample

TableHead	Biosorption of Zinc Sample	
Sl.no	**No.of Days**	**Concentration MG/I**
1	0	2.44
2	5	2.0
3	8	1.14
4	15	1.12
5	20	0.5

From the above result we can come to know that microalgae have good biosorption ability. This can be a better bioremediation for waste water treatment. We have observed reduction in concentration of heavy metals in correspondence to the time.

3.2 Biofuel

Table 3: ASTM Range of Biodiesel

Table Head	ASTM Range of Biodiesel	
Sl.no	***Fuel Properties***	***ASTM standards***
1	Kinematic Viscosity (C.st)	2.4 - 2.6
2	Flash Point (°C)	>150
3	Density(Kg/m3	870-900

4. CONCLUSION:

It was found that properties of biodiesel were in accordance with standards limits so it can be blended with fossil fuels or can be used individually. In the current study, three algal species were used to extract oil and its conversion to biodiesel. The study revealed that algae are fast growing and effective organism for biodiesel production as these can be grown in wastewater as well as in artificial media. Oil extracted from harvested biomass of these algae was transesterified to biodiesel using sodium methoxide as a catalyst. Resultant biodiesel was analyzed and compared with ASTM standards. It was found that properties of biodiesel were in accordance with standards limits so it can be blended with fossil fuels or can be used individually

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