

Microalgae Cultivation and Harvesting For Biodiesel Production

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Abstract: Microalgae have the capability to store carbon dioxide and convert into it energy compounds like starch and fatty acid. It can produce numbness of biofuels like, bio-oil via thermal liquefaction, syngas via gasification, biodiesel via transesterification, ethanol via fermentation and bio-methane via anaerobic digestion. The focus of this review paper is to investigate different cultivation and harvesting technique of microalgae biomass for biodiesel production.

Keyword: Microalgae, cultivation, harvesting, biodiesel.

1.Introduction: The fossil fuel satisfying around 88% of world energy requirements. The transport sector consumes 58% of the total fossil fuel usage and it also leads to create triggers environmental concerns, health problems and global climate change. So many researchers are turning their devotion to inventing new, green and renewable energy sources. Commercialization of biodiesel from waste frying oil, animal fats and vegetable oil, which create the competition with edible oil for agri land. This is still a sensitive and controversial issue [1]. Microalgae which have high growing rate (10 time than other biofuel crops) and convert solar energy into chemical energy via fixation of CO₂ are now gaining better attention as feedstock for biodiesel production [2].

This review summarizes the different cultivation and harvesting methods for biodiesel production. The main focus of this review is to provide a road map for governments and researcher for more practicable and economical.

2. Microalgae cultivation technologies: The growth and composition of microalgae highly influence by cultivation condition. The microalgae production technology is more complex and expensive than any other fuel crops because the required temperature range for high growth of microalgae is 20-30°C. It requires sunlight, nitrogen (N), phosphorus (P) and iron (Fe) for growth [3]. The microalgae cultivation techniques are divided into three major categories i.e. heterotrophic, photoautotrophic and mixotrophic cultures. In heterotrophic production carbon and energy sources are requires for growth, but in photoautotrophic utilizes only light as the sole energy source. In mixotrophic cultivation, depending upon the concentration of light intensity and organic compound either heterotrophic or photoautotrophic technique is utilized. The most widely cultivation technique is photoautotrophic cultivation because it is economically and suitable for mass production of algal biomass. Based upon the final product and algal strain the three cultivation systems are used, i.e. open pond, closed and hybrid [4-5].

2.1 Open-air cultivation systems: This cultivation system is also known as an open raceway pond system, which are made of closed-loop water recirculation channels, with 10-50 cm depth range. The depth of the pond is low so adequate solar penetration will be achieved for efficient photosynthesis of algal biomass. Paddle wheels are employed for better circulation. The poured concrete or dug into the earth with plastic liner is used for prevention of leakage and eliminate contamination issues [3]. The algal strain selection for cultivation, depends upon the local climate condition. This cultivation system is much cheaper than other system because of lower operating and construction cost. Open air cultivation system face some challenges like, risk of contamination; requires larger areas and operational conditions like water evaporation and temperature are uncontrollable [6].

2.2 Closed photobioreactor cultivation system: In this system the microalgae is cultivated in recycling reactor. There are different types of PBRs like, flat PBRs, tubular PBRs and bubble column PBRs. In tubular PBR glass or plastic transparent tubes are arranged in parallel in such a way proper sunlight will be offered for algal medium for photosynthesis. The algal growth is influenced by sunlight availability, temperature, culture pH and dissolved oxygen level. PBRs eliminate contamination issue and also offered controlled environment conditions. Fixation efficiency of CO₂ is also high due to proper mixing possibilities. PBRs are more expensive in term of operational cost due to high energy consumption and construction cost [7-8].

2.3 Hybrid cultivation system: Hybrid cultivation system utilized both open- air and PBRs cultivation system advantages. Zhou et al. (2012) developed effective hybrid cultivation system with low cost wastewater treatment and production of biofuels from algal biomass [8]. In this cultivation system the required nitrogen (N), phosphorus (P) and iron (Fe) for growth are utilized from the waste water which reduced the operating cost and also perform the waste water treatment. Molina et al reported that ammonium and phosphorus was removed in the range of 61-99% and 93-99% of the wastewater with 0.9g/L biomass productivity [9].

3. Algal biomass harvesting technologies: After the cultivation of algal biomass, the produced biomass undergo for separation from the bioreactor, this is known as harvesting. The harvesting of algal biomass accounts 20 to 30% of the total production cost, so it plays an important role in the economical production of biofuel. The potential of harvesting method depends upon the characteristics of algal strain (i.e. size and density) and desired product value. Harvesting of algal biomass is divided into two stages, first: bulk harvesting and second: thickening. In bulk harvesting the technique like, flotation, flocculation and sedimentation are employed for separation. In thickening process techniques like, filtration and centrifugation are used for achieving the concentrated form of the slurry [10-11].

3.1 Sedimentation: This method utilized the gravity force to form concentrated slurry. The energy efficiency of this method is very high. Algal biomass with high density and larger size could be easily and successfully separated by sedimentation method [12]

3.2Flotation: This harvesting technique is better for small and unicellular algae. It separates the algal biomass via gravity by gas or air bubbles attach to solid particles for carry out them from the liquid surface. It is much effective and beneficial than sedimentation [13].

3.3Flocculation: Microalgae have negative charge, flocculants displace the negative charge which allow aggregation algae cells. This process can be combined with sedimentation to increase the efficiency [12]

3.4Centrifugation: Centripetal acceleration is utilized to separate algal biomass into greater and less density regions, after that excess water is separated from the algal biomass. In this method within 2-5 min. about 80-90% algal biomass can be easily recovered [13].

3.5Filtration: Algal culture runs through the filter and filter holds the algal biomass and allow the water to pass through the filter, the process takes place in contention until filter contains thick algae paste. Vacuum filtration in combination filter aid for effective recovery of larger algal, while for smaller algal micro-filtration is used [14]

4. Conclusion: Microalgae had several advantages like, higher growth rate and oil contents than any other oil crops, make is a potential source of alternative to fossil fuel and an ideal candidate for biofuel production. The Hybrid cultivation system is most suitable for algal cultivation because it also utilized the N and P available in waste water and perform waste water treatment action. There is high water content present in algal cultures, which need to separate for biofuels production, above review concluded that not a single method is best method for harvesting of microalgae biomass.

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