BIOFUEL FROM ALGAE

Biofuel is fuel in liquid or gas form derived from biomass. Biofuel is considered as a promising source of energy to help reduce greenhouse gas emissions and increase energy security by providing an alternative to fossil fuels. Currently, the main biofuel products include biodiesel and ethanol. Biofuel can be produced from any carbon source that can be replenished rapidly e.g. plants.

Generally, corn, soybean, canola, jatropha, coconut, oil palm, animal fat are used as feedstock for biofuel production. However, these products are consumed by mankind and the competition between the biofuel production and food consumption can potentially cause the increase of oil price. In addition, even if all these oil products are used for biofuel production, they cannot realistically satisfy the biofuel consumption rate. Thus, the new sources for biofuel production are increasingly in demand. Researchers conducted studies on algae as one such source of biofuel.

Background information on algae:

Algae are Eukaryota although conventionally they have been regarded as simple plants within the study of botany.

Algae do not represent a single evolutionary direction or line but a level of organization that may have developed several times in the early history of life on Earth. Algae range from single-cell organisms to multi-cellular organisms, some with fairly complex differentiated form. All of them lack leaves, roots, flowers, seeds and other organ structures that characterize higher plants (vascular plants). They are distinguished from protozoa in that they are photoautotrophic.

Algae are usually found in damp places or bodies of water and thus are common in terrestrial as well as aquatic environments. Like plants, algae require primarily three components to grow: sunlight, carbon-dioxide and water. Photosynthesis is an important bio-chemical process in which plants, algae, and some bacteria convert the energy of sunlight to chemical energy. It is estimated that algae produce about 73 to 87 percent of the net global production of oxygen- which is available to humans and other animals for respiration3.

The existing large-scale natural sources are of algae are: bogs, marshes and swamps - salt marshes and salt lakes. Micro-algae contain lipids and fatty acids as membrane components, storage products, metabolites and sources of energy. Algae contain anything between 2% and 40% of lipids/oils by weight.

Algae culture for Biofuel production:

The difficulties in efficient biofuel production from algae lie not in the extraction of the oil or production of ethanol, but in finding an algal strain with a high lipid content and fast growth rate that is not too difficult to harvest, and a cost-effective cultivation system (i.e. type of photo-bioreactor) that is best suited to that strain.

Micro-algae have much faster growth-rates than terrestrial crops. The per unit area yield of oil from algae is estimated to be from between 5,000 to 20,000 gallons (18,927 to 75,708 litres) per acre, per year; this is 7 to 31 times greater than the next best crop, palm oil (635 gallons or 2,404 litres).

The production of algae has not yet been undertaken on a commercial scale, but feasibility studies have been conducted to arrive at the above yield estimate. In addition to the projected high yield, algae culture - unlike crop-based biofuels - does not entail a decrease in food production, since neither farmland nor fresh water is required. Many companies are pursuing the development of algae bioreactors for various purposes– including biodiesel production and CO_2 capturing.

Algae biomass production:

Producing algae biomass is generally more expensive than growing crops. Photosynthetic growth requires light, carbon dioxide, water and inorganic salts. Temperature must remain generally within 20 to 30 °C. To minimize costs, algae biomass production must rely on freely available sunlight, despite daily and seasonal variations in light levels.

Large-scale production of algae biomass generally uses continuous culture during daylight. And the practical methods of large-scale production of microalgae are raceway ponds and tubular photobioreactors.

A raceway pond is made of a closed loop recirculation channel that is typically about 0.3 m deep. Raceway ponds for mass culture of microalgae have been used since the 1950s. In raceway ponds, temperature fluctuates within a diurnal cycle and seasonally. Evaporative water loss can be significant. Because of significant losses of water to atmosphere, raceways use carbon dioxide much less efficiently than photobioreactors. Productivity is affected by contamination with unwanted algae and microorganisms that feed on algae. The biomass concentration remains low because raceways are poorly mixed and cannot sustain an optically dark zone.

Raceways are perceived to be less expensive than photobioreactors, because they cost less to build and operate. Although raceways are low-cost, they have a low biomass productivity compared with photobioreactors.

A tubular photobioreactor consists of an array of straight transparent tubes that are usually made of plastic or glass. This tubular array, or the solar collector, is where the sunlight is captured. Unlike open raceways, photobioreactors permit essentially single-species culture of microalgae for prolonged durations. Photobioreactors have been successfully used for producing large quantities of algae biomass. Photobioreactors require cooling during daylight hours. Furthermore, temperature control at night is also useful. Outdoor tubular photobioreactors are effectively and inexpensively cooled using heat exchangers. Large tubular photobioreactors have been placed within temperature controlled greenhouses, but it is quite expensive for biofuel production. Photobioreactors provide much greater oil yield per hectare compared with raceway ponds (Table 3). This is because the volumetric biomass productivity of photobioreactors is more than 13-fold greater in comparison with raceway ponds.

Source: http://www.iwawaterwiki.org/xwiki/bin/view/Articles/BiofuelfromAlage