Microalgae and Sustainable Energy Production

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Abstract

With the beginning of industrial revolution and economic growth, the compositions of atmosphere have been changing as well as the climate also gradually changing. There is rapid economic development and stability all over the world in last 50 years. In recent years increasing economic development has made so many industries in developing countries. The rapid industrialization increases energy consumption. The demand of energy in an advanced society is always increasing which causes the changing of environmental conditions. The air quality also declined significantly during the process of industrialization. The global energy requirement is increasing day by day and it also creates high prices of increased usage fuel. Actually the demand of energy in a country depends upon its population. The tremendous use of fossil fuel in industrial belt and in transport sector can create different types of pollutants in the environment. Recently the non polluting sustainable energy production has been focused in the regard of energy security and environmental pollution. To reduce the dependency on fossil fuel the use of microalgae -based biodiesel is very promising alternative. Microalgae are potential feedstock for the production of biodiesel. Microalgae is being re-emerged as a popular feed stock for the production of bio-fuel.

Key words: Pollution, Microalgae, Biodiesel, Photosynthetic CO_2 Sequestration.

Introduction :

As the Earth's natural environment is changing constantly, the different types of contaminants entering into the natural environment which causes adverse change in the environment and creates environmental Pollution. The combustion of fossil fuel is the principal source of air pollution. Air pollution is a type of environmental pollution. It shows effect on environment as well as human (Rosenstock 2003). During petroleum diesel combustion different types of air contaminants such as CO, SO_2, NO_2 particulate matter as well as volatile organic compounds also produced which are the causes of environmental pollution (Klass 1998).

In recent years increasing economic development has made so many industries. The rapid industrialization increases consumption of conventional energy.

The global energy requirement is increasing day by day and it also creates high energy prices of usage fuel and petroleum which is also used as main transport fuel. The demand of energy in an advanced society is always increasing which causes the changing of environmental conditions. Actually the demand of energy in a country depends upon it populations.

According to World Bank estimates the population in India has shown in the Table: I

Table - I Urban and rural populations in India:

	1965/6	1968/9	1970/1	1973/4
Urban	92(18.9)	101(19.4)	108(19.8)	120(20.5)
Rural	395(81.1)	420(80.6)	438(80.2)	465(79.5)
Total	487(100)	521(100)	546(100)	585(100)

Source : India- The Energy Sector by Handerson P.D (1975)
(in M. person). Figures in brackets indicate % shares

Petroleum & Uses Of Petroleum Products:

Actually fossil fuels occupy the world energy scenario both in solid and liquid form. Petroleum is most popular liquid form of fossil fuels. The dead and decay animal and plant materials in course of million years gave rise to oil and natural gas. The different petroleum products such as liquid Petroleum Gas (LPG), Gasoline, Kerosene, High Speed Diesels (HSD), Light Diesel Oil (LDO), Petroleum Coke are very important in our advanced society.

The production of petroleum products in India is given in the following Table - II.

Table — II Production of Petroleum products in India

Production of Petroleum Products		
Item	MT	%
Light distillates		
Naptha	0.90	5
Motor Spirits **Other**	1.44	8
	0.30	3
Middle distillates	2.64	16
Kerosene		
HSDO(High Speed Diesel Oil)	3.31	18
LDO(light Diesel oil)	3.85	21
Aviation, turbine fuel	1.09	6
	0.71	4
	8.96	4
Heavy end distillates fuel oil and fuel oil products		
Bitumen	4.78	27
Others (lubes and greases)	0.80	4
	0.80	4
	6.38	35
Total -	17.98	100

Source : India — The Energy Sector by P. Henderson(1975)

The following Table shows the consumption of petroleum in various sectors of India.

Table III .Petroleum consumption in various sectors of India.

Sector	Approximately Consumption
Trans port (Petrol, Diesel, Aviation Fuel	**51%**
Industry (Petrol, Diesel, Fuel, Naphtha, Natural gas)	**14%**
Commercial & other domestic (LPG & Kerosene)	**18%**
Agriculture (Diesel)	**4%**

Source: Poonia & Jethoo (2012)

The tremendous use of petrol in various sectors makes the gradual depletion of conventional fossil fuel. The increasing use of fossil in industrial belt can create different types of pollutants in the environment. It is a prediction that the global population may be increased from 6.6 billion in 2008 to 9.2 billion by 2050 (World Population Prospects 2006) and the resultant increase in the uses of fuel will create the increasing energy demands of the rapidly expanding economies of India and China.

Recently the non polluting sustainable energy production has been focused in regard of energy security and environmental pollution .To reduce the dependency on fossil fuel the introduction of bio-fuel is very promising alternative . Bio-fuel may be Bio-ethanol or Biodiesel.

Bio-ethanol is the very common form of bio-fuel. Corn and wheat are very popular feed stock for Bio-ethanol production. The ethanol may be obtained through the process of fermentation of simple sugars or the Polysaccharides such as starch or cellulose may be converted into simple sugars (Mussatto 2010).

Sugarcane and edible vegetable oils are most common feed stocks for the production of bio-fuel throughout the World. Ethanol is very common bio-fuel in Brazil. In Brazil more than half of the cars used the 95% anhydrous ethanol in the 80s (Solomon et al.2007). But India is facing the serious problems of food insecurity. It is true that the poor farmers do not take chance to give their agricultural lands for cultivation of bio-fuel feed stock. To avoid these type of problems, the use of microalgae for production biodiesel is a very promising alternative in bio-fuel technology. Microalgae can be used as potential feedstock for the production of sustainable transport fuel.

Production Of Algal Biodiesel -

Biodiesel is a type of bio-fuel which is composed of monoalkyl esters of long chain fatty acids. Biodiesel can reduce release of carbon monoxide, sulphur-dioxide and particulate than the diesel fuel (Sheehan John1998).

The production of biodiesel from microalgae is base catalysed trans-esterification with alcohol. The trans-esterification is a reversible reaction of oil (that is composed of triglyceride) with an alcohol to form fatty acid alkyl ester and glycerol. The reaction needs a 3:1 molar alcohol to oil ratio and the excess amount of alcohol is required to drive the equilibrium towards the products (Fukuda2001).

Advantages Of Algal Use:

Microalgae also known as microphytes present both in freshwater and marine water and they are able to produce half of atmospheric oxygen (Thurman 1997).

Microalgae have been exploited in the treatment of industrial waste water treatment plants for the biodegradation of the wastes (Mulbry et al.2008). The main advantage of cultivation of algae that no agricultural land is required for commercial production of algae as it can be grown near easily in sea water, sewage, industrial effluents as well as in waste land. According to some experts algae can be cultivated for biodiesel extraction in Sundarban delta spread over approximate 42600 Sq. Km. on the Bay of Bengal. (Belarbi et al.2003).

The production of biodiesel from microalgae may be 10 to 20 times higher than the yield obtained from other conventional oil producing crops (Bajhaiya et al.2010).

Microalgae can produce more oil than the Palm, Soybean, Coconut etc. The Table (IV) shows a comparison of biodiesel production from microalgae and other plants.

Table IV. Comparison of some sources of biodiesel

CROP	OIL YIELD (L/Acre)
Corn	68.13
Soybean	181.68
Sunflower	386.07
Rapeseed	480.69
Canola	495.83
Jatropha	788.33
Oil Palm	2403.47
Microalgae	19000-57000

Source : Bajhaya. et al. (2010)

Microalgae are able to sequester a large amount of carbons through photosynthesis. The efficiency of Co_2, fixation of ***Chlorella vulgaris*** in a membrane photo bioreactor is up to 260 mg L^{-1} H^{-1} (Cheng et al.2006).

The microalgae can reduce the emissions green house gas released from thermal power plants and the released CO_2 can be fixed by microalgae and thus it can be utilized in large scale for microalgae culture (Cheng et al, 2006).

The commercial production of microalgae for biodiesel production is facing so many obstacles.

There are two major types of large-scale algae culture system of which open ponds give a low productivity as compare to photo bioreactors [Chisti 2007].

In photo bioreactors high capital investment is required initially which can produce biomass finally with low price (Norsker et a1,2011).

Much more concentrated algal broth can be produced in photo bioreactors than open pond culture system. The photo bioreactors of tubular types produce dewatered algal biomass [Norsker et a1,2011) whose dry weight is 64 per Kilogram.

The impact of genetic engineering will improve the prospects of algal oil (Chisti 2010).

Conclusions –

Petroleum is a limited resource which is too expensive . As World eagerly hunting for alternative fuel sources, microalgae is given wide interest for the production of renewable energy. Lipids obtained from microalgae hold big promise as a bio-fuel feedstock. To replace petroleum based transportation fuels and to reduce CO_2 emissions in environment algal bio-fuel is receiving considerable attention in recent years. The best efficient improvement in microalgal technology can come from improving growth strategies and engineering practices. The environmental pollution will be lower in algal fuel than other current strategies of depending fossil fuels. The bio-fuel production brings a major challenge to accommodate the global demand for liquid fuels. We can hope the big challenge of microalgal technology will meet the demand.

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