International Journal of Advanced Research in Engineering Technology & Science ISSN: 2349-2819
Email: editor@ijarets.org Volume-5, Issue-10 October- 2018 www.ijarets.org

GLOBAL CLIMATE CHANGE: ALGAE AS A SOLUTION

Dr. Abha Mathur
Department of Chemistry, Govt. College, Malpura, Tonk

Abstract

Today, the world is witnessing an extraordinary situation in form of deteriorating climate. conditions across various parts of world. Our planet has witnessed large cycles of climatic change throughout history. However, most of those cycles were natural phenomenon known as climate cycles. We have already witnessed seven such cycles with last one bringing the Ice age to stop. This tune the situation has changed as the conditions are moving beyond the regular climate cycles and can be mostly attributed to the human causes which have had a highly negative impact on the climate after the beginning of industrial revolution.

One of the major causes of this continuous change in climatic conditions is excess of heat trapped on earth due to global warming which is disturbing the delicate balance of heat across the regions. Industrial revolution allowed mankind to come up with various sources for release of carbon dioxide which is considered as one of the most important reason for global warming. This increase was supported by the increase in use of CFC based compounds making the atmosphere susceptible to this increase in climate conditions.

Algae biofuel is a promising energy source and is in the last stages of development. Although the production of biofuels with algae is not yet a cost-effective solution for the replacement of gasoline, adaptation of the advance methods and the economies of scale can change it for some markets in the future.

KEYWORDS: Climate Change, Global warming. Green house effect, Carbon dioxide, Consequences

Introduction

Climate

Climate is the long term behaviour of the weather, Its description includes the following parameters.

1. Averages of temperature and rainfall.
2. The extremes of the temperature and rainfall and the frequency of their occurrence.
3. The meteorological measurements such as wind velocity, air pressure, solar radiation and cloud cover, etc

The two major determinants of the climate are as follows-

1. ***The angle at which the sun rays strike the earth's surface***

Compared to equator the sun strikes the poles at every shallow angle and the intensity of solar radiation is much less at poles and for this reason the pole are cooler than tropical region.

2. ***The general circulation***

This is determined by ocean currents and global wind system and is responsible for redistribution of the heat. The earth's rotation and topography break up the wind system into different sells to produce the characteristic patterns of prevailing winds.

The general circulation is responsible for weather patterns. It also determines as to which point on the earth would be wet, dry, sunny, warm, cold, cloudy, stormy and calm

Causes of Climate Change

Drastic changes in the climate are driven by the following factors:

1. Small natural changes in earth's orbit around the sun. This kind of change in orbit alters the amount and seasonal distribution of solar energy which the earth receives.
2. The slight variation in the output of the sun.
3. Voleanic eruptions which sends dust clouds high in the atmosphere
4. Atmosphere-ocean interactions.

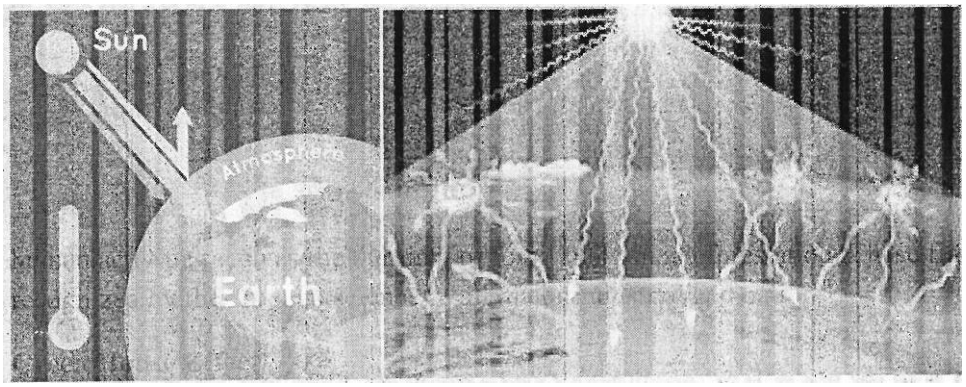
Global warming due to Green house effect

Global warming is the rise in the average temperature of earth's atmosphere and oceans since the late 19th century and its projected continuation, since the early 20th century, Earths mean surface

temperature has increased by about0.8c, with about two-thirds of the increase occurring since 1980. Warming of the climate system is unequivocal, and scientists are more than 90% certain that it is primarily caused by increasing concentration of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation. These findings are recognized by the national science of all major industrialized nations,

Green House Effect

The trapped infta red radiation leads to the warming up of atmosphere inside the green house, This is known as green house effect. A similar situation prevails in atmosphere. The gases such as carbon dioxide trap the infra-red radiation emitted by earth surface and prevent them from escaping the earth and its atmosphere, keeping it warm.



The Earth's temperature balance is maintained by subtle interplay of force. Without them the Earth would be 33.C colder than it is today. Radiation of the sun passes through the atmosphere warms the Earth and reflected back into the space. Naturally occurring "greenhouse" gases in the atmosphere trap some of this radiation, keeping the planet warm enough for life to flourish. This natural greenhouse warming, caused mainly by carbon dioxide and water vapour is spiralling out of control as a result of human activities.

The gases mainly responsible for greenhouse effect are

1. Water Vapor
2. Carbon Dioxide
3. Methane
4. Nitrous oxide

5. Chlorofluorocarbons

Water vapor

The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate, Water vapor increases as the Earth & atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.

Carbon dioxide (CO_2)

A minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric CO concentration by more than a third since the Industrial Revolution began. This is the most important long-lived reason of climate change.

Methane

A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes im landfills, agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere.

Nitrous oxide

A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning

Chlorofluorocarbons (CFCs)

Synthetic compounds entirely of industrial origin used in a number of applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also greenhouse gases.

Effect of Global Warming

This natural greenhouse Warming, caused mainly by carbon dioxide and water vapor is spiraling out of control as a result of human activities. The burning of fossil fuel and deforestation release carbon dioxide into the atmosphere. Concentrations are now 26% higher than in preindustrial times and are rising by 0.5% each year. Other greenhouse gases produced by human activities include methane and nitrous oxide.

If no action is taken to regulate greenhouse gas emission, the Earth could heat up by 0.3 degree C each decade. Over the next century this world means a warning of between 2 degree and 5 degree, the best estimate being about 3 degree C- change unprecedented in the past 10,000 years. Resulting shifts in temperature and rainfall could move climates on several 100 KM towards the poles, seriously disturbing the Ecosystems, Agriculture and food production.

Global warming will accelerate sea level rise, modify ocean circulations and change marine ecosystems with considerable socio-economic consequences.

Algae Biofuel as a potential saviour

Biggest reason for rise of the above greenhouse levels is the constant burning of fossil fuels. This problem can be solved by switching to a cleaner fuel alternative such as wind energy, hydro energy etc. One of the alternatives emerging as a favourable alternative is algae biofuel.

Introduction

Because of the social and political instability of the major oil producing areas, oil prices have been steadily rising, which in turn has hampered the already slow economic growth as consumers are forced to spend more on petroleum from their limited income resources. It is clear from the incidents of the past few years that India cannot ignore the potential dangers of the economy, climate and national energy security from increasing dependence on petroleum fuel. Since India imports more than 80 percent of our liquid luel, it is important for our national energy security that we develop long-term domestic sources of transport fuel. The increase in fuel costs and consumption and the lack of natural fuel resources have sought research in alternative forms of fuel over the past decade. Each year, we spend $ 88 billion overseas in exchange for fuel consumption. It is approximately 240 million dollars per day that can be returned to the Indian economy through domestic produced renewable fuels, which can help us deal with major economic

problems. We need to reduce our greenhouse gas emissions and develop sustainable and reliable energy sources to protect and conserve our land, water, air, and soil. Liquid transportation fuels are responsible for nearly one-third of our fossil fuels carbon emission footprint. Status quo is no more alternative for us now and we have to find new. sustainable and domestic alternatives for petroleum fuels.

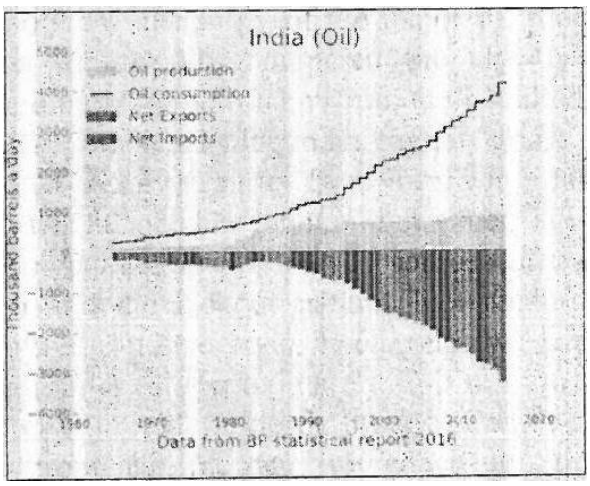


Figure: Oil Data for last 50 years

Modern biofuels have been seen as a greener alternative to petrol and diesel since the 1900s, but there are still many problems in their use and production. Both, the first generation of bio-fuel which is primarily ethanol and is produced by plant crops and the second generation which is derived from plants and animal waste, are a concern for environmentalists as biofuels use fertile land and nutrients which might otherwise have been used for much more needed food production.

Fortunately, the solution to these challenges is algae, which come in the form of the oldest creatures of this earth and can help in solving all these major issues. The third generation of biofuel was produced with this hope that unlike its predecessors, these biofuels are derived from algae and therefore in principle solve the food-versus-fuel dilemma of crop-based bio-fuel. It is also claimed that algae will be used more efficiently than making biofuels from terrestrial plants and this technique will use poor quality land which otherwise would not have been able to develop any crops.

Many companies and government agencies are funding research to make algae fuel production commercially viable, Millions of dollars have been spent in trying to get a miracle from algae to

develop new fuel. Most of the money have been used to refine the engineering process, because of which it can grow the algae crop at the speed of light and oil can be extracted and refined as fuel. The solution for optimization is primarily seen as non-biological technology; however the species selection and development status are also accepted as important factors.

Algae

Algae are small biological plants that use photosynthesis to convert CO, into the sunlight, including some nutrients and rich chemicals containing nitrogen and phosphorus. These algae species are mainly Umcellular or Diatom microalgae that produce high carbohydrate compositions suitable for ethanol production, high lipid structures suitable for biodiesel production and high hydrocarbon compositions suitable for making renewable distillates. That's why billions of dollars are being invested in the research and development of algae-based technologies

Soon algae fuel will start replacing petroleum fuel in our tank. In fact, large quantities of petroleum will be extracted from algae that have been produced millions of years ago. Now we need to replace this "old algae" with "new algae crop".

Algae can grow faster than any other plant and so far more than 100000 algae freshwater and saltwater water species have been discovered and are constantly being searched. Algae can produce. 60 times more oil por unit area than conventional crops such as palms, soybeans, rapeseed or jetrobas.

Almost 1000 algae species have been studied, showing the possibility of biofuel production Optimal selection of algal species for biofuel production is based on the ability to maintain the enlture and increase the species growth rate, biomass specific material of protein, carbohydrate and lipid, and overall supporting photosynthesis environment.

Algae can also be grown using wastewater for the cultivation of algae crops. By using wastewater such as municipal waste or sewage and industrial runoffs, algae production can be increased using their nutrients and also help in the treatment and purification of wastewater.

Table 1-Chemical Composition of Algae Expressed on A Day Matter Basis(%)

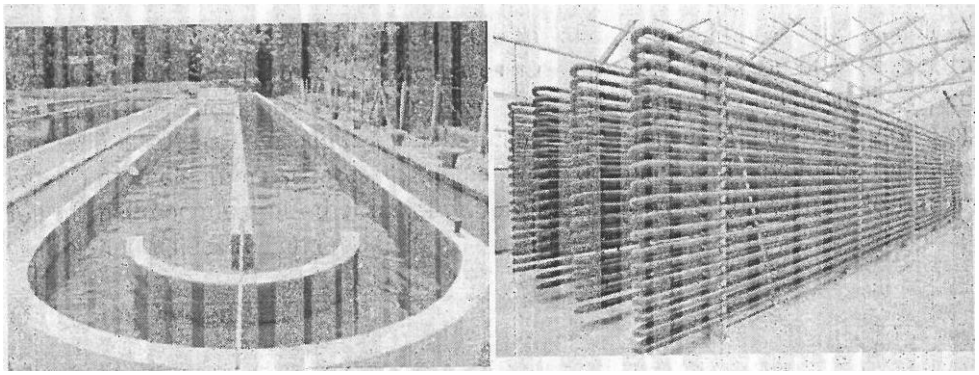
Strain	Protein	Carbohydrates	Liprds	Nucleic acid
Scenedesrnus obliquus	50-56	10-17	12-14	3-6
Scenedesrnus quardricauda	47	-	19	-
Scenedesmusdimorphus	8-18	21-52	16-40	-
Chlamydomonasrheinhardii	48	17	21	
Chlorella vulgaris	51-58	12-17	14-22	4-5
Chlorella pyrenoidosa	57	26	2	-
Spirogyra sp.	6-20	33-64	11-21	-
Dunalicllabioculata	49	4	8	-
Dunaliellasalina	57	32	6	-
Euglena gracilis	39-61	14-18	14-20	-
Prymnesitumparvum	28-45	25-33	22-38	1-2
Tetraselmismaculata	52	45	3	-
Porphyridiumcruentum	28-39	40-57	9-14	-

Algae Cultivation

Micro-organisms are cultivated using rich CO, on land in large ponds or in enclosed Photo-bioreactors. CO, can be obtained as flue gases from power plants or other fossil fuels from combustion and biological processes. In these way algae cultivation can help to recycle this specific greenhouse gas and algal biomass can help reduce greenhouse gas emissions if converted into biofuels. In most cases, algae plants are designed and developed for the maximum production of fuel, chemical or other industrial products. However, the actual design depends on plants location and its desired end product.

1. Open pond system

The open pond system is one of the easiest ways to cultivate algae with high oil content. In this method, algae are grown in open ponds in very hot and sunny environments. Although this is the simplest form of algae production, there are some major deficiencies in it. Open systems uses a monoculture which is very weak for viral infections. To increase algae production using this method, the temperature of the water needs to be controlled.



2. Closed-loop system/Photobioreactors

The closed-loop system is designed to produce algae more quickly and efficiently than the open pond system. In this method, algae are placed in clear plastic bags or borosilicate glass rubes, known as Photo bioreactors, so that they can be exposed to sunlight. These bags are protected from external elements through stacking and covering. Cleat plastic bags provide the adequate surface for sunlight to increase algae production rate.

Within these tubes, algae can be grown at the maximum level, even to the point where they can be harvested every day. Unlike the open pond method, this method prevents viral contamination. It can even provide high-level control, however, running Photo bioreactors is more expensive and difficult than using the open pond system.

Algal fuel

Algal biofuels are an alternative to fossil fuels, which are produced by specific algae species. Lipid (oil) portion of algae biomass can be extracted and converted into biodiesel by the same process

used for any other mineral oil through a hydrocracking refinery process which breaks the molecules in small hydrocarbon chains used in diesel engines

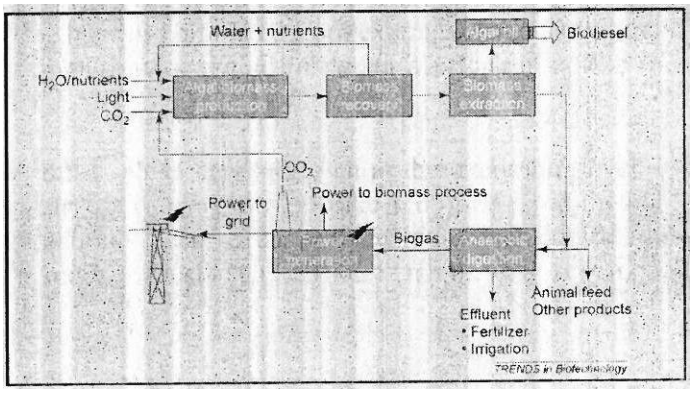
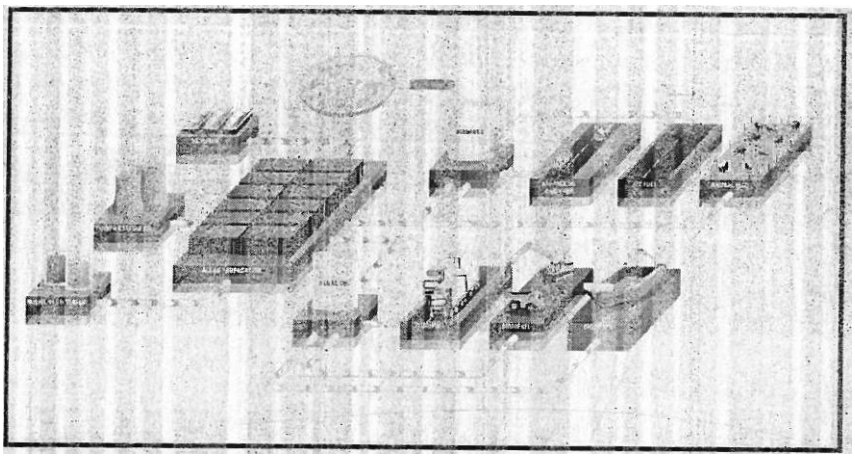


Figure: Algae biofuel production scheme

Green waste residue from algae oil extraction can be used for the production of Butanol by using solar-powered biorefinery. The energy density in this fuel is found to be 10% less than gastiline, but more than methanol or ethanol. Bio-gasoline produced from algae biomass can be used in internal combustion engines. The main component of natural gas Methane can be produced from algae using many methods such as pyrolysis, gasification or anaerobic digestion.



Advantages of Algae Fuel

Algac fuels have emerged as one of the most pronusing long-term and sustainable sources for the production of biomass, oils and their co-products. The biggest benefit of algae is that it is environment-friendly. The other benefits are as follows:

- Algae grow very fast and can double their number every few hours
- Algae can produce biofuel, more than 2000-5000 gallons per year per aere
- Algae consume CO, and can use emissions of power plants and other facilities
- Algae do not compete with agriculture and can be cultivated on land that is not used for other crops or even on seawater
- Algae grow in waste nutrient water such as sewage, auimal waste, and industrial pollution and clean these wastes
- Algac biomass can be dried and "pelletized" and used as a fuel or energy source
- Algae use photosynthesis for the production of carliohydrate and oxygen, making natural
- biomass oil products. Algae fuels are biodegradable and non-toxic because they do not contain sulphur.
- Algae produce CO, on burning them, but the same CO, is also absorbed by new growing algae.

Challenges with Algae

The biggest problem with the third generation of biofuels has been to increase their production cate very fast so that the small culture flask can increase the size of algae to thousands of cubic tmeters in size.

In larger algae cultures, culture and cutting processes need to increase the biomass density of algae to make the production economically viable but the desired growth rate is not being schieved because organisms shade light from each other. This means that they do not get the sufficient sunlight required for photosynthesis that is necessary for biofuels to be sufficient enough and to produce essential carbon-rich compounds.

We do not even realize how algae respond to its environment. In the endeavour of higher production rate, we are genetically modifying the species as a solution to the underlying biological inefficiency but the effect of tampering with those factors which are fundamental to life on Earth can cause the risk of producing unstable harmful algal species that can destroy the fishery and affect the drinking water supply

References:

1. IPCC Fifth Assessment Report, 2014 United States Global Change Research Program, Global Climate Change Impacts in the United States, Cambridge University Press, 2009
2. Naomi Oreskes, The Scientific Consensus on Climate Change. Science 3 December 2004; Vol. 306 no. 5702 p. 1686 DOI: 10.1126/science. 1103618
3. Mike Lockwood, "Solar Change and Climate an update in the light of the current exceptional solar minimum," Proceedings of the Royal Society A, 2 December 2009, doi 10.1098/rspa.2009.0519;
4. Judith Lean. "Cyceles and trends in solar irradiance and climate," Wiley Interdisciplinary Reviews: Climate Change, vol 1, January/February 2010. 111-122.
5. Global Warming, Articles on Global Warming by Ashley Edwards
6. 'Microalgae Biofixation Processes by Eai Technolie
7. 'Life Cycle Assessment of Biodiesel Production from Microalgae' by Laurent Lardon
8. 'Second Generation Biofuels' by Peer M Scenk
9. 'Algae as a Biodiesel Feedstock' by Ron Putt
10. 'Algae Biofuels' by Stoel Rives