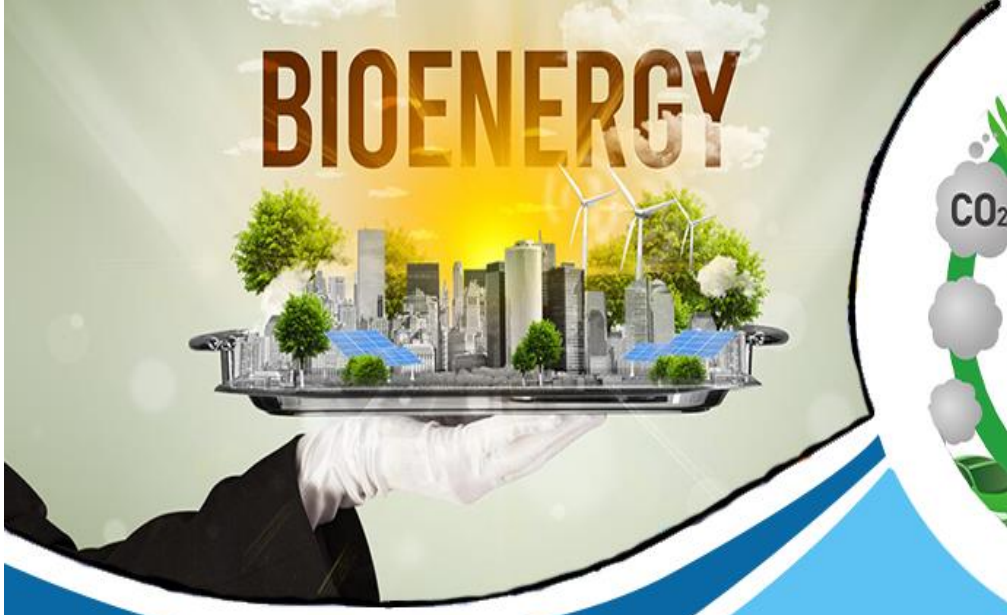

Team Hermetica

Biofuel from Biowaste:

The technology of making fuel out of discarded

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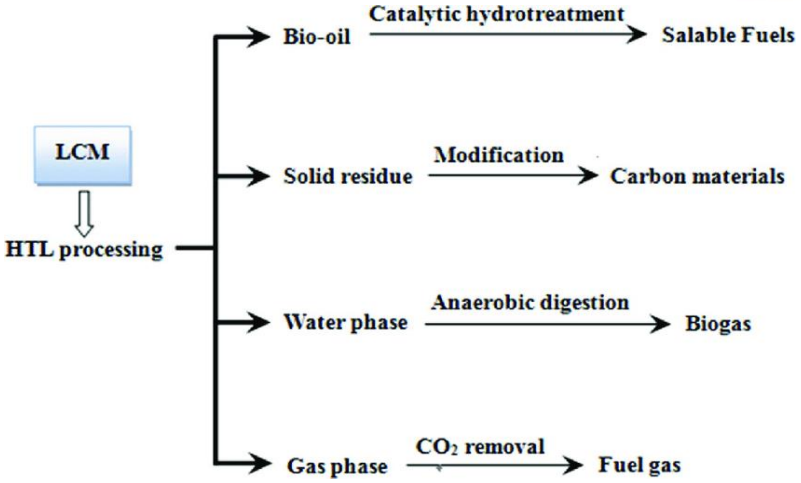
Introduction:-

The conversion of organic wastes into energy by biochemical methods has been increasing dramatically over the past 5 to 10 years. Transformation of high-strength wastewaters, slurries, food wastes, and various other organic wastes into biogas, “green” electricity, renewable natural gas (RNG), and heat is one of the most effective and sustainable methods of redirecting organic waste from landfills. The anaerobic conversion of organic matter to methane and carbon dioxide, many industries are now able to cover their thermal and electrical needs or at least reduce their fossil-fuels dependency, by utilizing such technology to better manage their waste products. About one third of the world’s food–nearly 1.3 billion tons–is lost or wasted, according to the Food and Agriculture Organization of the United Nations. For all industrialized nations, food waste accounts for roughly $680 billion annually. In addition, composting and digestion of food waste are inefficient and slow. Biogas, energy of organic waste captured through anaerobic digestion, can also be burned to produce electricity and heat (cogeneration). Therefore, appropriate methods are required for the management of food waste. Anaerobic digestion can be an alluring option to strengthen the world's energy security by employing food waste to generate biogas while addressing waste management and nutrient recycling. The quantity of wasted food around the globe and its bioenergy potential via anaerobic digestion.

Anaerobic digestion is one of the processes to convert bio-waste to biomethane and to produce commercial amounts of electricity but it takes a lot of time for conversion. In our project we have added the process of hydrothermal liquefaction before anaerobic digestion by using hydrothermal liquefaction before anaerobic digestion, virtually all of the energy is extracted from the biowaste. In hydrothermal liquefaction, the waste is basically pressure cooked to produce a crude bio-oil. That oil can be refined into biofuel.

The remaining biowaste, which is in an aqueous state, is anaerobically digested by microbes within days. The microbes convert the waste into methane, which can be used to produce commercial amounts of electricity and heat.

Description :-



Here two processes are coupled for final product.

- Hydrothermal Liquefaction and Anaerobic Digestion.

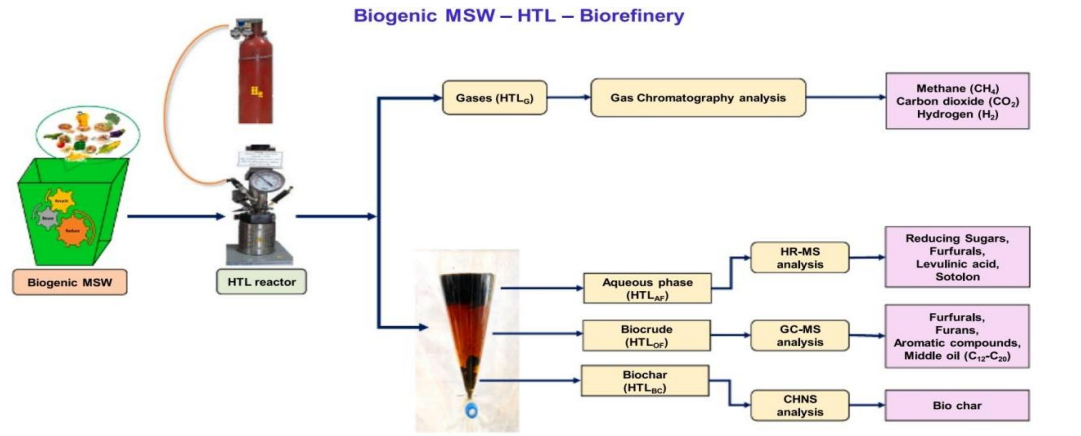
In this project Hydrothermal liquefaction (HTL) is operated at the sub-critical region of water, typical HTL conditions range from 250 to 350 ^{0}C and 5 to 20 MPa for residence times of 10 to 60 min, manifest water catalyzed thermal depolymerization that leads to formation of biocrude along with biochar, biogas and aqueous phase.

The reaction mechanism involved during HTL is complex, namely

- Depolymerization of the feedstock components (carbohydrates, proteins, and lipids),
- Decomposition of monomers (glucose, amino acids, and fatty acids) to reactive fragments by bond cleavage, dehydration, decarboxylation and deamination, and
- Aggregation of the reactive fragments .

The major advantage of HTL is its flexibility to use wet biomass as feedstock and utilizes only 10–15% of the energy (from feedstock) accounting for an overall energy recovery efficiency of 85–90% . It can use a wide range of feedstocks namely hard/softwood, sludge, compost, manure, kitchen waste, food waste, plant material, meat processing and dairy industries . The HTL derived biocrude has a unique chemical composition, which is analogous to fossil-based crude oil and it can directly enter into the existing fuel market with little upgradation. In general, biocrude contains a mixture of aliphatic hydrocarbons (saturated and unsaturated), aromatic hydrocarbons, alcohols, phenols, fatty acids, amides, furfurals, aldehydes, ketones, and other organic compounds. The process parameters such as reaction temperature, pressure, solid to liquid ratio, composition of feedstock, and nature of catalyst influence the

process efficiency and product specificity. The HTL derivatives in general have less oxygen, sulphur and moisture content with a maximal carbon share.



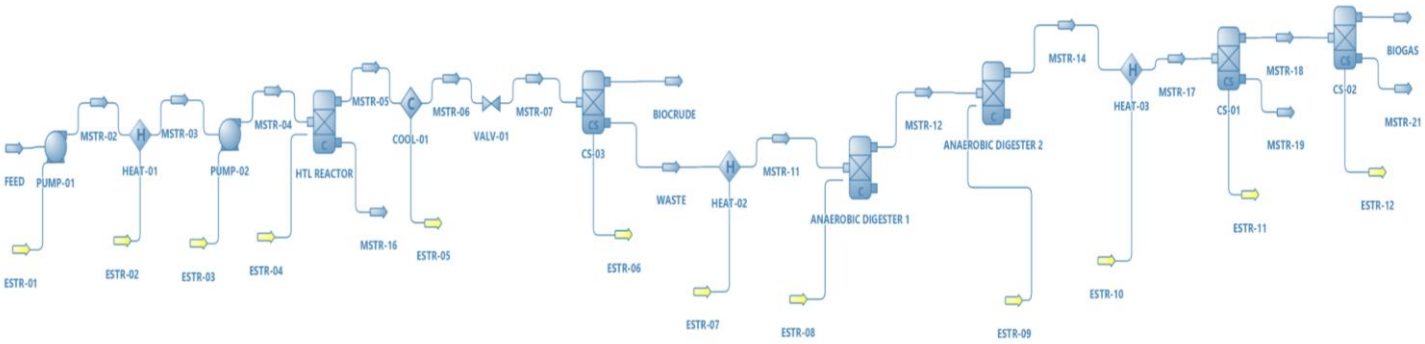
During HTL, the biowaste is converted to water-soluble compounds (aqueous phase) and water insoluble compounds (organic phase). Around 55–60% of the total HTL-liquor is formed as the aqueous fraction.

Here the hydrothermal aqueous phase is converted to biomethane via anaerobic digestion.

Anaerobic digestion (AD) has been widely applied for the conversion of food waste and other readily-biodegradable organic waste streams into biomethane, which is then used for heat and electricity generation. However, in most countries, the lower costs of traditional, fossil-based energy sources have historically challenged the economic feasibility of AD projects as viable renewable energy systems. Furthermore, AD of particulate materials is characterized by slow kinetics, which considerably limits overall biomass conversion and energy yield. Hydrothermal biomass conversion is a promising technology for resource recovery from wet organic waste streams, because the water in the feedstock is utilized as a reaction medium. Hydrothermal processes can produce valuable energy products, while reducing the enthalpy requirement associated with the vaporization of water. In addition to having typical oil yields ranging between 40 to 60% (w/w), HTL also produces a considerable amount of dissolved organic carbon in the form of an aqueous phase (referred to here as “aqueous phase”). The aqueous phase may be composed of monosaccharides, oligosaccharides, fatty acids, amino acids, and the corresponding degradation products of all macromolecules.

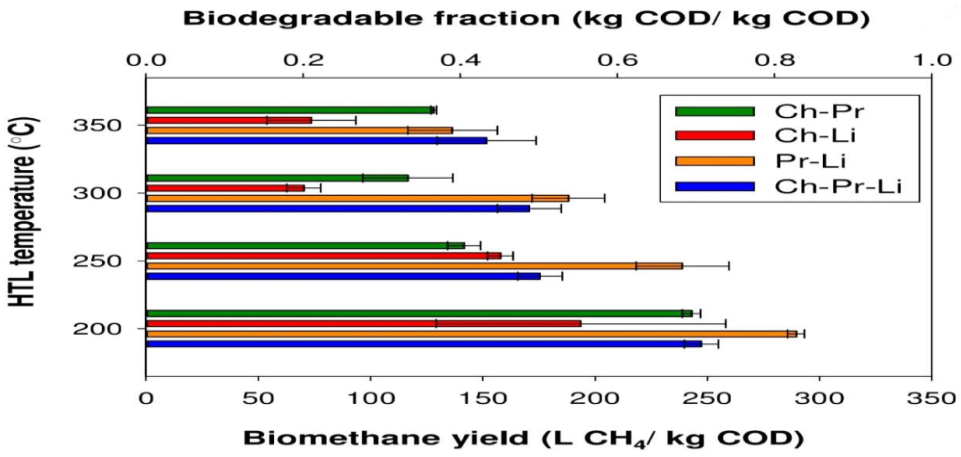
Here in anaerobic digestion, bacteria break down organic matter (aqueous phase of HTL) in the absence of oxygen. Anaerobic digestion for biogas production takes place in a sealed vessel called a reactor, which is designed and constructed in various shapes and sizes specific to the site and feedstock conditions. These reactors contain complex microbial communities that break down (or digest) the waste and produce resultant biogas and digestate (the solid and liquid material end-products of the AD process) which is discharged from the digester.

The biogas produced is used for the production of electricity.



- **Conversion of biowaste to biocrude and biogas.**

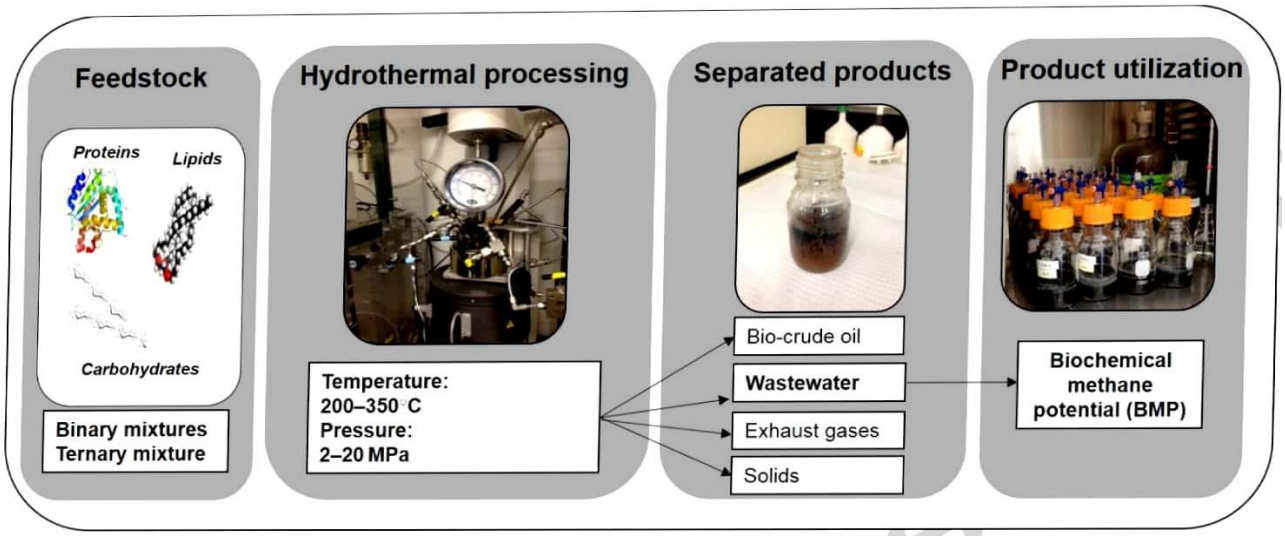
In this flowsheet, the whole conversion process is shown with different reactors, exchangers and separators before being processed to biocrude and biogas, the biomass passes through different units and after these processes the biocrude is converted to biofuel and biogas is converted to electricity.



This chart shows the biomethane yield depending on different combinations of carbohydrates (Ch), protein (Pr) and lipids (Li).

Effect of temperature and pressure:

The efficiency of our plant is maximum at ideal temperature and it falls with increase and decrease in temperature. The two factors of utmost significance, which have effect on biogas production, are the sublayer temperature and the process temperature of anaerobic digester. These temperatures decide the inhibition/stimulation of a particular microorganism kind (for instance, an optimal temperature for the survival of thermophilic and mesophilic bacteria are 55°C and 35°C, respectively). This, in turn, renders various organic material biodegradability levels that influence the biogas production amount



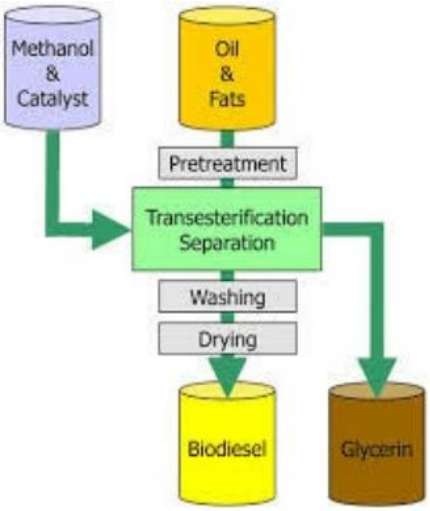
and quality, attaining the maximum at 55°C. Excluding temperature, 'the aqueous phase', organic matter content that undergoes microbial action is of greater significance in deciding the biogas production quantity and quality. The sublayer pH and C/N ratio allows us to determine the organic matter content. Maximum biogas production is possible with the maintenance of ideal values for pH, C/N ratio, pressure and temperature, in accord with the microbial activity.

PAST IDEAS

Transesterification:

Biofuel is produced from oils or fats using transesterification and is the most common biofuel in Europe. It can be used as a fuel for vehicles in its pure form (B100), but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles.

The major drawback of this process is that it takes Longer Reaction Time to complete the whole process.

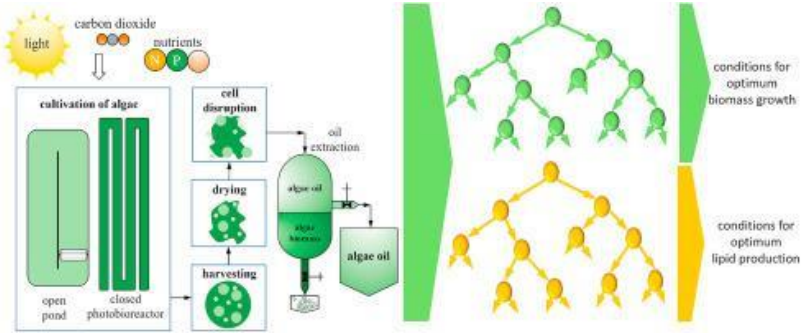


Lipid and Algae Biomass:

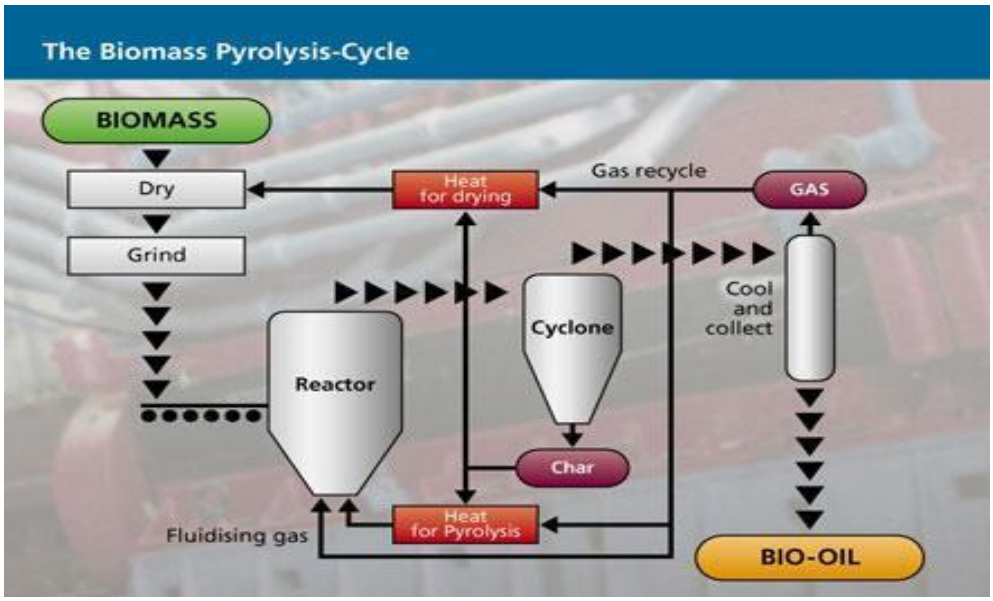
A lot of research is being carried out for developing micro algal biodiesel technology by performing bioprospecting of high-lipid-containing strains as well as by inducing higher lipid production by various physiological and genetic strain improvement methods. Therefore, lipid extraction is an extremely important process for the production of micro algal biodiesel. There are also other methods such as algal biorefinery for the production of multiple algal products and thermochemical technology for the production of bio crude. As fuels are a commodity product, extraction of lipids from algae is technically and economically viable even in integrated concepts. When produced in huge quantities, extraction of lipid for biodiesel production from strains containing even around 10% lipid content will be feasible.

The main drawback of this process is it occurs occasionally so this process couldn’t be performed all the time. And it is time reliable.

Pyrolysis Process :



Biomass pyrolysis is the thermal decomposition of biomass occurring in the absence of oxygen. It is a fundamental chemical reaction that is the precursor of both the combustion and gasification processes. The product of biomass pyrolysis includes methane, Hydrogen, carbon monoxide and carbon dioxide. Pyrolysis can be performed at relatively small scale and at remote locations which enhance the energy density of biomass resources and reduce transport and handling costs. Pyrolysis offers a flexible and attractive way of converting solid biomass into an easily stored and transported liquid, which can be successfully used for the production of heat, power and chemicals



The major disadvantage of the Pyrolysis process is that it is very dependent on the moisture content of feedstock, which should be around 10%. At high moisture content a high amount of water is produced and at low moisture content there is risk that the process only produces dust instead of oil.

MICROEMULSION

The micro emulsion is defined as thermodynamically stable, isotropic liquid mixtures of oil, water and surfactant (compounds that lower the surface tension of a liquid, the interfacial tension between two liquids).; this process will solve the problem in viscosity and some other atomization properties of oil. Generally the alcohol used to increase the volatile property of oil, it reduces the smoke. Alkyl nitrate will be the cetane number improver. The microemulsion process also used to get a good spry property when injected into the engine by nozzle. If microemulsified diesel used in diesel engine,

IT'S disadvantages are incomplete combustion and carbon deposit.

Impact and Large scale applications :-

- The aqueous fraction of hydrothermal liquefaction, which is used to process or purify can be used to produce the bio methane by anaerobic digestion. This bio methane is helpful in producing commercial amounts of electricity which can be used in different fields.

- Depending on the processing conditions the biofuel can be processed for heavy engines including marine and rail or can be upgraded to transportation fuels, such as diesel, gasoline or jet fuels.

- Bioproduct or solid, liquid residue is rich in nutrients and can be used as fertilizer, soil conditioning or animal feed. Hence biomass production continues to have high priority in alternative energy research.

- Biofuel based lubricants are becoming of increasing interest to both major producers and the consumers because of their greater biodegradability, lesser toxicity, non- bio accumulative nature and good physical properties.

- As we are using the bio waste so it will be helpful in reducing the pollution and reducing the carbon footprints.

- Biofuel is known to be environment friendly and it can also help to clean up oil spills and grease. It has been tested to work as a potential cleaning agent for areas where crude oils contaminate the water.

- In hydrothermal liquefaction wet biomass can be processed into crude bio oil, we don't need to dry the materials.

Advantages :-

1.Short Period Of Time

Due to the addition of hydrothermal liquefaction before anaerobic digestion, the 4-week process gets completed in one week only as the components of aqueous phase are suitable for enzymes in anaerobic digestion.

2. Efficient Fuel

Biofuel is made from renewable resources and relatively less-flammable compared to fossil diesel. It has significantly better lubricating properties. It causes less harmful carbon emission compared to standard diesel. Biofuels can be manufactured from a wide range of materials. The overall cost-benefit of using them is much higher.

3. Cost-Benefit

As of now, biofuels cost the same in the market as gasoline does. However, the overall cost-benefit of using them is much higher. They are cleaner fuels, which means they produce fewer emissions on burning. With the increased demand for biofuels, they have the potential of becoming cheaper in the future as well.

4. Reduce Greenhouse Gases

Studies suggest that biofuels reduce greenhouse gases up to 65 percent. Fossil fuels, when burnt, produce large amounts of greenhouse gases i.e., carbon dioxide in the atmosphere. These greenhouse gases trap sunlight and cause the planet to warm. Besides, the burning of coal and oil increases the temperature and causes global warming. To reduce the impact of greenhouse gases, people around the world are using biofuels.

5.Economic Security

Not every country has large reserves of crude oil. For them, having to import the oil puts a huge dent in the economy. If more people start shifting towards biofuels, a country can reduce its dependence on fossil fuels.

6. Reduce Dependence on Foreign Oil

While locally grown crops have reduced the nation’s dependence on fossil fuels, many experts believe that it will take a long time to solve our energy needs. As prices of crude oil are touching sky high, we need some more alternative energy solutions to reduce our dependence on fossil fuels.

7. Lower Levels of Pollution

Since biofuels can be made from renewable resources, they cause less pollution to the planet. However, that is not the only reason why the use of biofuels is being encouraged. Besides, biofuels are biodegradable that reduces the possibility of soil contamination and contamination of underground water during transportation, storage or use.

8. Commercial amounts of electricity

When done on large scale, the biomethane produced after anaerobic digestion can be used to produce commercial amounts of electricity and heat.

Disadvantages :-

1.Corrosion

Corrosion in the subcritical water environment is a critical issue. In particular acidic and oxidizing conditions can cause rapid corrosion, and this can be even more severe at subcritical conditions than at supercritical conditions, due to the relatively dense and polar character of subcritical water. Main forms of corrosion are pitting corrosion, general corrosion, intercrystalline corrosion and stress corrosion cracking. So we need to keep proper care of reactor.

2.Salt Disposition

Salt deposition may occur in the reactor if the amount of minerals in the feedstock is very high. This could lead to reactor clogging.

3. Weather Problem

Biofuel is less suitable for use in low temperatures. It is more likely to attract moisture than fossil diesel, which creates problems in cold weather. It also increases microbial growth in the engine that clogs the engine filters.

4. High Power Requirement

Elevated power is required to heat a slurry with high water content to reaction temperatures . The net amount of power required can be reduced by heat integration between inlet and outlet streams, but an external energy source is always necessary.

Future Prospects. :-

- In this present time almost all the world is dependent on the United states, brazil and European countries for fuels(diesel, petroleum) and the use and demand and cost of these fuels will double or triple in the upcoming time. So the biofuels obtained from bio waste will be more economical and easily accessible to people and also helps the countries to be self independent in view of fuels production.
- In the current situation most electricity is generated from water . The major product of this project which is methane be used to generate the electricity thus reducing the dependency of electricity generation on water. Thus helps to reduce the water crisis and this water can be used in other purposes such as agriculture.
- As the world wide population is continuously increasing, demand for food and thus consequently production of waste food is also increasing . A survey shows that wastage in food has increased by 50% since 1975 in the globe. But with the help of this project we can utilize all this waste product in production of biofuel, electricity etc. which will be helpful in keeping our environment clean.
- As in this project we are using the bio waste so it will be helpful in reducing the pollution and reducing the carbon footprints and danger of rising global warming in future.