

FACTFILE: GCE ENVIRONMENTAL TECHNOLOGY

BIOFUELS



Biofuels

Learning outcomes

Students should be able to:

- demonstrate an understanding of the basic steps in the industrial production of bioethanol from biomass, including chemical equations for fermentation and esterification;
- describe the main stages in the manufacture of biodiesel from vegetable oils using methanol and sodium hydroxide;
- explain the advantages and disadvantages of using biodiesel as a substitute fuel; and
- understand why the increasing global production of biofuels is contentious, taking into account the following issues:
 - environmental impact of farming energy crops intensively, for example palm oil;
 - designation of land away from food production into cash energy crops, particularly in the developing world;
 - destruction of natural habitats.

Course Content

Biofuel is a term used to describe a wide range of energy sources derived from organic matter. In the field of transport there are two main biofuel substitutes for traditional fuels such as petrol and diesel. These are;

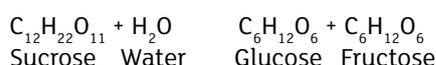
- Bioethanol, and
- Biodiesel.

Bioethanol is made by fermenting sugars from sugar cane, wheat and other plants while biodiesel is made from rapeseed oil and other plant oils.

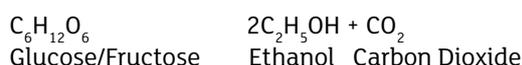
Production of bioethanol

Bioethanol can be produced by a sugar fermentation process in a variety of different techniques;

1. The plant feedstock is first crushed to release starch.
2. The material is heated; water and enzymes such as yeast or an acidic solution are added to assist fermentation into glucose and fructose.



3. The glucose and fructose then react further with the yeast to produce ethanol and carbon dioxide.



The bioethanol contains significant amounts of water which is then removed by fractional distillation. Ethanol has a lower boiling point than water (78.30C) and so turns into the vapour state before water and can be condensed and separated.

The main source of sugar required to produce bioethanol is gained from crops such as corn, maize, wheat, waste straw, sawdust and willow trees which are grown specifically for this purpose. Bioethanol can be blended with petrol and used in standard vehicles. Environmental benefits derived



from the use of bioethanol are;

- reduction in the use of fossil fuels;
- the water produced in the production process does not pose a pollution risk; and
- the carbon dioxide produced is equal to the amount taken from the atmosphere as the plant material grows.

Production of biodiesel

Biodiesel is produced in a process called transesterification. Essentially glycerine is extracted from the oil feedstock using an alcohol such as methanol with sodium hydroxide as a catalyst. This produces methyl esters (which is the chemical name for biodiesel) and glycerine. Typical



oils which can be used for production purposes are soybean, rapeseed, palm, corn or used vegetable oil.

The process can be summarised in the following word equation;

Oil Feedstock + Methanol + Sodium Hydroxide
 → Biodiesel + Glycerine

After the reaction process has taken place the biodiesel and glycerine products settle out as the glycerine is heavier. It can be isolated and used in other industries such as pharmaceuticals and cosmetics.

Some advantages of using biodiesel as a substitute fuel are:

- it can be regarded as carbon neutral releasing as much carbon dioxide as taken in by the plant stock when growing although the use of machinery and fertilisers (which will use energy in their production) on the crop may reduce this benefit: Research suggests they reduce carbon emissions by 50-60%;
- biodiesel is biodegradable and completely non-toxic so spills of the fluid will not have such a detrimental effect as traditional diesel;
- it can be used in traditional diesel engines;
- government tax incentives make the fuel economically valid; and
- biodiesel emits less particulate pollution than traditional diesel.

Some disadvantages of using biodiesel are:

- it can lead to lower fuel economy in the vehicle;
- power available in the vehicle may be reduced;
- it is considered not suitable for use in low temperatures; and
- it may have a detrimental effect on engine durability.

The global debate surrounding the production of biofuels

There is a growing tide of concern around the increased production of biofuels and the impact this has in certain areas. Biofuels take a large expanse of area to grow. This means that land has to be cleared to allow for this. This can result in rainforests and other high biomass lands being cleared on a mass scale so increasing the amount of greenhouse gas emitted.



This level of deforestation causes loss of natural habitat for animals and indigenous people who live there. This is possible to happen in lower income countries such as parts of South America and South Eastern Asia leading to exploitation of human rights in the areas affected.

Farmers in developing countries may be tempted to move away from using land for food crop production to a cash crop such as biofuel style plants so reducing food supplies which in turn leads to an increase in food prices in what is possibly a poor economy,

Soil erosion can increase in areas where the natural balance of plants has been disturbed to provide one crop only.

Significant amounts of water are used on the crop as it grows which can lead to water shortages.

Intensive farming of crops for use in biofuel production can be labour intensive, use considerable amounts of energy and in doing so release greenhouse gases into the atmosphere.

Pupil Activity

Make a presentation outlining the advantages and disadvantages of using biofuels as a substitute for traditional fossil fuels such as diesel and petrol. In your presentation suggest what the alternatives to using biofuels might

