Biofuels

By Adam Collett – 10th September 2018

In a world where fossil fuels are being used at an exponential rate, finding alternative sources of energy is fast becoming a top priority on every country's agenda. Global energy consumption soared to a massive 11.4 billion tonnes of oil equivalent in 1997, 80% of which came from fossil fuels and 60% of which was used for transport. (International Energy Agency, 2008)

Given the current and future energy scenarios it is of no surprise that research into renewable energy is now booming, with a vast range of different sources and technologies available. In terms of transport fuel, biofuels derived from plants are heading the way as a promising substitute, largely due to their perceived renewable nature and reduced greenhouse gas emissions; however their biggest selling point is that they have been proven to work with little or even no adaptations to existing engines and are relatively simple to produce on industrial or micro-scale. This article aims to give an overview of biofuels, including types, chemistry and the current global situation.

What are Biofuels?

Biofuels are defined as organic fuels derived from biomass. Commonly used as fossil fuel substitutes they take the form of solid, liquid or gas. (Renewable Fuels Agency, 2009) Biofuels can be categorised into three main types: first, second and third generation. Made from agricultural crops such as rape, sunflower, sugar, wheat and animal fats they currently make up the vast majority of transport biofuels on the global market in the form of Biodiesel (a diesel substitute) and Bioethanol (a petrol substitute). These two forms account for approximately 2.5% of all diesel and petrol sold in the UK as part of the Renewable Transport Fuels Obligation introduced in 2004. (Biofuels Research Advisory Council, 2006)

The second generation of biofuels, currently in development stages are due to become commercially available in 3-5 years time. (Kivner, 2006) Developed in response to ethical concerns over first generation fuels, new technology will use non-food crops, grown on marginal land and use entire plants to create fuel leaving no waste. Crops currently undergoing trials for this include Willow (salix) and Jatropha (jatropha curcas) and are mainly taking place in developing countries. (Biofuels Technology Platform, 2008)

Third generation fuels, still being developed will be derived from algae. (Environment and Energy, 2008) Many countries have vast amounts of sea available to cultivate algae, meaning it could resolve the problems of land needed to grow crops. If cultivated in large enough quantities, algae could produce a

much greater volume of oil for fuel than conventional fuel crops without impacting on agricultural land. (Oilgae, 2006)

What is Biodiesel?

Probably the most commonly discussed and used first generation biofuel is biodiesel. Derived from vegetable oil or animal fats, which are subject to a chemical reaction to create a fuel, it is mainly used as a diesel substitute. (Knothe et al, 2004)

A variety of feedstocks are used to make biodiesel, the most common being lipid fats in the form of vegetable oils from plants such as such as sunflower, rapeseed and palm. It can also be made using animal fats usually in the form of tallow that are waste fats from the meat industry. Although most vegetable oils for biodiesel are grown specifically for this purpose, waste oils such as used cooking oil (UCO) can also be utilised to make biodiesel. (Knothe et al.2004)

Although some vehicles can run on 100% biodiesel alone, it is commonly blended with petro-chemical diesel in varying ratios. In line with the international requirements of the Kyoto protocol to reduce CO2 emissions, the majority of countries have opted to blend it at a ratio of between 5 and 20% to enable most vehicles to run successfully on it without modifications to the engines. (Knothe et al, 2004)

Early Development of Vegetable Derived Fuels

Using plant derived oils, as a transport fuel is not a new technology. In fact the diesel engine invented in 1900 by Rudolf Diesel (1858-1913) was originally designed to run on peanut oil. (Dieselveg, 2008) Diesel saw great environmental and agricultural advantages of running vehicles on vegetable oil. He envisaged it as a self-sustaining way for countries to produce their own fuel and reduce reliance on international petroleum supplies and campaigned tirelessly to promote his ideas. He is most famously quoted as saying in 1912 that

The use of vegetable oils for engine fuels may today seem insignificant but such oils may become, in the course of time, as important as petroleum and the coal-tar products of the present time. (Diesel, 1912)

Unfortunately, Diesel died before his vision became a reality and the true sustainability of his invention was almost forgotten as the petroleum industry adapted his engine to run on a cheaper by-product of petrol, which they named ‘diesel.’

Limited research into plant-derived fuels continued after Diesel’s death despite an almost total dependence on petrodiesel worldwide. For example vegetable oils were used as fuel in Britain during World War II but only in emergencies when

petrodiesel supplies were limited. After the war, cheap seemingly endless amounts of petroleum oil were available, putting a stop to nearly all use of and research into vegetable oils. (Pahl, 2005) It was not until approximately 30 years later, when concerns over both oil reserves and the impact of burning fossil fuels on the environment came to light, that Diesel's work was resumed.

Progress in Biofuels

The countries of Europe were amongst the first signatories of the Kyoto Protocol to instigate Biofuels as a renewable fuel. (Pahl, 2005) Mainly focused on Biodiesel production and consumption, I 2005, Europe was the global leader in Biodiesel production with an estimated capacity of 4.4 million metric tonnes. (Pahl, 2005)

Although there has been encouraging progress in mainland Europe, the UK has been extremely slow to embrace biofuels. (Department for Transport, 2003) Progress has been mainly stimulated by a number of government policies introduced since 2002. (ECOTEC, 2002) In order to fulfil its commitment to the Kyoto Protocol, the UK introduced its own Renewable Transport Fuels Obligation (RTFO) in April 2004, which requires suppliers of fossil fuels to ensure that a specified percentage of road fuels they supply are made up of renewable fuels. (Renewable Fuels Agency, 2009) Currently, the majority of the 2% obligation is met through domestic feedstocks. Together with the 20% tax break on biofuels introduced as part of the EU Directive on Energy Taxation, the RTFO has significantly increased sales and use of biofuels. However, as in mainland Europe there remains concern as to whether the target of 5.75% of renewable fuels by 2010 can continue to be met through domestic feedstocks. (Turley et al., 2003) A report commissioned by the Department for Environment, Food and Rural Affairs (DEFRA) in 2003 estimated that the volume of biodiesel and bioethanol needed to meet this target would rise from 0.8 million tonnes in 2005 to 2.5 million tonnes in 2010, making feedstock production extremely challenging with the introduction of new materials such as waste products being of increased importance.

The Future

As the world continues to deplete its precious reserves of oil, and the renewable transport fuel targets continue to increase, there is more and more demand for biofuels. As these demands simply cannot be met through local sources more and more countries are looking to import oil and ethanol in vast quantities leading to concerns over the amount of land needed to meet global demand as well as causing a direct conflict with food production. In a world where vast numbers of people starve to death every day, this could definitely be construed as hypocritical. (Stratton, 2008) Research carried out by the Food and Agriculture Organisation of the United Nations in 2008 found that a large proportion of crops for biofuels are being grown in developing countries, funded by the developed, often on unsuitable land, casting some doubt over their true

environmental benefit. (Food and Agriculture Organisation of the United Nations, 2008)

With this information in mind, it is easy to see how people could perceive growing fuel as a quick fix with potential to do more harm than good. However, whatever the flaws, biofuels do have some promising potential, if produced, managed and used in the right way. For instance, there is huge potential for producing fuel from products which would otherwise be waste and destined for landfill or incineration. Possibilities include car tyres, waste food, animal fats, and used cooking oil (UCO). Although it is obvious that the quantities of waste products is not sufficient to meet the demands of even a fraction of the global population, it is still a resource, which if used in the right way, can play its part in the solution.

So biofuels can be controversial but they must not be dismissed, simply because they are not the sole solution. The answer to meeting the demands of transport fuel and weaning ourselves off the fossil fuel we have become so addicted to is never going to be clear cut. To be truly successful it requires the use of every single resource to be managed in a way, which will bring the most benefit to everyone.

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