

## Fuel for Thought

There are an incredibly large number of changes inevitable with regard to the motor car as a consequence of depletion of oil resources, Government Legislation, public opinion and continuing pressure from green organisations. If road tolls are implemented, employers may recruit employees who are located shorter distances from the place of work. This would mean a dramatic change in the use of the motor car especially if cars were to be prohibited from city centres. It would seem a safe assumption that future fuels will have to be based on alternative sources.

Chemical Engineers are constantly developing better fuels for automobiles. This means producing fuels, which will provide improved performance and economy while reducing harmful emissions. Approximately 40% of unleaded petrol is made up of aromatic hydrocarbons, Not only do these cause high CO, F-IC and NO<sub>x</sub> emissions, but some can cause cancer. The worst offender is benzene which is naturally strictly controlled. Butane is also volatile and is responsible for evaporative emissions leading to ozone formation and photochemical smog. If these components were reduced, the octane quality would have to be replaced from elsewhere. This means, for the immediate future, the use of oxygenates will play a large part in fuel development.

An alternative approach is to tackle the problems presented by fossil fuels and change the fuel used by motor cars.

### METHANOL

Methanol produces several advantages; it burns cleanly in an internal combustion engine, emissions are reduced, its combustion is more complete than that of petrol, it does not release carcinogenic benzene vapour or aromatic hydrocarbons into the air, it has a high octane number, there is a plentiful supply, it is low in cost and is safer and less volatile than petrol. In addition, only small fundamental changes would be required to an engine to allow its use. Methanol can be made from various carbon containing raw materials. In some countries, methanol has been used as part of a mixture with petrol.

However, there is a down side. It is difficult to mix petrol and methanol unless a co-solvent such as tertiary-butyl alcohol is used. This mixture produces approximately 40% less energy than petrol. Furthermore, the mixture is hygroscopic. When the water content reaches about 0.5% the two layers separate leaving a layer of petrol on top of a water / alcohol mixture.

Methanol is corrosive and will eventually eat through conventional petrol tanks, rubber hoses and fuel lines. As well as being toxic, methanol conducts electricity. That means electronic devices on the vehicle would have to be at least well insulated. There would also be concerns in terms of the effects on the safety and health of motor engineers and those involved in handling fuel. Although other pollutants are reduced, levels of methanol (UCHO) have been found in exhaust emissions. Methanol is the first member of the homologous series of aldehydes. It is formed by partial oxidation of methanol and is known to be carcinogenic to humans. Long term exposure can cause blindness.

### MTEE

Methyl tertiary butyl ether mixes well with hydrocarbons in all proportions and does not separate into layers. In consequence, no co-solvent is required. It can be made from methanol and is a high-

octane fuel, which burns cleanly in an internal combustion engine. The solubility of water in ethers is much less than in alcohols so there are no problems with water content and the fuel is not corrosive.

#### HYDROGEN

Hydrogen is plentiful as most of the Earth's surface is covered by water. Hydrogen may therefore be made quite easily. Hydrogen burns with a hot clean flame and as it produces only steam emissions it would not pollute the air. The problem is how to store it. If it were to be stored in steel cylinders at a pressure of say; 135 times atmospheric pressure, up to 99% of the weight would be that of the steel cylinder and only 1% being the hydrogen. Vehicles using hydrogen would carry a lot of extra weight around as well as losing considerable space occupied by the cylinder.

#### METAL HYDRIDES

Hydrogen can be made to react with metals such as iron, nickel, magnesium or palladium to make metal hydrides. These compounds absorb large quantities of hydrogen gas which is released again when the hydride is heated. This hydrogen could be released by the heat from the car's engine as it moves along.

#### ELECTRICITY

Electric vehicles are clean, quiet and cause no exhaust pollutants and neither are they new. As everyone may remember, the majority of electric vehicles for many years were milk floats. The main disadvantage is the time taken to re-charge batteries. This can often take several hours depending upon the battery type. Another problem is the rather poor performance of the vehicle.

Electrical energy charges into the vehicle batteries at a rate of approximately 55J/s. The fuel tank on a petrol engine vehicle can be filled in a few minutes. A typical filling station petrol pump delivers petrol at a rate of approximately 1 litre per sec providing  $34 \times 10^6$  J per litre of energy when burned. The petrol pump therefore replaces the vehicle's energy supply 600000 times faster than the battery charger.

For example, 1 tonne of lead acid batteries only store the same amount of energy as is contained in approximately 3.5 litres of petrol. The capabilities of electric vehicles can be improved by using sodium sulphur batteries which have an energy density of 520kJ/kg – four times the capacity of a lead acid battery.

Although today's electric vehicles have benefited greatly from modern technology, the biggest problem continues to be their limited range. There are prospects for NiMH (nickel metal hydride), nickel sodium chloride and lithium-ion batteries which would be significantly smaller and lighter in size. In particular, the lithium-polymer type uses a sheet of polymer plastic in place of liquid electrolyte.

#### COMPRESSED AIR

Operation is similar to that of a steam engine. It is doubtful whether or not this method would provide a satisfactory solution mainly due to the substantial weight of the air tank. The efficiency is said to be significantly less than an electric vehicle. Additionally, there would be enormous cost in compressing the air which would render the system both uneconomical and impractical.

## FUEL CELL

In a fuel cell oxygen and hydrogen are combined to produce electricity. The system can run continuously as the fuel and oxygen are not sealed within the cell.

Hydrogen is introduced to the cell anode which removes the hydrogen atom electrons hence turning them into positively charged ions. They subsequently pass through an electrolyte to the cathode. Simultaneously, the negatively charged electrons move to the cathode by means of a suitable connection which produces electric current.

A single cell produces very little voltage; however, when produced in stacks increased voltage can be achieved. In a pure hydrogen fuel cell there are no emissions although in a system which extracts its hydrogen from fossil fuel there will be a small amount by-products, the major substance being water.

## HYBRID

There are some variations in hybrid vehicles. Parallel hybrids employ both an electric motor and a petrol engine which can drive the vehicle. Switching between petrol and electricity is carried out depending upon driver demands and conditions. The flywheel hybrid stores electrical energy in its flywheel rotating at an incredibly high RPM which is contained in a vacuum.

After being charged up by the vehicle's petrol powered engine, it can continue rotating for long periods assisting drive and acceleration. The series hybrid uses a conventional internal combustion engine which produces power to drive an electric motor and charge the battery pack. Some incorporate a system to use the heat produced during braking to re-charge the batteries

## GAS

There are some vehicle manufacturers who offer dual fuel' (petrol & LPU) vehicles as an option. Alternatively, retrofit LPG kits are still predominant. LPG has been used as an alternative fuel source for a number of years. LPG has attained recognition predominantly within Europe and the U.S.A. Emissions from an LPG powered engine, when in comparison to petrol engines, results in a dramatic reduction in CO, HC, CO<sub>2</sub> and NO<sub>x</sub> emissions.

## THE FUTURE

If an 'ideal' power source were achieved tomorrow, eliminating the need for exhaust pipes, this would not necessarily reduce the number of vehicles on our roads. There would still be "three car families", gridlock and congestion within our Cities. There are also those who would prefer to ban cars altogether and return to the days of the horse. Are there too many cars on our roads? The land area of the UK is approximately 93000 square miles. There are over 22 million road vehicles in the UK. Taking an average vehicle size of 8 feet wide by 20 feet long, it follows that it would be possible to park 1 74240 vehicles within 1 square mile. This equates to the fact that collectively, UK vehicle population would actually occupy 0.14% of the precious countryside referred to by anti-car campaigners!

In the meanwhile, it is important to use the valuable reserves of crude oil economically. The internal combustion engine has been a valuable source of business for the last 100 years or so for those involved in vehicle sales, repair, servicing, component and accessory supply.

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