

Prepared by Bio Engine Technology Ltd for the UK Government Department for Transport and Office for Zero Emission Vehicles.



Bio Engine Technology Ltd



Dews Coaches, St Ives, Cambs

Ending the sale of new diesel buses

What is required of any alternative form of power?

- 1 The replacement for the diesel engine must be competitively priced. The alternative fuel must also be competitively priced. The margins in the bus hire business do not permit the extravagant operation of non-competitive vehicles. In the absence of suitable replacements, operators will continue to use their existing fleets of fossil fuel burning vehicles in a Cuban-style of transportation. It is remarkable how long a bus or coach can be induced to operate where the alternative is not competitive and requires considerable capital expenditure.
- 2 Commercial vehicles must operate, preferably around the clock, with the minimum of 'down time'.
- 3 Refuelling should be accessible, swift, convenient and without hazard and readily available within the operational area of the coach.
- 4 The fuel should release the minimum, preferably nil, CO₂ or harmful particulates. Its manufacture should not involve CO₂ or harmful particulates.
- 5 All the above have to be seen in the light of financial viability.

Bearing the foregoing in mind, the current forms of alternative propulsion do not attract the bus and coach operators as financially viable.

- 1 **Electricity.** Operational time on a full charge is increasing but, due to the downtime time required to recharge, there will be no opportunity for a vehicle operate around the clock.
- 2 The weight of batteries cannot be substantially reduced, reducing the payload of a commercial vehicle or the passenger capacity of a bus (EV) and thus making them unviable.
- 3 Recharging of a bus on a route will require the provision of a second bus, and crew, to maintain a service.
- 4 Coaches used on long distance European continental journeys will have to be recharged frequently, delaying arrival times and inconveniencing passengers.
- 5 Additional vehicular requirements, such as lighting and passenger cabin heating will consume battery power and reduce mileage.
- 6 Provision of electricity is not CO₂ free. Depending on its source, from wind to natural gas and nuclear, the CO₂ and particulate contents are variable.
- 7 **Hydrogen.** Depending on capital cost, could be used for a fleet operating from one or more depots equipped with high pressure hydrogen storage and dispensing facilities.
- 8 The production and storage of hydrogen involves various safety aspects and a great deal of energy (25-30% of the energy stored) that must be taken into account when calculating the effective use of the gas as a fuel.
- 9 Even using hydrogen in its liquid state, the size and weight of its containing cylinders is several times that of tanks used to contain diesel fuel.
- 10 Recharging vehicle gas receivers with a volatile gas under considerable pressure requires skill and dedication. It is something best done in a bus depot.
- 11 Coaches operating a distance from their depots, such as the continent, will require access to suitable recharging facilities.

Bio Engine Technology Ltd is a company set up to administer, with support from the ERDF, the development of the Rankine Cycle engine. Aided by the company's engineers, this has been achieved by research and computerisation by Riventa Limited of Truro in the form of computation fluid dynamics and the projected use of contemporary materials.

The purpose of this research has been to establish parameters within which the Herbl™ alternative vehicle engine will operate effectively and efficiently on neutral CO₂ without an exhaust containing harmful particulates.

In the foregoing pages, we have set out the requirements for bus and coach operators together with the present alternative available forms of low emission propulsion. We will now outline the advantages of the Herbl™ engine and fuel as a low cost, environmentally safe, effective alternative that will be welcomed by the bus and coach operators.

The Herbl™ is a simple but powerful engine that is particularly suited to Heavy Goods Vehicle, bus and coach use.

Features of the Herbl™ engine.

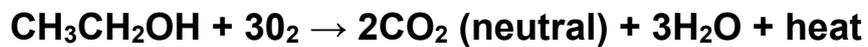
- 1 A simple, two-cylinder, double-acting design that has the equivalent smooth power strokes of a V8 Otto Cycle engine.
- 2 Low stressed and quiet, the exhaust is composed of just neutral CO₂ and water vapour, making it ideal for city centre and urban use.
- 3 Remarkably high torque from standstill. This obviates the requirement for a heavy, expensive gearbox.
- 4 The high torque is suitable for HGV use. The research was carefully defined around the use of the Herbl™ engine and fuel in a 29-seater bus. The torque was 6,911-foot pounds on an output shaft at zero revolutions = 9,400Nm.
- 5 This enabled the fully loaded bus to start on a 1:10 gradient and accelerate to 70 mph without changing gear.
- 6 The engine can be scaled to any size in vehicular and marine use.
- 7 In operation, the engine is at least as efficient as a diesel, it is quieter and can provide lighting and warmth to the passenger compartment without increasing fuel use or reducing mileage. Driving will be similar to the use of automatic transmission.

The Herbl™ engine is packaged with the most suitable, CO₂ neutral liquid fuel. **Herbl™ bio fuel.**

This is the universally available bioethanol. It must not be confused with ethanol or methanol, these are similar chemically but are natural gas, that is fossil fuel, based. Bio-methanol is a fossil fuel partly obtained from plant sources, but the process is expensive. Bioethanol is the only non-poisonous fuel and is found in alcoholic drinks.

It is important that the Herbl™ Rankine Cycle engine is legislated to be associated with Herbl™ bioethanol fuel, as a diesel engine is with diesel fuel. This is to avoid the oil companies substituting dangerous, fossil fuels in place of the clean bioethanol.

When burnt, bioethanol produces just heat, neutral CO₂ and water.



In the UK, up to 5% by volume is currently added to petrol (E5) to reduce the output of additional CO₂ and harmful emissions. It is also required by the oil companies as an additive to improve the function of petrol as a fuel in high compression engines. Bioethanol percentage can increase to 10% in 2020.

1. Global production of bioethanol is about 100bn litres per annum of which about 85% is produced by the United States and Brazil, using corn and sugar cane respectively.



US bioethanol production facility. Heat and energy are provided by the bioethanol fuel.

Other major producers are the E.U.; 5.75%, China; 2.5%, Canada; 2%, Thailand; 1.25%, Argentina; .6%, India; 0.3% and the Rest of the World; 3.5%.

2. Unlike many other countries, the UK bioethanol industry has failed to receive support or encouragement from its government. From enquiries made by Bio Engine Technology Ltd, it appears that the government has been influenced by oil companies lobbying, often through third parties; see 6. below.
3. This extract from: *The Future of the British Bioethanol Industry*, House of Commons Library, 15th January 2019, explains the situation in the UK.

European industry body *ePURE* estimates that in 2017 the UK had an installed production capacity of 985 million litres of renewable ethanol. This places it as the third-largest production capacity in Europe, after France (2,055 million litres) and Germany (1,180 million litres).

In April 2018, the Renewable Energy Association (an industry body) reported as part of a consultation on an EU trade measure that there were three bioethanol producers in the UK: Ensus, Vivergo, and British Sugar. It also stated that the UK has a potential production capacity of “around 900 million litres” of bioethanol and said that the industry is directly responsible for employing 280 people. However, in late 2018, two of these plants ceased production.

4. The remaining major producer of bioethanol in the UK is Vivergo in East Yorkshire which produced 420 million litres of bioethanol and 500,000 tonnes of animal feed last year.
5. Bioethanol was the fuel used in motor cars before refined oil was introduced. Henry Ford built his Model T and subsequent vehicles to use bioethanol for many years. Many other vehicles operated on bioethanol and can today, although their drivers are not aware that the yellow fuel cap signifies that the engine will perform on high percentages of bioethanol.
6. As the UK government, and some UK based ‘green’ organisations have chosen to be poor advocates of bioethanol, it is necessary to dispel some of the myths associated with the fuel.

a) From the days of Prohibition, the oil companies have lobbied several themes to dissuade the public from using bioethanol or alcohol related products. My shaving foam container is among many items that bear the unrelated legend, 'Contains no alcohol'. Oil companies persuade motorists in the US to buy 'ethanol-free' gasoline although its absence ruins their high compression engines.

b) A current theme concerns the emotive one of deforestation. The production of bioethanol is in no way associated with deforestation, has more than enough raw material and no bioethanol manufacturing plants are situated in areas of deforestation. Deforestation is for soya beans.

c) The oil companies claim that the production of bioethanol consumes foodstuffs required in the developing world. This is untrue, such organic matter that is grown in N America for bioethanol production is not edible. Where edible crops are used to produce bioethanol, only 5-10% of a plant is edible, the remaining stems and leaves are waste and animal feed is made from the processed material.

d) If nutrition in the developing world was a concern of the oil companies, they could buy foodstuffs and distribute them where they think there are areas of deprivation.

7. The oil companies have chosen to use fossilised instead of fresh organic matter because they can control its sourcing and distribution. The universal adoption of fresh organic matter, bioethanol, as a fuel will reduce its cost as it enables agriculture and industry to flourish in developing countries.
8. As a fuel, bioethanol has an Octane rating of 113 and is suited to the Herbi™ engine as it burns at a higher temperature than petrol.
9. Mixed with water, bioethanol can be drunk, it causes no marine disasters.
10. Bioethanol is welcomed by the manufacturer as it can be easily delivered by road in a similar manner to fossil fuels.
11. Bioethanol is welcomed by the retailers as it can be conveniently stored at ambient temperature and pressure.

12. Bioethanol is welcomed by the user as it can be easily dispensed into vehicles in a similar manner to fossil fuels.
13. Bioethanol has a lower energy content than petrol, this means it requires a 20% larger fuel tank. However, that tank is much smaller than a hydrogen cylinder and lighter than a EV battery.
14. Bioethanol is a powerful fuel. It was used at 25% dilution with water as fuel to power the German A4 (V2) rocket to 3,500 mph at an altitude of 128 miles.
15. Depending on national taxation levels, bioethanol is priced compatibly with petrol. Petrol prices could be 'gold-plated' where a government was determined to achieve low national pollution levels.

Summary

The foregoing outlines the features of the Herbl™ engine and fuel that offer a cheap, simple, but most essentially, a clean alternative to the harmful CO₂ and particulate exhaust of the current HGVs and buses.

The essential constituent of the engine and fuel combination is the bioethanol fuel. It has been available for thousands of years, is identical wherever it is made in the world and is entirely sustainable. The Herbl™ engine is the most efficient unit to convert the energy in the bioethanol into rotary motion.

The bioethanol, or alcohol, fuel is the most convenient alternative high energy fuel available and it requires no development.

The reciprocating Herbl™ engine has lain dormant for a century, at the behest of the oil companies, until this company developed it for this purpose.

There is an opportunity for the UK to provide an answer to a problem the world faces, one which it will welcome, be able to handle and willing to pay for.

All the basic research work has been undertaken; the optimum lay out, solenoid valve design, computer function and most effective working fluids are known. The results are available to be seen and Bio Engine Technology Ltd is willing to enter a consortium with a suitable company to develop the engine.

The immediate requirement is for the UK **Government Department for Transport** and **Office for Zero Emission Vehicles** to enter into discussions with **Bio Engine Technology Ltd** in order to explore the possibilities of this simple, cheap but clean alternative form of bus engine.