THE PERFORMANCE OF BIOMASS DERIVED ULTRACARBOFLUIDS IN STANDARD DIESEL ENGINES

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Introduction

The impetus for the replacement of petroleum-derived diesel fuels ,whether wholly or partially,arises from the need to conserve a non-renewable energy resource and because of the significant pollutants generated by their combustion.However the use of bio-mass derived fuels may also offer strategic and economic advantages.

The majority of the world's energy resources occur in nature as solids e.g coal and various biomass and waste materials.Bio-fuels such as wood ,charcoal and agricultural residues are a major source of energy in many of the developing countries providing as much as 14% of the current world energy requirements.This is eqivalent to some 25 million barrels of oil a day,the same as OPEC's current production[1].Worldwide there is substantial land potentially available for growing energy crops.

The possibilities for diesel fuel replacement are;

i Complete replacement by a suitable vegetable oil e.g. rape seed oil [2] , soya bean oil [3], esterified sugar beet exract [4].Some research is also in progress into the use of elephant grass oil (Miscanthus)[5].

ii Partial replacement by blending diesel with vegetable oils in varying proportions up to 20% by weight[6].

iii Partial replacement by blending with an aqueous suspension of a non-renewable fossil fuel e.g.coal[7].

iv Complete replacement by a slurry of coal in vegetable oil.

or

v Complete replacement by a 100% bio-renewable ultracarbofluid. This could comprise some formulation of water, charcoal , and a vegetable derived oil.

The research summarised here is concerned with the last alternative.

Biomass-Derived Ultracarbofluids

Typically biomass derived ultracarbofluids consist of charcoal 45%-54%,oil-blend 16%-29%, water 30%-35%, surfactant 1%, plus corrosion inhibitors etc in trace amounts.

The solid constituent is of necessity finely-divided and in practice needs to be ground to < 20μm particles in order to minimise erosion in the fuel system i.e transfer lines and injectors.Clearly low ash charcoal is preferable for optimum energy efficiency but also mainly to keep residue build-up in the engine to a minimum.The higher the proportion of charcoal in the blend the greater the gross energy output.

The possible replacement of the fuel oil fraction ,typically 15% to 30%,by a bio-renewable vegetable oil is of considerable interest.Several commercially available oils have been tested as fuel components.Using ordinary vegetable oils as fuel usually results in problems with severe engine deposits,ring sticking ,accumulation of deposits on injector nozzles and lubricant contamination ..For this reason vegetable oils for use as fuel or fuel component have to be modified by trans-esterification. Rapeseed methyl ester shows great potential for use as fuel or as a fuel component for diesel engines.

The ultimate test for any fuel is to determine how well it burns over long periods of time, and the impact of its use on the combustion system and auxilliary equipment.However any blend can, of course, be characterised by conventional property measurements i.e viscosity,cetane number,grossheat combustion , cloud point, flash point, density, particle size and ash content.

Ucf Peformance

Coal-water slurries have been studied extensively as fuels.Initial results confirmed that the main problems encountered when using coal-water slurries are,with fuel injection system operability, wear and poor combustion efficiency of the coal particles .

However, improvements have been recently been reported in reduced wear of injection components,by the addition of lubricant (8).

Bio-ultracarbofluids

Initial research on bio-ultracarbofluids utilised a 4-stroke single cylinder,indirect injection diesel engine with speed range of 650-800 rpm . The optimum perfomance has been achieved using coal 40%,water 30%, fuel oil 29%, additive 1%. The operating variables were;

-coal particle mean diameter :	8 μm
-injection timing :	42 degrees BTDC
-injection pressure :	12.5 MPa
-intake air temperature :	313 K
-intake air pressure :	0.22MPa

Specimen results in comparison with Esso diesel 2000 fuel oil are given in Fig 1.

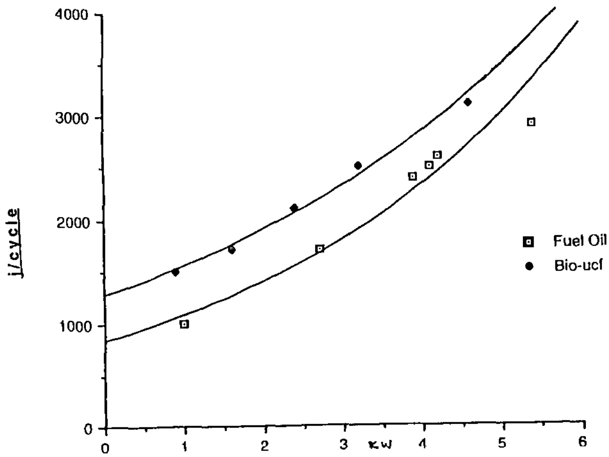

Figure 1: Energy consumption as a function of delivery power

The present research utilises a 4-stroke, 2 cylinder 600cc Lister-Petter diesel engine.A Heenan Froude hydraulic dynamometer is connected to the engine, as are auxilliary data collection apparatus as shown diagrammatically in Fig. 2.

The fuel formulation under investigation are based upon rape seed oil , peanut oil or sugar beet extract oil. Three different types of charcoal are under test. Also three different surfactants have been evaluated.In each case performance is compared with that of standard Esso diesel 2000.
The data obtained are;

engine torque	exhaust temperature
fuel consumption	oil temperature
air consumption	coolant temperature
speed	air temperature

Exhaust emissions are continuously monitored for levels of CO_2,CO and HC's levels.

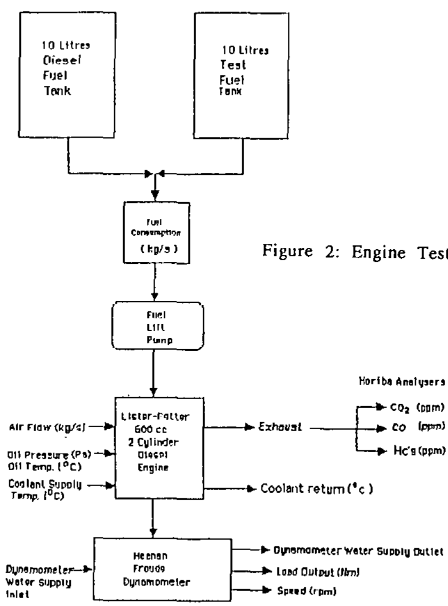

Figure 2: Engine Test Rig

Economics

The European Community's interest in bio-fuel arises in part from the Common Agriculture Policy (CAP).Farming at the present represents nearly 5% of the aggregrate Gross National Product of the EC member states and involves 9% of the workforce .Bio-mass crop production can contribute to this industrial activity and hence make a socio-economic contribution to rural development .Growing bio-mass will also avoid desertification of countryside. One tonne of crushed rapeseed produces about 320 kilograms of oil,and charcoal is readily available commercially.Additives are more expensive but are used only as 1%.It has been calculated that bio-ultracarbofluids will cost 21p per litre as compared to 12p for diesel , on the assumption that the rapeseed oil was grown on non-subsidised land .Hence preliminary estimates suggest that, with subsidies and economies of scale, the price of bio-ultra carbofluid could be comparable to diesel.

Conclusions

Results to date suggest that bio-ultrcarbofluids can be used in diesel engines without modifications. However the long term effects of corrosion, erosion and particle size on fuel handling systems require more detailed research using ASTM and EC test standards. The long term storage of the formulated fuels needs to be researched to see if this has any adverse effects such as oxidation of the oil components or settling of charcoal.

The EC is currently very keen to encourage the growing of energy crops since it will result in a reduction in the greenhouse gases, particularly CO_2 ,and reduce dependence on fuel imports. It would also encourage farmers to grow crops on set aside scheme.Hence there are good prospects for limited use of bio-ultracarbofluids.This would be greatly increased by direct or indirect state subsidies [9].

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