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ALTERNATIVE FUELS IN THE AUTOMOTIVE MARKET

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ABSTRACT

A review of the advantages and disadvantages of alternative fuels for road transport has been conducted. Based on numerous literature sources and in-house data, CONCAWE concludes that:

- Alternatives to conventional automotive transport fuels are unlikely to make a significant impact in the foreseeable future for either economic or environmental reasons.

- Gaseous fuels have some advantages and some growth can be expected. More specifically, compressed natural gas (CNG) and liquefied petroleum gas (LPG) may be employed as an alternative to diesel fuel in urban fleet applications.

KEYWORDS: Gasoline, diesel fuel, natural gas, liquefied petroleum gas, CNG, LNG, Methanol, LPG, bio-fuels, ethanol, rape seed methyl ester, RSME, carbon dioxide, CO2, emissions.

INTRODUCTION

This section of the report concentrates on bio-fuels as these are likely to impact on existing storage and distribution systems for gasoline and diesel fuel, either as 100% replacements, or as blends. Gaseous fuels and methanol would only affect fuel quality if there was a major demand switch away from conventional automotive fuels. This is viewed as highly unlikely and is beyond the scope of the current report.

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GASOLINE

Although pure ethanol can be used as a fuel for spark ignition engines, its characteristics differ from conventional gasoline sufficiently that substantial changes to the engine are needed. For use in the existing vehicle fleet, maximum ethanol content in gasoline must be limited to around 10% (the current European limit is 5%). For gasoline/ethanol blends the main impacts on fuel quality were described in Section 6 and are summarized below:

- increased vapour pressure
- water tolerance/loss to water bottoms
- effect on distillation curve
- driveability
- materials compatibility (at high ethanol concentrations)

DIESEL FUEL

Initial studies on the use of plant oils in diesel engines concentrated on the use of pure oils. Although many diesel engines will operate on these products, they lead to a rapid build-up of gums. These cause plugging of injectors and combustion chamber deposits, and do not meet the high standards of cleanliness expected of today's diesel fuel. Trans-esterification of the oil to produce methyl esters overcomes these problems, provided that the process includes a thorough removal of the glycerine residues produced as a by-product. Various national specifications have been issued for RSME in Europe . RSME meeting these specifications can operate in most road diesel engines without major problems, although there are some performance areas where a deterioration compared with conventional diesel may be expected.

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Both engines are representative of technology targeted to meet stringent emission regulations (US 1998 or Euro 3).

If methane emissions from leaks could be reduced, the CNG engine would have a CO2 advantage over the Dl diesel engine. The great advantage of the CNG diesel engine is its low NOx emissions, which makes it attractive for urban transport applications (buses, delivery trucks, and possibly passenger car fleets, e.g. taxis). The low NOx emissions are ascribed to a particularly sophisticated lean combustion system.

BIO-FUELS

One of the motivations for the use of bio-fuels is that they are perceived firstly to be renewable energy sources, and secondly, because of their biological origin, to make a zero contribution to CO2 emissions. Both of these assumptions can be challenged on closer inspection, and a detailed analysis of the whole production process is needed to obtain the true picture. A number of comprehensive studies have been carried out, 16, 26 to 35 and form the basis of the review that follows.

Energy balance

A schematic view of the energy balance for ethanol production from sugar beet is shown in Figure 3. The major part of the input comes from 'free' solar energy. Nevertheless, substantial inputs, which have a large impact on the overall energy balance, are required:

- to produce the crop (fertiliser, fuel for farm equipment)
- to pulp the sugar bearing roots
- to separate and dry the alcohol after fermentation

The analysis focused on the incremental cost of the CNG programmes for the vehicles under consideration. It also converted these results to an incremental cost on a gasoline or diesel litre equivalent basis. A litre equivalent is the quantity of CNG required to drive an equal distance to that achieved with a litre of gasoline or diesel

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fuel in a comparable vehicle. To evaluate the potentially high costs during the initial stage of CNG vehicle introduction, evaluations were conducted on an annual basis from the assumed date of implementation (1991 or 1996) until 2005. All costs were in 1990 US cents. Taxes on CNG were assumed to be the same as a litre equivalent basis of gasoline. Gasoline taxes in the nine cities included in the private and fleet vehicle programmes were estimated at 7.7 cents per litre. No taxes were assumed on diesel fuel or CNG used for transit buses.

In addition to the private costs of vehicle ownership and operation, social benefits for each of the three CNG vehicle cases were evaluated. The main social benefits of CNG vehicles would be emission reductions and the potential energy security benefits of reduced oil imports. Probable emissions of non-methane hydrocarbons, carbon monoxide, nitrogen oxides, and particulates from CNG and future conventional vehicles were evaluated. Note that these estimates did not review total hydrocarbon emissions, which might be important, given the greenhouse potential of methane. The potential emission reductions from CNG vehicles were valued at “avoided cost”, that is the cost-effectiveness of other ways of achieving the same emission reductions as CNG vehicles. Cost effectiveness estimates varied substantially by region. For example, emission control costs for nonmethane hydrocarbons were reported to range from $5,000 to $20,000 per metric ton in Los Angeles and from $2,000 to $6,000 per metric ton in other areas. The potential benefits from increased energy security depend on the reduction in gasoline consumption and the per barrel benefits of reduced imports. CNG use might also provide other benefits, such as reduction in air toxics or greenhouse gases, but these could not be evaluated with the available information.

CONCLUSIONS

Natural gas and LPG offer some environmental advantages. However, comparison of hydrocarbon emissions should be based on total, not non-methane, hydrocarbons. The complexities and cost of storage and handling LNG suggest that CNG provides a more practical alternative. LPG is an even more attractive proposition

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in this regard but its availability is limited. The energy density of CNG and the weight of on-board storage cylinders place serious range limitations on dedicated vehicles. LPG performance is significantly better in this context. Slow filling times and the complexity of CNG refuelling installations (plus the capital cost) are also likely to limit the popular appeal of the fuel. Filling rate performance is superior for LPG and less complex, lower cost refuelling systems are available.

The issue of methane leakage and unburned methane emissions needs to be considered in any “cradle to grave” analysis of the greenhouse effect for CNG

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