13. Anhydrous Ethanol

13.1 Background

Anhydrous ethanol can be used as an additive in petrol, or as a fuel in its own right. Despite this, as an automotive fuel it is usually composed of 85% ethanol with 15% petrol (E85P) and this is the fuel that will be examined in this chapter. The reason for this is that the addition of 15% petrol improves the ignitability of alcohol, especially at low temperature. Other additives have also been trialled as ignition improvers. Ethanol is probably the most widely used alternative automotive fuel in the world, mainly due to Brazil's decision to produce fuel alcohol from sugar cane.

13.2 Results

The upstream emissions associated with anhydrous ethanol are essentially the same as those associated with hydrated ethanol, with a requirement for extra energy input arising from the extra process step to transform the hydrated ethanol to anhydrous ethanol. According to Table 10 of the chapter on hydrated ethanol, 30% more energy is needed to convert hydrated ethanol to anhydrous ethanol. Our calculations also include the emissions associated with the production of the 15% of petrol added to the anhydrous ethanol. We have taken tailpipe emissions as being those from a representative car, and compare E85P against PULP.

13.2.1 Greenhouse gas emissions

Figure 13.1 depicts the greenhouse gas emissions estimated for the reference fuel (PULP) for light vehicles, and for anhydrous ethanol (E85P). These are shown as emissions on an energy basis, and as emissions per kilometre for a car.

Exbodied greenhouse gas emissions of E85P are approximately half those of PULP, or less, depending on the fuel source provided it is sourced from renewable material. Ethanol manufactured from fossil fuels emits more greenhouse gases than petrol.

13.2.2 Particulate matter emissions

Figure 13.2 depicts the particulate matter (PM10) emissions estimated for PULP and E85P. These are shown as emissions on an energy basis, as emissions on a per km basis for cars. Emissions from PULP are generally comparable to those from E85D, though if waste (wheat waste or wood waste) is used as a combustion source (instead of natural gas) then the particles emitted during the upstream phases mean that the exbodied particulate matter emissions are greater than those from PULP.

13.2.3 Emissions of oxides of nitrogen

Figure 13.3 depicts the oxides of nitrogen (NOx) emissions estimated for E85P and PULP. These are shown as emissions on an energy basis, and as emissions on a per km basis for cars. NOx emissions from E85P, in comparison with those of PULP, are very variable. The exact nature of the process and the assumptions made in terms of life-cycle allocations are crucial in determining whether the E85P emissions of NOx are less than those of PULP (which occurs when waste material is used), or greater than those of PULP (which occurs when fossil fuels or non-waste material are used).

13.2.4 Emissions of hydrocarbons

Figure 13.3 depicts the non-methanic hydrocarbon (HC) emissions estimated for PULP and E85P. These are shown as emissions on an energy basis, and as emissions on a per km basis for cars. PULP. If natural gas is used to fire the plant then exbodied HC emissions of E85P are comparable to, or possibly slightly below, those of PULP. If wheat or wood is used as an energy source, or if fossil fuels are used to make the ethanol, then HC emissions are greater than those from PULP.

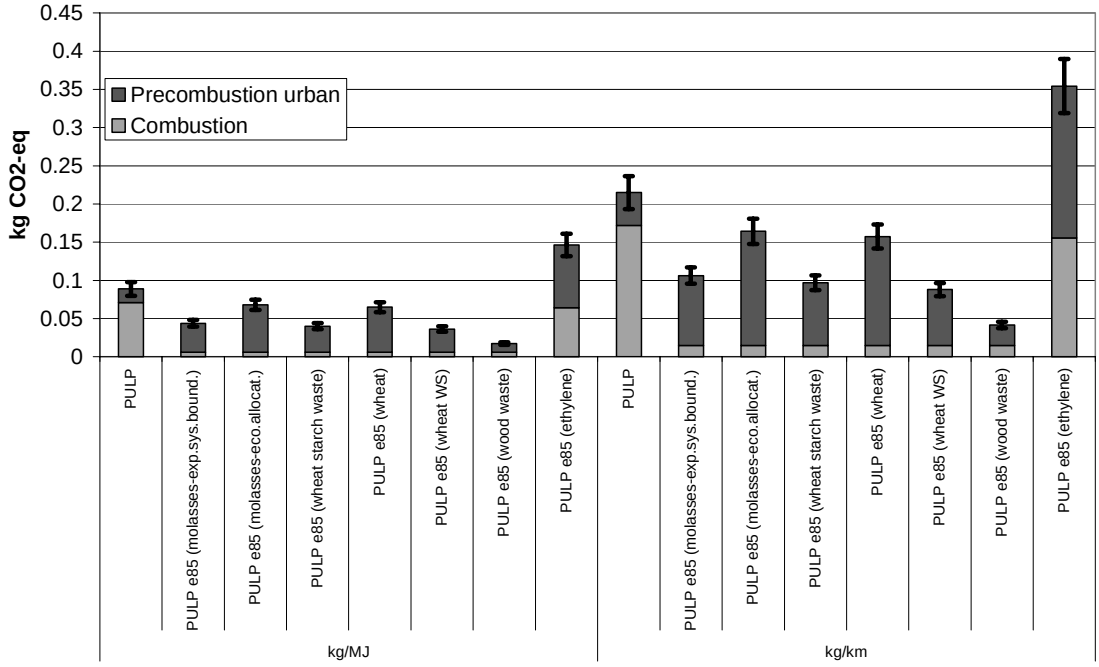

Figure 13.1
Exbodied emissions of greenhouse gases for premium unleaded petrol and anhydrous ethanol (E85P).

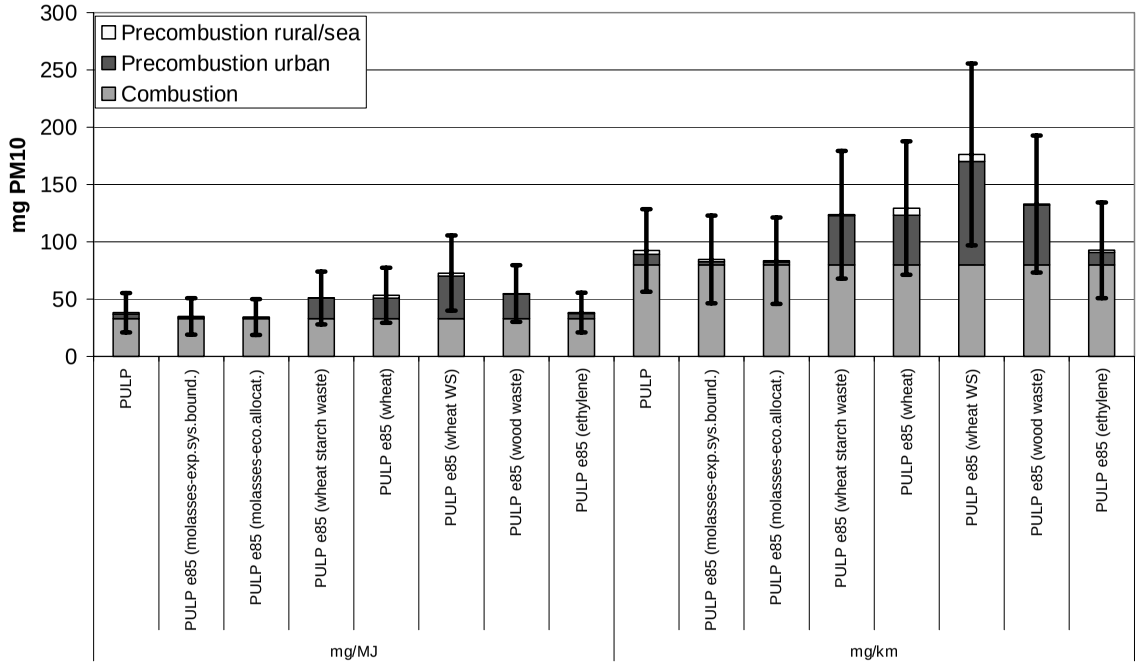

Figure 13.2
Exbodied emissions of particulate matter for premium unleaded petrol and anhydrous ethanol (E85P).

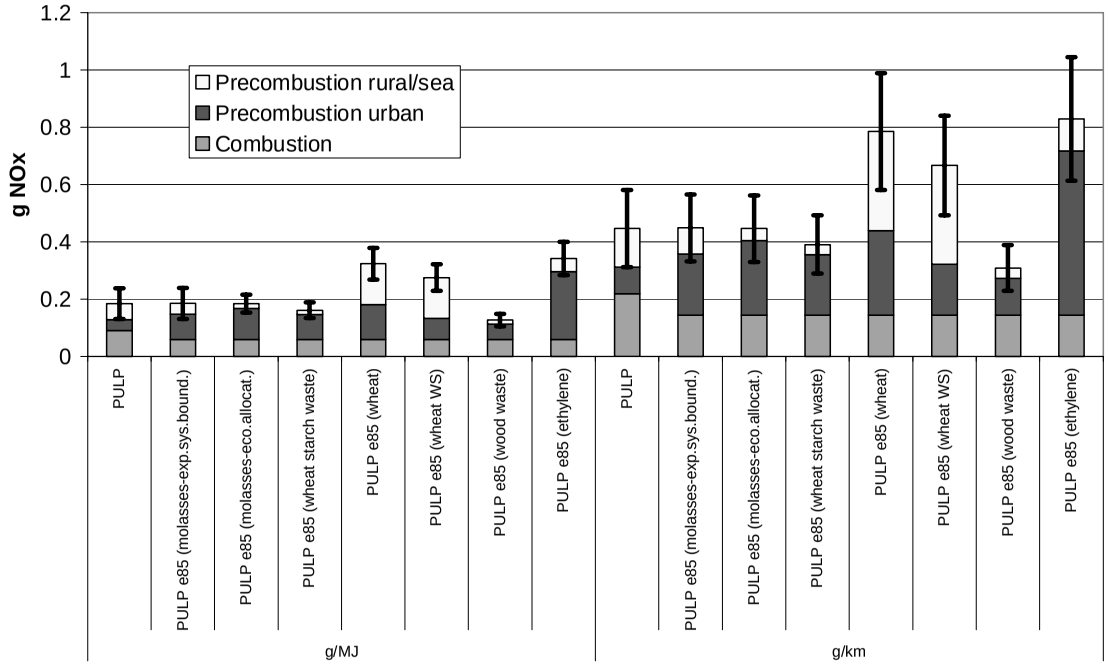

Figure 13.3
Exbodied emissions of oxides of nitrogen for premium unleaded petrol and anhydrous ethanol (E85P).

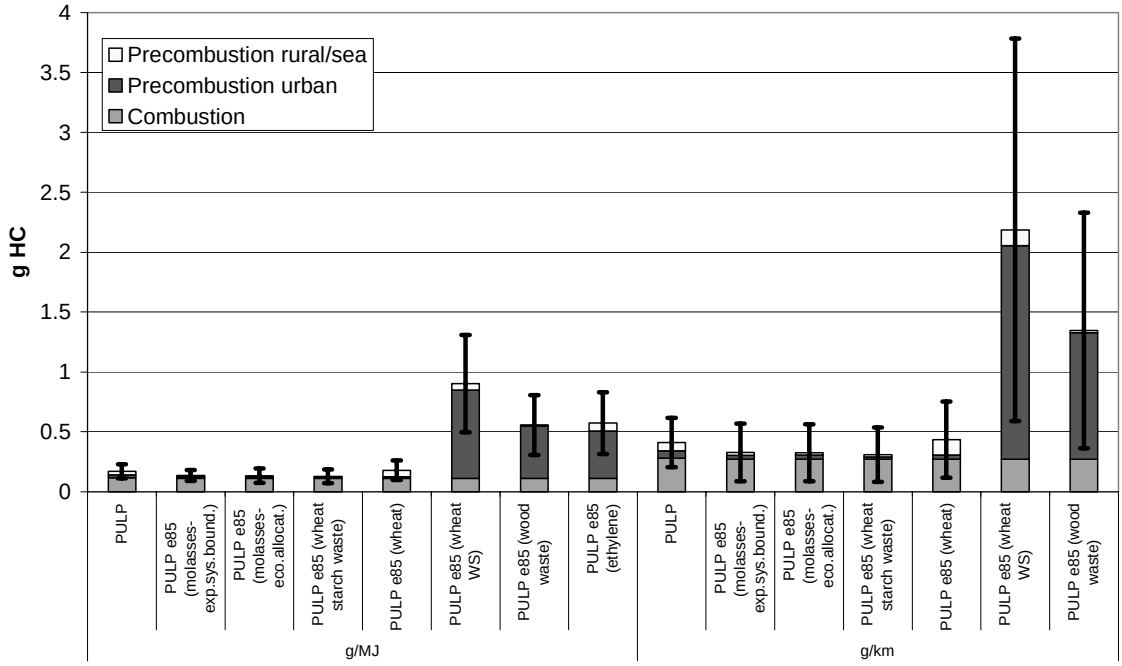

Figure 13.4
Exbodied emissions of hydrocarbons for premium unleaded petrol and anhydrous ethanol (E85P).

13.3 Viability and Functionality

There is considerable international experience on the use of ethanol in Brazil where sugar-derived ethanol is used as an automotive fuel. The ethanol used in Brazil is called Alcool and consists of 93% ethanol by volume. IEA Alternative Fuels Information Service (1996) note that "the techniques for the production and use of methanol and ethanol as a vehicle fuel are known. Obstacles that hinder the use of alcohols as a vehicular fuel are the relatively high costs of alcohol and the investments necessary to introduce an extra fuel."

The viability and functionality issues related to ethanol and its use in heavy vehicles (as diesohol) or in light vehicles (as petrohol) have been examined in other chapters, and the same considerations will apply for E85P.

13.4 Health and OH&S

Ethanol produces a marked decline in the emissions of air toxics, except for the aldehydes. When weighting factors are applied, the weighted air toxics emissions from ethanol are below those of petrol.

13.5 Environmental Issues

ESD issues

Ethanol is not persistent in the environment. Virtually any environment supporting bacterial populations is believed to be capable of biodegrading ethanol. Atmospheric degradation is also expected to be rapid. Provided that the source of ethanol is not fossil fuels then it satisfies ESD

principles. The particulate emissions are lowered as are the emissions of ozone pre-cursors. The concentrations of emitted air toxics are lower from ethanol than from petrol.

In particular, we draw attention to the fact that appropriate disposal of the refinery waste-products is crucial to environmental impacts or benefits. Dunder application is often criticised as being the cause of poor waste quality in Queensland, though there is little evidence of this (www.sunfish.org.au/fishkills/fishkills.htm). Conversely, appropriate and careful disposal of dunder means that many farmers in the district near Sarina now use it as a fertiliser and soil conditioner - even though it was once considered a poison.

Sustainability
Ethanol from sugar or wheat is liable to be a niche fuel and thus there are no sustainability issues associated with it. Large-scale usage of ethanol will require ligno-cellulosic production to be economical.

Foran and Mardon (1999) contains details of ethanol and methanol production technology and supply constraints, and of the environmental consequences of both crop and fuel production processes. They claim that if ligno-cellulosic ethanol production is used then it would be possible to establish biomass plantations over the next 50 years that meet 90% of Australia's oil requirements, and specifically to supply all transportation fuels. To do this using ethanol requires biomass production to cover up to 19 million hectares of Australia's croplands and high rainfall pasture zones. Their modelling approach envisages substantial environmental benefit. In addition to the reduction in greenhouse gas emissions (up to 300 million tonnes by the year 2050), the large-scale planting of tree and shrub crops as ethanol feedstock would help to control dryland salinity and associated problems.

Groundwater
We are not aware of any issues related to groundwater contamination except to note that in the US the replacement of MTBE by ethanol in oxygenated fuels was specifically done to reduce groundwater contamination.

13.6 Expected Future Emissions

Ethanol can be expected to meet all future Australian Design Rules for all pollutants, except for hydrocarbon emissions.

13.7 Summary

13.7.1 Advantages

- As a renewable fuel it produces less fossil CO_2 than conventional fuels
- Tailpipe emissions of NOx and PM appear to be lower on average.
- Air toxic levels (except for aldehydes) are lower than those of conventional fuels.

13.7.2 Disadvantages

- Cold starting in cool climates is difficult unless ethanol is blended with petrol as a starting aid, or unless some other starting aid is used.

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