Feasibility Study for Biodiesel Production and Use to fuel one of CAT’s vehicles

Trish Morrow

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Feasibility Study for 
BIODIESEL PRODUCTION, 
and use to fuel one of CAT’s vehicles 
and for sale to Central Australian communities 

Figure 1: A mixture of vegetable oil, caustic soda and methanol, being stirred to produce biodiesel.

by 
Trish Morrow 
10 October 2003
Photograph 2: This vehicle, owned and operated by Alice Springs Entrepreneur Ian Cunningham, runs on biodiesel made from recycled vegetable oil and cooking fat.

ABSTRACT

Biodiesel is a diesel fuel substitute which is made from a mixture of used cooking oil, caustic soda and methanol. Biodiesel can be made for as little as 40 cents per litre (depending on economies of scale, and taxation), a possible saving of up to 60 cents per litre on the price of diesel fuel at the bowser.

This report discusses the feasibility of making Biodiesel fuel in CAT’s workshop, for use in CAT’s bus which is used by Education and Training staff to transport students to classes. Ian Cunningham of Alice Springs is offering training courses for any Indigenous communities in Central Australia who would like to learn to make a diesel fuel substitute from used cooking oil from their community store or community kitchen. If CAT was to make and use this fuel, this would help to promote the concept of Biodiesel and illustrate its feasibility for any community residents who may wish to manufacture their own biodiesel.

Biodiesel fuel is already being used extensively throughout Australia and overseas. An Alice Springs entrepreneur, Ian Cunningham, has been making and using the environmentally-friendly fuel for several years now. On several occasions Ian has driven his own vehicle from Alice to Darwin and return, using 100% biodiesel. Biodiesel fuel has been made and used extensively overseas. A notable example of this is a filmmaker Joshua Tickell who drove his “Veggie Van” over 25,000 miles from one side of the US to the other, in 1997/1998. The famous Veggie Van was fuelled entirely by biodiesel made from waste vegetable oil from fast food restaurants.

Biodiesel can be used in any engine which uses conventional diesel fuel, and no engine modifications are required. The only drawback is that vehicle hoses need to be checked after the first six months of operating on biodiesel. Using biodiesel is easier on your engine than ordinary diesel due to a property of biodiesel called “lubricity.” This higher lubricity increases the engine’s life.
Not only can money be saved by making your own biodiesel but the vehicle’s exhaust emissions will be cleaner to, on the whole. Biodiesel made from waste vegetable oil has been found to be the most climate friendly fuel available, according to a recent study carried out by the Australian Greenhouse Office. The use of 20% biodiesel (made from canola oil) has been found to result in a 31% reduction in particulate matter, a 21% reduction in carbon monoxide emission and a 47% reduction in total hydrocarbons\(^3\), as well as a reduction in emissions of aromatic compounds and sulphur. The exhaust from biodiesel fuel does not irritate your eyes and some people even say that it smells like fish and chips!

Biodiesel is made by mixing waste cooking oil with methanol and lye. A chemical reaction caused transesterification makes this mixture into biodiesel and glycerin\(^4\). The glycerin byproduct can be used as a substitute for soap.

Why isn’t everyone using biodiesel? One reason is that while Biodiesel is safer than ordinary diesel to store and use, due to its higher flash point, making your own biodiesel is an extremely dangerous process, and anyone who signs up for one of Ian’s workshops will be expected to wear a raincoat, rubber gloves, solid shoes and eye protection. Making biodiesel involves the use of methanol which can kill you or can cause blindness. You can be affected by breathing in the fumes and by absorption through your skin\(^5\). The manufacturing process also uses caustic soda which can irritate your eyes and burn your skin if you don’t take the proper precautions.
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Photograph 1. Biodiesel plant in Slovakia producing 12,000MT/year [http://www.ekoil.sk/E%205000.htm]
1.0 INTRODUCTION

Biodiesel is a diesel fuel substitute which is made from a mixture of used cooking oil, caustic soda and methanol. Biodiesel can be made for as little as 40 cents per litre (depending on economies of scale, and taxation), a possible saving of up to 60 cents per litre on the price of diesel fuel at the bowser.

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Biodiesel is made by mixing waste cooking oil with methanol and lye. A chemical reaction caused transesterification makes this mixture into biodiesel and glycerin\(^9\). The glycerin byproduct can be used as a substitute for soap.

**WHO IS MAKING AND USING BIODIESEL?**

**OVERSEAS?**

**IN AUSTRALIA?**
There are at least four commercial producers of biodiesel in Australia\(^10\).

**RATIONALE**

Recycling plastic has the potential to lead to an excellent “triple bottom line” outcome for a small business in Alice Springs employing Indigenous people. The costs of landfill disposal can be of the order of $40 per tonne\(^11\), or up to $30 per cubic metre\(^12\), depending on the density of the waste. Throwing plastic away also results in the incalculable loss of energy and raw materials used in processing of the original beverage containers.

**PROCESS DESCRIPTION**

First, the plastic is sorted to ensure that confused householders have not thrown in the wrong type of plastic. It is melted in an ordinary oven at a temperature of approximately 160°C. A sheet of baking paper or parchment paper is placed beneath the plastic while it melts, to ensure that the plastic does not stick to the metal or timber sheets used for a subsequent pressing operation. The oven used at Hebden Bridge appears to be an ordinary household oven. It was purchased second-hand for £40. The plastic does not completely liquefy in the oven, rather, it becomes pliable like plasticene or modelling clay. It tends to spread out in the oven to form a sheet or thin block of plastic.
EQUIPMENT REQUIRED

The plastic recycling facility will attempt to recover its costs by carrying out glass recycling as a sideline. Some of the plastic recycling equipment (such as the plastic shredder and the bottle washing equipment) is dual purpose and can serve for part of the glass reprocessing operation also. However it will also be necessary to purchase some supplementary items, including a glass breaker (hammermill), several belt conveyers (some with magnetic head pulleys and dust collection hood), a rotary dryer with a trommel screen section and a gas burner.

PLANT LAYOUT AND DESIGN

1. Factors affecting the design – technical, legislative, environmental, economic, health and safety, product quality
2. assumptions
3. design details and calculations
4. operation and maintenance

COST BREAKDOWN – for plant as designed.

Equipment List (Fixed Capital)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>COST</th>
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<tr>
<td>Glass Hopper</td>
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<tr>
<td>Initial Belt Conveyor (with or without cleats)</td>
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</tr>
<tr>
<td>Primary Crush</td>
<td></td>
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<tr>
<td>Rotary Dryer w/Trommel Screen Section &amp; Gas Burner</td>
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<tr>
<td>Belt Conveyor with Magnetic Head Pulley</td>
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<tr>
<td>Impactor or Hammermill</td>
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<td>Belt Conveyor with Magnetic Head Pulley &amp; Dust Collection Hood</td>
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<tr>
<td>Motor Control Centre with Frequency Controller on Impactor &amp; Feed Conveyors</td>
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<tr>
<td>Sizing Apparatus</td>
<td></td>
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<tr>
<td>Baghouse</td>
<td></td>
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<tr>
<td>Bag Packer with Beam Balance</td>
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<tr>
<td>Installation - Mechanical, Electrical</td>
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</tr>
<tr>
<td>TOTAL</td>
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TAXATION
Biodiesel excise
Diesel fuel rebate
RRPGP program for diesel generators

COST BENEFIT ANALYSIS
Integrated cost-benefit assessment using Life Cycle Assessment and Environmental Economic Evaluation to document environmental costs and benefits
Compare against the base case of no recycling with all waste going to landfill
Include a sensitivity analysis with changes in the prices paid for products, in the mix of recyclables collected and higher or lower yields for the recycling process itself.

LEGISLATION
In the Northern Territory, relevant legislation includes the Waste Management and Pollution Control Act and the Work Health Act. Is there any relevant Commonwealth legislation also?

Alice Springs (Garbage Dumps) By-Laws may also be relevant. Not really.
Public Health Regulations
Trade Measurement Act
Waste management and pollution control act 2003

Trade waste agreements – Alice Springs Town Council ??? Check any local wastewater legislation or council pamphlets on trade waste.

Insurance?????
Power Consumption?
Australian Standards

1. Identify appropriate model for the biodiesel production process
2. Establish strong linkages with contacts in the biodiesel industry and related associations e.g. Biodiesel Association of Australia
3. Visit a medium-scale biodiesel facility – if possible obtain access to financial information as well as details of the production process and equipment
4. Identify problems which are likely to be encountered during establishment of a biodiesel manufacturing facility and ways in which they have been resolved.
5. Estimate of quantities of raw materials available in Alice Springs and the minimum amount which is required to enable the machinery to be operated.
6. Investigate machinery needed and its cost (including any oil collection vehicles,. Forklifts, etc).
7. Document operational costs (including power, maintenance, water, wastewater).
8. Research environmental, occupational health and safety, taxation and other relevant legislation.
10. Investigate disposal or management of any wastes arising from the recycling process.
11. Carry out a cost benefit analysis.
12. Carry out a social impact assessment/social benefit analysis.
13. Investigate transport costs (e.g., for acquiring machinery).
15. Research ways of addressing staffing and training issues.
17. Implement a pilot scale trial program including collection of waste oil from a sample of food production premises and storage at CAT.

ENVIRONMENTAL AND SOCIAL IMPACTS

The majority of the environmental benefits associated with plastic and glass recycling are as a result of the reduction in water pollution and air emissions, compared with what would be incurred from the manufacture of new glass or plastic directly from raw materials. The environmental costs of the collection system are comparatively quite low. The improved outcomes for natural resource management, which result from the recycling of glass and plastic, account for about a fifth of the environmental benefit. In fact, because of the high density of glass and even of crushed/flattened plastic, the savings in landfill space only account for approximately 1.5% of the environmental benefits or recycling glass and plastic.

HUMAN RESOURCES MANAGEMENT

Annual leave loading 17.5%

Training
Record keeping

http://www.domme.ntu.ac.uk/people/alotfi/personal/recycle/plastic.html
Legislative requirements e.g. environmental permits

WORKPLACE HEALTH AND SAFETY CONSIDERATIONS

Dust control

Site ventilation and operator training help with this. Dust may exacerbate emphysema and bronchitis and other pre-existing medical conditions\(^4\). The respirable particles in the dust are probably much less numerous than the non-respirable particles.

Photo: [http://www.veggievan.org/](http://www.veggievan.org/) American filmmaker Joshua Tickell drove this “Veggie Van” over 25,000 miles from one side of the US to the other, in 1997/1998\(^5\). The famous Veggie Van was fuelled entirely by biodiesel made from waste vegetable oil from fast food restaurants.

PUBLIC RELATIONS AND MARKETS –

Waste oil collection

Sales

Ian Cunningham is safety-conscious when pouring methanol, wearing a raincoat, g-safety glasses. Methanol is a highly poisonous substance, which affects the central nervous system. It may be absorbed through the skin.
Lye solution being added to molten cooking fat to make biodiesel, at a workshop in Alice Springs organised by Laurence Wilson.

Molten cooking fat being strained to remove lumps of fish and chips, for making biodiesel.

Caustic soda being measured, to make lye solution for biodiesel.
Lye solution being added to molten cooking fat to make biodiesel, at a workshop in Alice Springs organised by Laurence Wilson.

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Caustic soda being measured, to make lye solution for biodiesel.
1 URL: http://www.veggievan.org/ Biodiesel, Vegetable Oil Fuel, and the Veggie Van
2 URL: http://www.biodiesel.com/why_biodiesel.htm Why Biodiesel
3 URL: http://www.biodiesel.com/why_biodiesel.htm Why Biodiesel
4 URL: http://www.kelseyville.com/biodsl/ Getting back in the saddle
6 URL: http://www.veggievan.org/ Biodiesel, Vegetable Oil Fuel, and the Veggie Van
7 URL: http://www.biodiesel.com/why_biodiesel.htm Why Biodiesel
8 URL: http://www.biodiesel.com/why_biodiesel.htm Why Biodiesel
9 URL: http://www.kelseyville.com/biodsl/ Getting back in the saddle
11 URL: http://www.alicesprings.nt.gov.au/council/services/landfill.asp#charges Alice Springs Landfill and Bowerbird Tip Shop
14 URL: http://www.cwc.org/plastic/pl977fs.pdf Dust Monitoring of a Polypropylene Film Densification at a Small-Scale Plastics Facility
15 URL: http://www.veggievan.org/ Biodiesel, Vegetable Oil Fuel, and the Veggie Van