Solomon Islands Electricity Authority

LATA COCONUT OIL FUEL TRIALS

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Table of Contents

1. Project Title

Lata Coconut Oil Generation Trials

1.1. Introduction

The Solomon Islands Electricity Authority (SIEA) is a Solomon Islands Government owned utility responsible for the generating, transmitting and distributing as well as selling of electricity supplies in the Solomon Islands.

SIEA operates in nine (9) locations throughout the Solomon Islands with its Lungga and Honiara Powerstations serving Honiara. It has an installed capacity of 28 MW and a peak system load of 12.3 MW.

The Authority has a total customer base of 10,150 with Electricity Sales for 2007 being 64.5 GWh. SIEA has a single-tier tariff with three distinct categories; Domestic, Commercial/Industrial/Government and 11 kV Tariff. The tariff has two components; a Base Tariff and a Fuel Surcharge.

1.2. Location

The project site is located some at Lata, Santa Cruz, in the Temotu Province. This is some 36 hours by boat from the capital Honiara.

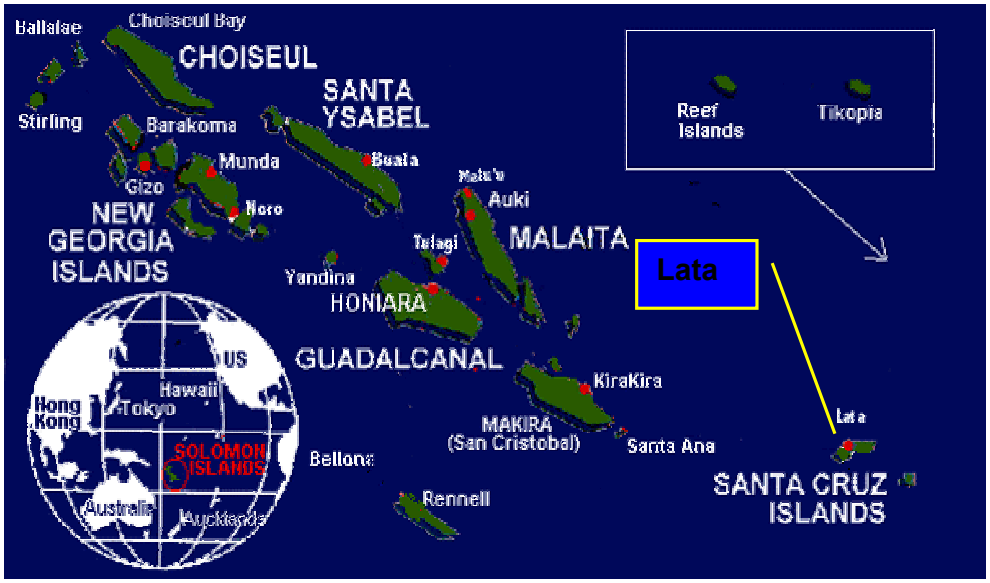

Figure 1: SI Map Showing Lata

1.3. Responsible Agencies

The implementing and executing agency for the project is the Solomon Islands Electricity Authority, with the project being under the direct control of the SIEA General Manager, and coordinated through the Chief Engineer. The project was also supported by NZ Aid Volunteer to the Temotu Development Authority.

The conversion of the engine to dual fuel costed SBD17,000 and was financed by AusAID.

1.4 Project Description

This project will see SIEA will then carryout a pilot project at Lata, Santa Cruz, which will use one of SIEA's three diesel generators converted to run on pure coconut oil.

1.5. Project Objectives

The overall objective of this project is to determine the viability of SIEA using coconut oil as a diesel substitute for power generation. The experiences learned during the pilot project will be used to carry out conversion in other locations thereby reducing the Authority's fuel bill and creating income generating activity for the rural population.

2. Project Background

SIEA's operations in Lata face a number of unique problems which differ from its other operations.

One of the major difficulties faced in the regularity of shipping services to Lata which can see no boats traveling there for up to months. At such times, SIEA has had to either borrow fuel or impose load shedding to ensure whatever fuel is remaining carries the operation to when the next shipment arrives.

Lata is also SIEA's outer most operational center and hence the landed cost of diesel there is the most expensive in SIEA's operation.

This added to the fact that the Temotu Development Authority runs a coconut oil extraction mill there created an ideal opportunity for the setting up of the pilot project.

If the trial is proven to be successful, it would create a win-win situation for both SIEA and the Temotu Development Authority. Furthermore, the success of the trials would allow SIEA to have the same set up at its other provincial locations.

3. The Conversion and Trials

This section presents some of the theory comparing the characteristics of coconut and other vegetable oils and that of diesel. These properties present different technical issues that need to be overcome to be able to use coconut oil as a fuel source for electricity generation.

3.1 Theory

All vegetable oils can be combusted to produce energy. In many cases they can be used as substitute for petroleum diesel in compression ignition engines. However, its tendency to form gums or vanishes can give rise to problems when using it in an engine.

The following table compares properties of diesel fuel and some vegetable oils relevant to their potential for use as diesel fuel.

Fuel	Specific Energy (MJ/kg)	Cetane Number	Kinematic Viscosity (cS)	Solidification Point (°C)	Iodine Value	Saponification Value
ADO	45.3 Gross 42.5 Nett	40 - 60	2 – 4	- 9 (Cloud point)	-	-
Coconut Oil	42 Gross 38 Nett	60 (Est)	26 @ 40 °C	20 – 25	10	268
Palm Oil	39.6 Gross		89	30 – 35	54	199
Rapeseed	40 Gross	41	37 @ 40 oC	-10	125	189
Soybean	37	34	38 @ 40 oC	-16	130	191
Linseed	39.7		29 @ 40 oC	-24	179	190

Table 1: Comparison of Diesel and Vegetable Oil Characteristics.

In making the modifications to run the diesel engine on coconut oil, one of the important characteristics to address is the Solidification point of the coconut oil. Diesel has a solidification point of -9 °C whilst coconut oil solidifies at 25 °C.
It can be noted from the table above that coconut oil has a much higher viscosity that than commercial diesel. This will affect the flowability of the fuel and hence the characteristic of the spray pattern as the fuel is spray.

Whilst dual fuel systems are commercially on the market, the Authority decided to use materials that are available through local suppliers to carry out the modifications. The reasons are twofold; cost of commercially available kit versus purchase of materials and to give SIEA engineers the experience in carrying out the modifications.

3.2 The Engine

The engine used in the trial is Perkins 1006 – TAG high speed diesel engine whose details are listed below.

Engine Make:	Perkins
Model:	1006-TAG
Engine Speed:	1,500 RPM
Rating:	88 kW_e
Year Installed:	1993

It should be noted that the engine has been in operation for just on 10 years at the point where the trials were conducted

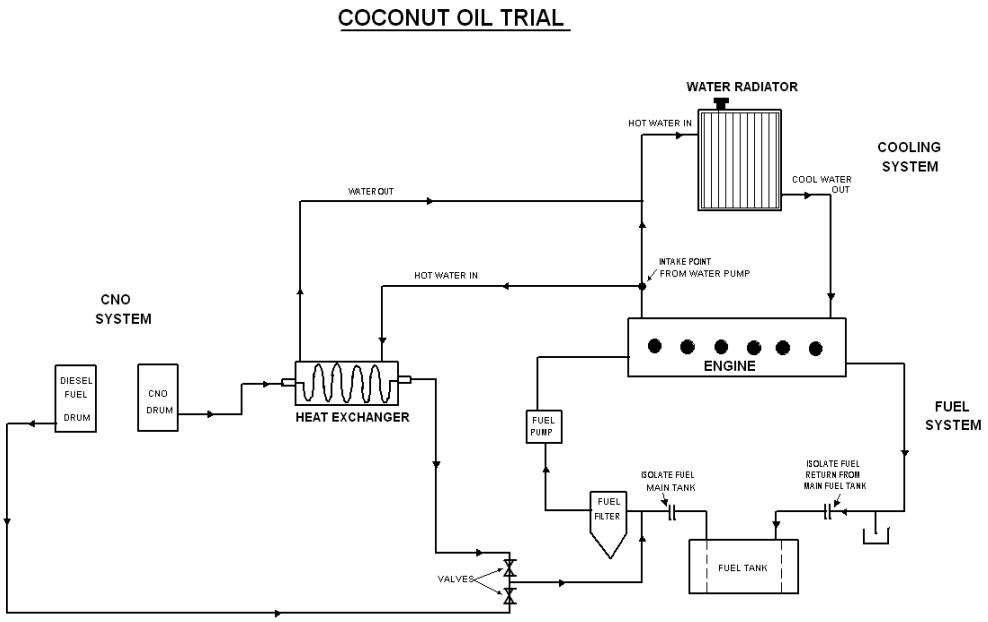

Figure 2: Schematic of Modifications for Duel Fuel

3.3 The Modifications

The following section describes the modifications made to convert the engine running on diesel to also run on coconut oil. Modifications were made on the fuel system, addition of a heat exchanger to heat the coconut oil and the fuel pump.

3.3.1 Fuel System

The trials used a dual fuel system with two day tanks for diesel and coconut oil. The engine is started using diesel and allowed to run with load for 30 minutes before it is switched to coconut oil. The engine is

switched to diesel again and allowed to run for another 30 minutes prior to shutting down. This allows the engine fuel lines and components to be flushed of coconut oil.

Figure 1 shows the dual fuel arrangement for the trials. An additional tank was installed for the coconut oil fuel while use was made of the existing diesel tank.

To be able to switch from one fuel source to another, two 12 mm taps were installed at the outlet of the day tanks. Switching between fuel sources was done manually by the operator.

3.3.2 Heat Exchanger

From Table 1 it can be seen that coconut oil has a higher solidification temperature that diesel.

A heat exchanger to heat the coconut oil was fabricated using 10mm and 15mm copper tubes as the exchanger element. Hot water from the engine was tapped from the engine and circulated through the heat exchanger. Coconut oil was then passed through the heat exchanger to raise its temperature.

3.3.3 Fuel Pump

A 12VDC automotive pump is used to pump coconut oil from the CNO day tank through a water separator, the main fuel filter, heat exchanger and then to the fuel injection pump.

3.4 Trial Results

Following initial retro-fit a trial run was conducted on 9 December 2002. The engine was run at full load for 3 hours. During the initial trials the following was noted.

The heat exchanger was heating the coconut oil to only 50 ^{o}C where ideally it should be 70 ^{o}C to make the coconut oil flow better.

Secondly, at a measured flow rate of 0.5 litres per minute the engine was starting to hunt as it was being starved of fuel.

The generator set was carrying a 25 kW load during the trial. There was no significant change in the performance of the engine during the trial. Power produced was constant during the switch to coconut oil and all engine temperatures and pressures were normal.

As a result of the initial trial, it was recommended that a new pump be purchased to increase the flow rate of the coconut oil as well as a heater capable of heating the coconut oil to 70 ^{o}C. The new pump purchased must have a flow rate of at least 2 litres per minute.

Following the purchase of a new 12VDC pump and installation of the new heater, trials resumed on 18 September 2003.

During the second trials, the engine parameters were noted and whilst generally these are comparable with the parameters when operating on diesel, a number of significant observations were made.

The engine was seen to be "hunting" causing frequency instability even after the new 12VDC pump had been installed. The flow rate measured after the installed was 2 litres per minute. Further investigations found that the fuel filters had been clogged with dirt and particles from the coconut oil and hence the reason for the engine "hunting". The coconut oil used in the trials was extracted from pressed copra which had been dried in hot air driers.

As a consequence, the operators had to regularly, at least 3 – 4 each day, switch to diesel to enable them remove the coconut oil filters for cleaning. Periods between fuel filter changes were found to be much shorter when using coconut oil compared to diesel. This is despite the coconut undergoing filtration on site to remove as much of the particles as possible.

As well, the engine temperatures were observed to be very high and had resulted in a number of shutdowns. However, this could not be directly attributed to the use of coconut oil as the engine as not been fully serviced before its use in the trials.

A decision was made to discontinue the trials on 21 October 2003 as it was evident that the problem of the quality of the coconut oil would need to be seriously addressed to carry out further trials.

4. Experience Gained

The trials though of short duration had shown that the use of coconut oil for electricity generation is a viable option that SIEA can undertake easily. The dual fuel conversion can be done by it engineers and tradesmen using readily available materials or commercially available duel fuel engine kits which would cost considerably more.

However, in order for the use of coconut oil to be truly viable as a diesel substitute the matter of the quality of the coconut oil must be addressed through the use appropriate filtering processes by the supplier of coconut oil or another extraction process that would produce better quality oil.

5. Future Undertaking

SIEA is keen to pursue the use of coconut oil as diesel substitute in its provincial centers. This is especially so as the price of crude oil continues to rise and taking into account the fact that fuel alone constitutes 70 – 75 percent of the Authority's operational cost. It will also open up a potential business activity which the rural population can be engaged in.

SIEA has a plan to convert the majority of its operating plant in Gizo, Noro, Tulagi, Auki, Kirakira and Lata to duel fuel.