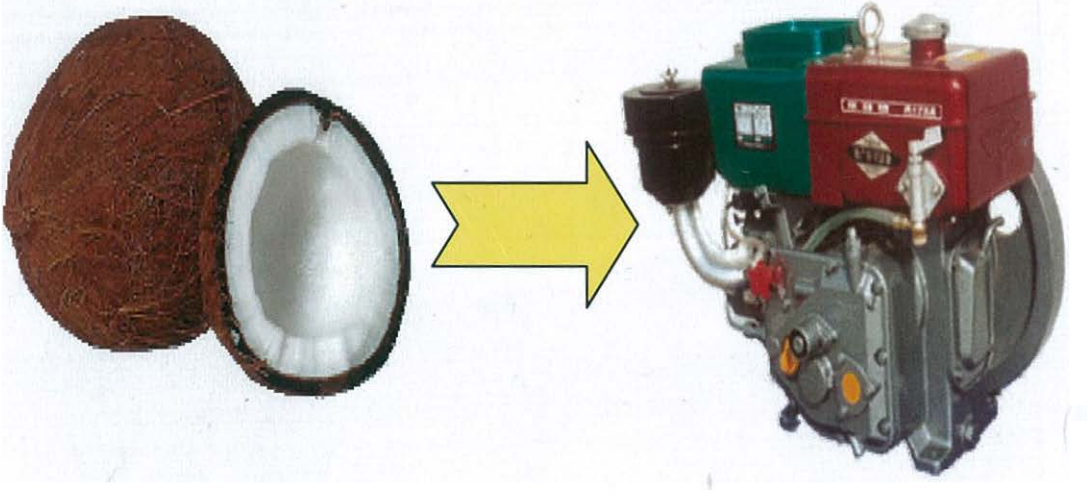
Coconut Oil as an Alternate Fuel – Lessons learned from a pilot project

Progress in fisheries related applications



A trial initiative of the PNG National Fisheries College
Kavieng, Papua New Guinea
2007

CONTENTS

Acknowledgements

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Abbreviations used in the report

- EU DEVFISH-Development of tuna fisheries in the Pacific ACP countries Project
- NFA-National Fisheries Authority
- K – kina
- PNG – Papua New Guinea
- SPC – Secretariat of the Pacific Community
- WCPO – Western and Central Pacific Ocean

Exchange Rates

- K1.00 = US $ 0.3485 @ May 2009

Introduction

In November 2006, the Board of the Papua New Guinea approved an allocation of funds to the National Fisheries College (NFC) to undertake a research project to consider the potential application of coconut oil as an alternative fuel for use within the fisheries sector. Working in partnership with a Kavieng based fisheries and seafood processing company, Emirau Marine Products (EMP), the project set out to establish a small coconut oil processing facility and then use the oil to test operations in a variety of engines and working environments.

In the context of fishing vessel operations, the challenge was to determine whether coconut oil could be produced and processed as a cost effective alternative to diesel. For coastal communities, the wider challenge was to document potential use of coconut oil as a community fuel source. EMP is New Ireland Provinces major buyer of Beche de Mer and, with concerns as to the status of the Beche de Mer resource, the company believed it could be possible to divert a degree of community fishing effort away from Beche de Mer to copra production, especially if the price of copra could be increased from the then 30 toea (US$0.10) a kilogram to a level where community interest in copra production could be sustained.

The project was prompted by the dramatic increase in the cost of diesel and petrol in 2006 and 2007 and the negative impact on the fisheries sector, most notable in the domestic tuna longline fishery where, in PNG, the main fleet operators had ceased fishing operations and tied up their vessels.

Project Components

The main components of the NFA/EMP project are:

- Establishment of an oil production facility
- Monitor oil production and operational costs
- Examine and test options for engine operations using coconut oil
- Examine oil filtering and processing options
- Review community level oil production potential level and operational applications
- Look at options for bi (co)-product development and use
- Assess operational economics and commercial viability

Overview of Project Progress

By June 2007, the project was in full scale oil production with 2 operational oil presses, two press filters, 20,000 litres of holding tanks and a single copra shredding machine. With a staff team of 6 persons, the project was able to process around 1200 kilograms of copra per day producing 700 – 800 litres of coconut oil. The raw oil was pumped through a series of 3 settling tanks and then returned through the screen filters ready for use.

In the course of following months, the project produced around 140,000 litres of coconut oil which has been tested and used in various machinery and equipment with a mixture of both success and failure. Considerable effort was put in to oil filtering and processing

options as it was initially found that a basic filtering process was insufficient to prevent filter and injector blockages in standard engines (for example, a Toyota Hilux). The project declined to adopt the accepted practice of using a coconut oil and kerosene mix to avoid fuel blockages and instead focused on improving filtration and oil processing methodologies and on consideration of options for engine conversion systems to allow for more efficient utilization of coconut oil fuel.

It should be noted that the project primarily used kiln dried copra which has an associated carbon residue in the oil that needs to be eliminated from the oil before it can be used as a fuel. This problem did not occur when high quality sun or heat dried copra with no carbon residue was used.

With the assistance of two small grant allocations from the EU DEVFISH Project, specialist technical advice and assistance was obtained to procure several simple engine conversion systems from Australia. For smaller engines, these systems contained a small electric in-line heater that can be fitted to the fuel line to pre-heat the oil. For larger engines, the system comprises a heat exchanger to pre-heat the oil prior to injection and two additional filters to ensure that the oil was filtered to 5 microns.

The heat exchanger and filter system

Following considerable experimentation, the project consolidated a process to produce Fat Free Fuel. This process involves careful mixing of raw oil with a small volume of water and caustic soda which is stirred into the oil until it is completely mixed. Once left to settle, the fatty acids within the oil separate and coagulate in the bottom of the tank and the remaining oil is poured off, heated and the finely filtered prior to use.

Subsequent testing of the fat free fuel has resulted in a conclusion that it burns better than raw oil and eliminates injector blocking issues. However, it should also be noted that the fine filtering process is fundamental to ensuring fuel quality and a lack of filtering will invariably result in fuel filter blockages.

Coconut oil fuel has been tested in a range of engine applications with the most complex being a 450 hp turbo charged Cummins, the largest being a 30 year old Nigata, and the simplest being the Chinese built 6.6 hp Jiang Dong. The project continues to produce and utilize coconut oil fuel in several applications.

Lessons learned to date

Establishment of an oil production facility

- Establishment costs were higher than anticipated due to the electrical demand of the oil presses and copra cutter;
- The operation of an oil processing facility requires a high level of hands on engineering management and regular maintenance is imperative to efficient operations;

Monitor development and oil production costs

- In the duration of the project to date, the price of copra has been reflective of the volatile changes in the fuel oil market. At project commencement, local purchase price was 30 toea (US$0.10) per kilogram, this rose steadily to K 1.00 (US$0.35) where it stabilized for a time, then jumped as high as K 1.40 (US$0.49) only to gradually decrease in the latter part of 2008 to 60 – 70 toea (US$0.21-US$0.25).
- Assuming a K 1.00 (US$0.35) per kilo buy price, the basic operational economic parameters are summarized as follows:
  - Daily processing of 1200 kg = K 1200.00 (US$420)
  - 1200 kg produces around 800 litres of oil
  - 10% volume loss for fat reduction process gives 720 litres finished fuel
  - Costs:
    - Labor (6 persons @ 8 hours) = K 160.00 (US$56)
    - Electricity (approx) = K 45.00 (US$16)
    - Operational overhead = K 200.00 (US$70)
    - Total production cost = K 1605.00 (US$562)
    - 720 Litres @ K 1605.00 **= K 2.22 (US$0.78) per litre**
- With the effective utilisation of process waste products, the cost of fuel production can potentially be further reduced as follows:
  - The copra waste can be reconstituted to a fine mix with reprocessing through the copra crusher to produce around 400 kg per day of copra powder which can potentially be sold as stock feed for around 20 toea (US$0.07) per kg. This provides around K 80.00 (US$28.00) per day of cost offset;
  - The waste fatty acids can easily be packaged as a form of industrial hand soap with potential production of 5 kg per day to contribute an additional K 50.00 (US$17.50)per day to cost offset;
  - In this scenario, the daily production cost is reduced to K 1475.00 (US$516) and the cost of production is reduced to **K 2.04 (US$0.71)per litre;**
- Given cost factors such as depreciation and equipment replacement and the fluctuation of copra prices, the likely production cost of coconut oil fuel is between **K 2.30 – K 2.50 (US$0.81-US$0.86) per litre;**

Examine and test options for engine operations using coconut oil

Small engines:

- There are a range of small diesel engines that can run successfully on straight filtered raw coconut oil and these engines have a wide range of potential applications;
- Small coconut oil driven engines can be successfully used on small boats although a high degree of engineering management is required;
- Coconut oil powered engines are potentially much cheaper to operate than normal outboard engines but do not produce high speeds;

The coco-cat

Summary operational data
▪ Twin Jiang Dong 6.6hp water cooled engines ▪ 1 litre of coconut oil per engine per hour ▪ 10 – 15 litres of water per engine per hour ▪ 1000 – 1400 kg carrying capacity ▪ 4 – 5 nautical miles for K 6.00 kina {US$2.10}(assumes K 3.00 {US$1.00}per litre)

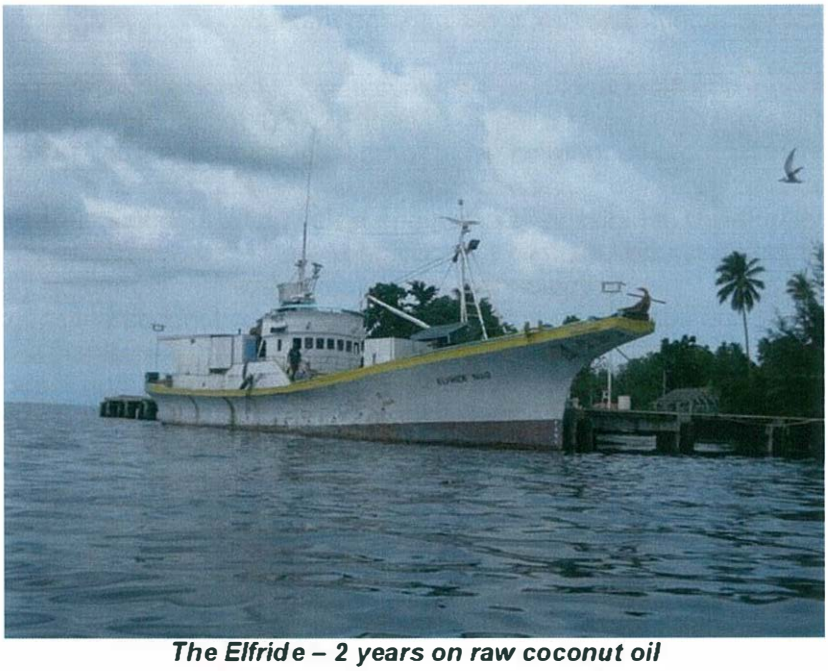
The Sunsette Rigby 22

Summary operational data

- 22 hp vertical shaft air cooled engine fitted to a normal 70 hp outboard
- 13 knots top speed
- 5 – 6 litres of processed coconut oil fuel per hour
- Around 18 kina (US$6.30)per 12 – 13 nautical miles

Larger engines

- Coconut oil can be successfully used with larger engines. The project has tested processed and non-processed coconut oil on various engine types including the Toyota Hilux, a Toyota 5 ton truck, a rotary injected turbo-charged Cummins genset and a 30 year old 450 hp Nigata;
- The Toyota and Cummins engines operate better on processed coconut oil fuel but the large injectors of the Agasaka will manage raw non processed oil;
- Generally, a high level of engine monitoring and maintenance may be required especially if the coconut oil has not been adequately filtered;
- With a potential retail price of K3.00 (US$1.05) per litre, the coconut oil fuel can potentially provide quite significant savings in the cost of engine operation. The 5 ton Toyota truck has been tested with 10,000 litres of processed coconut oil fuel during times at which the diesel fuel price ranged from K 3.70 – K 4.70 (US$1.30-1.66) per litre;



The Elfride – 2 years on raw coconut oil

Summary operational data

- 450hp Agasaka main engine
- Over 100,000 litres raw filtered coconut oil in 18 months of operation;
- Assuming a coconut oil fuel cost of K 3.00 (US$1.05) per litre and given diesel prices ranging from K 3.30 - K 4.70 (US$1.16-1.65)per litre during the operational period, the potential cost saving is significant;

Examine oil filtering and processing options

- The standard manual filters are effective to perhaps 20 – 25 microns but filtering to 5 mircons is required for successful engine operation;
- For commercial operations, a centrifugal or fine bag filter system is recommended;
- The project achieved improved engine reliability and performance with the fat free fuel process;

A 5 micron bag filter system

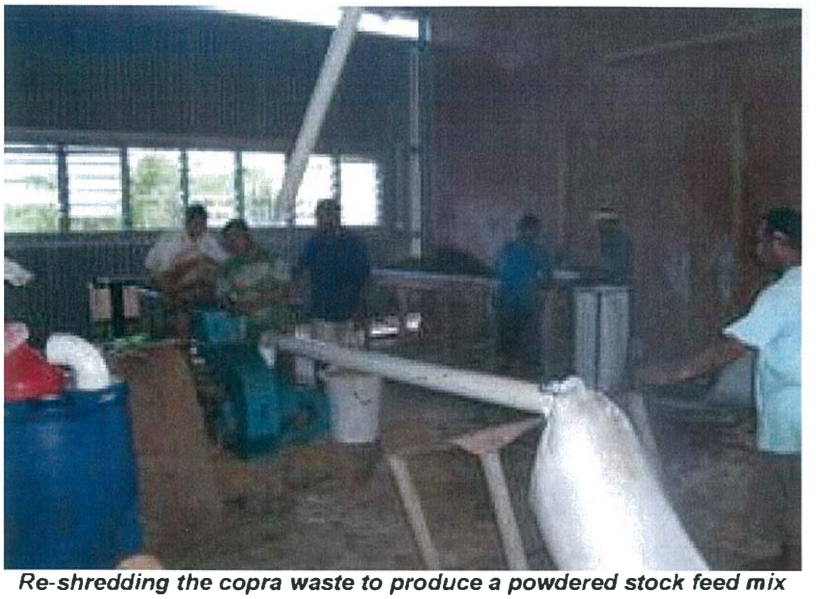
Review community level oil production potential level and operational applications

- There are several options for small scale low cost local level coconut oil production with potential volumes of 12 – 20 litres of oil per day although there are no clear examples of committed local level small scale coconut oil production in New Ireland;
- With the small coconut oil powered engines, it is possible to develop local level electricity generation based on using coconut oil fuel although again, there are currently no operational examples of this technology;
- The processed coconut oil fuel burns successfully in a lamps and stoves and could provide a viable alternative to kerosene lamps and cookers in rural areas;
- There are a number of current initiatives in support of the further development of small scale coconut oil production and there is a substantial and accessible information network documenting coconut oil and fuel production in local and commercial contexts;

The coconut oil hand press in operation

Look at options for bi (co)-product development and use

- The waste copra can be re-processed into a sand like powder and bagged up for sale as animal feed;
- The copra waste makes a very good low cost base for feed pellet production and, given access to a steady supply of fish meal and other key ingredients, there is possible potential for feed meal production to develop as an additional component of coconut oil production;
- The waste fatty acid compounds of the coconut oil fuel production process has application as a hand-wash and is very effective at removing oil, grease and dirt;



Re-shredding the copra waste to produce a powdered stock feed mix

Assess operational economics and commercial viability

- In the project duration the price of copra has varied dramatically. At less than 60 – 70 toea (US$0.21-US$0.25) per kg copra processing is not really commercially worthwhile however, with prices in excess of K1.00 (US$0.35) per kilo, copra production has enjoyed an upsurge during the project period;
- The project has established that, if diesel prices remain above K 3.50 (US$1.23) per litre, there is potential for a commercially viable option to produce and utilize coconut oil fuel;

Remarks

Project reporting is ongoing and on completion will provide a more detailed summary of results. It is currently intended that the project be advanced to a commercial enterprise and in this process, NFA will withdraw from operations and fully hand the reins of the Project to the private sector.

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