COCONUT OIL AS AN ALTERNATIVE FUEL – PROGRESS IN FISHERIES RELATED APPLICATIONS
Lessons learned from a pilot project

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Introduction

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

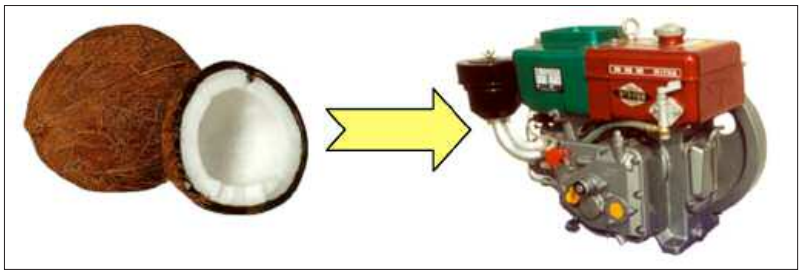
In the context of fishing vessel operations, the challenge was to determine whether coconut oil could be produced and processed as a cost-effective alternative to diesel. For coastal communities, the wider challenge was to document potential use of coconut oil as a community fuel source. EMP is the major buyer of bêche de mer in New Ireland Province. With concerns about the status of the resource, the company believed it might be possible to divert a degree of community fishing effort from bêche de mer to copra production, especially if the price of copra could be increased from the then 30 toea per 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 notably the domestic tuna long-line fishery. In PNG, the main fleet operators had ceased fishing operations and tied up their vessels.

Project components

The main components of the project are to:

- establish 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 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 two operational oil presses, two press filters, 20,000 litres of holding tanks and a single copra shredding machine. With a staff of six, the project was able to process around 1200 kg of copra per day producing 700–800 litres of coconut oil. The raw oil was pumped through a series of three settling tanks and then returned through the screen filters ready for use.

In the 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 success and failure. Considerable effort was put into 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 considering options for engine conversion systems to allow for more efficient utilisation of coconut oil fuel.

It should be noted that the project primarily used kiln dried copra which leaves a carbon residue in the oil that needs to be eliminated 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 grants 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 is 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 is filtered to 5 microns.

After considerable experimentation, the project consolidated a process to produce fat-free fuel. This process involves carefully mixing 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.

Tests of the fat-free fuel show 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 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 utilise coconut oil fuel in several applications. It is currently intended that the project will be developed into a commercial enterprise, which will mean that NFA will withdraw from operations and hand over the reins to the private sector.

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;

Monitor development and oil production costs

- Over the life of the project, the price of copra has reflected the volatility of the fuel oil market. When the project began, the local purchase price was 30 toea per kilogram. This rose steadily to K 1.00 where it stabilised for a time, then jumped as high as K 1.40 only to gradually decrease in the latter part of 2008 to 60–70 toea.
- Assuming a K 1.00 per kilo buy price, the basic operational economic parameters are as follows:
  - Daily processing of 1200 kg = K 1200.00
  - 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
    Electricity (approx) = K 45.00
    Operational overhead= K 200.00
    Total production cost = K 1605.00
    720 Litres @ K 1605.00 = K 2.22 per litre
- With the effective utlisation of process waste products, the cost of fuel production could 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

Heat exchanger and filter system

around 20 toea per kg. This provides around K 80.00 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 per day of cost offset.
- In this scenario, the daily production cost is reduced to K 1475.00 and the cost of production is reduced to K 2.04 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 per litre.

Examine and test options for engine operations using coconut oil

Small engines

- Various small diesel engines 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.

Larger engines

- Coconut oil can be successfully used with larger engines. The project has tested processed and non-

Summary operational data

- Twin Jiang Dong 6.6 hp 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 (assumes K 3.00 per litre)

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 K 18 per 12–13 nautical miles

Top: The coco-cat

Bottom: The Sunsette Rigby 22

Summary operational data

- 450 hp 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 per litre and given diesel prices ranging from K 3.30 to K 4.70 per litre during the operational period, the potential cost saving is significant

The Elfride – two years on raw coconut oil

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 is required, especially if the coconut oil has not been adequately filtered.
- With a potential retail price of K 3.00 per litre, the coconut oil fuel can 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 a period when the diesel fuel price ranged from K 3.70 to K 4.70 per litre.

Examine oil filtering and processing options

- The standard manual filters are effective to perhaps 20–25 microns, but filtering to 5 microns 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.

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 possi-

A 5 micron bag filter system

ble 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 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.

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

- Waste copra can be reprocessed into a sand-like powder and bagged up for sale as animal feed.

- 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 potential for feed meal production to be developed as an additional component of coconut oil production.

- The waste fatty acid compounds from the coconut oil fuel production process can be used as a hand-wash for removing oil, grease and dirt.

Assess operational economics and commercial viability

- Over the project, the price of copra has varied dramatically. At less than 60–70 toea per kg, copra processing is not really commercially worthwhile. However, with prices in excess of K 1.00 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 per litre, there is potential for commercially viable production and use of coconut oil fuel.

Coconut oil hand press in operation