THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1980/B:14
FISH CAPTURE COMMITTEE

FUEL SAVING POTENTIAL IN NORWEGIAN FISHERIES

BY

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ABSTRACT

This paper attempts to identify key areas for fuel saving activities in fishing, giving rough figures for the saving potential.

Large savings may be achieved by proper choise of speed, by operating existing vessels and machinery properly, and by selecting energy efficient fishing methods.

Very interesting possibilities exists for making new vessels more energy efficient.

The aim of the paper is to stimulate discussion on fuel saving, and to point to the most profitable areas for exploration in this field.

PREAMBLE.

1. The aim of this presentation is to stimulate discussions on fuel economy in fishing, an industry squeezed between dwindling rescources on one hand, and increasing fuel prices on the other.

The figures presented here are "Guesstimates" that will be revised as we gain more insight into the fuel usage and practice in the different fisheries.
They are based on a number of internal memos produced at our institute last year.
These memos served as guidance and a base for discussions on where our institute should concentrate our efforts in the fuel saving field.

They also serve as a starting point for projections on the relative competitiveness of various methods of fishing in the face of rising fuel prices, work that is just now getting under way.

It is my belief that discussions on these matters may be of greht benefit, a proper evaluation of the fuel saving possibilities may be of immense value to people now investing in new vessels and equipment.

2. Energy intensity in food production.

Usually studies into this field deals with energy input and output, or energy input into each gram of protein produced.

A houswife bying food for dinner is not very concerned about the number of M.Joules or grams of protein she buys, she compares the cost pr pound of the various foodstuffs and the less money she has in her purse the more important this consideration is.

Based on widely varying figures available on energy input into production of poultry mutton and beef.

I have tried to figure out the energy input pr kg of foodstuffs that compete directly with our frozen fish fillets in world markets, and compare them to our own products.

TABLE 1.

		MJ/Kg
Beef:	range fed, Argentina, N. Zealand	3-5
Beef:	grass fed, US, UK, N.Zealand	16-42
Beef:	feed lot, US	120
Poultry	UK (1972)	60
Fishing	UK (1972)	80
Fishing	Norway (1978)	80

The value shown for fishing in Norway is average for frozen filets.

3. ENERGY USE IN NORWEGIAN FISHERIES.

Table 2 reflects the great difference in fuel consumption for different methods of fishing in the Norwegian fisheries.

It shows kilograms of fuel pr kilogram of gutted and headed fish landed (fuel ratio).

Table 2.

Method of fishing	Fuel ratio: kg fuel/kg fish
Bottom trawling, middle water	1,0
Bottom trawling, near water	0,6
Longlining, middle water	0,3
Longlining, near water	0,2
Coastal fishing	0,1

Based on this table we have estimated energy input into each kilogram of frozen filets on the Norwegian market.

Results are shown in table 3.

Table 3. Energy input pr kilo frozen filet (Norway 1979).

	Trawling Middle water		Trawling Near water		Longlining Middle water		Longlining Near water		Coastal fishing	
	MJ/KG	%	MJ/KG	%	MJ/KG	%	MJ/KG	%	MJ/KG	%
FISHING	85	76	50	65	25	48	17	38	9	25
PROCESSING	13	12	13	17	13	25	13	29	13	36
TRANSPORT	10	9	10	13	10	19	10	23	10	38
DISTRIBUTION	4	3	4	5	4	8	4	10	4	11
TOTAL INPUT	112	100	77	100	52	100	44	100	36	100

Filet yeld is 50% of the headed and gutted fish landed.

For trawling, the energy input from the fishing operations amounts to from 50-85% of the total input.

If we compare energy input for beef from table 1 with the energy input into filets, it seems evident that frozen filets are quite vulnerable to increases in fuel prices.

It is also evident that filet production based on long-lining is less vulnerable than if it is based on trawling.

It is also clear that an effort must be made to bring down fuel consumption in our industry if it is to remain competitive.

The question arising is then: Where are the most profitable areas to explore for fuel saving?

4. AREAS FOR FUEL SAVING.

So far we have identified the following worthwile areas for further investigation, but it is safe to say that the list will be added to.

a. Speed and power reduction

b. Choice of fishing methods

c. Improved propulsion systems

d. More flexible machinery systems

e. Use of heavy fuels

f. Improved auxillary power systems

g. Improved hull forms

h. Waste heat recovery

i. Engine de-rating

j. Improved use of controllable pitch propellers

k. Improved fishing gear

l. Alternative energy scources

m. Fish forecasting

We have "quesstimated" the fuelsaving potensial for each of these areas, some of the figures are quite reliable, others are outright queswork.

5. SPEED AND POWER REDUCTION

The smaller and middle-size Norwegian fishing vessels are grossly "overpowered".

In the top of the speed range resistance increase with speed in the 6th to 8th power.

A 10% reduction in free running speed therefore reduce fuel consumption with 30-40%.

On a yearly basis this would give the following estimated fuel savings:

- Trawling : 12-15%
- Longlining : 15-20%
- Coastal fishing: 20-25%
- Purse seriners : 20-25%

The total estimate saving for the Norwegian fleet: 60-80000 tons a year.

The question of economical speed is presently being investigated, and is dealt with in the paper "Fishing Vessel Speed and Fuel Economy" by Digernes and Endal.

6. CHOICE OF FISHING METHODS

From table 3 it is quite evident that there are considerable savings involved switching from trawling to longlining. Approximally 25% of our food fish is taken by trawlers.

Reduction in fuel consumption for food fish by switching to passive methods estimated to 15 to 20%.

7. IMPROVED PROPULSION SYSTEM

Reduction of propeller design rpm and number of propeller blades are effective ways of reducing fuel consumption.

Such actions are usually limited to new vessel constructions.

EXAMPLE:

Seiner 185 feet, speed 16 knots, power 3600 hp at 350 rpm on the propeller.

If propeller speed is reduced to 200 rpm and propeller diameter increased accordingly, the neccesary power is reduced to 3000 hp at 16 knots.

Rule of thumbs: A 40% reduction of design rpm for the propeller will reduce fuel consumption 15% when free running.

Additional benefits may be reaped by reducing the number of blades.

Reducing number of blades from 4 to 2 will reduce fuel consumption an additional 15%, for a total of 30%.

Draft limitations and hull design may hamper such development, as propeller diameter increase.

A 110 ft vessel with 2200 hp, 4 bladed propeller at 14 knots running at 350 rpm has a propeller diameter of 2,47 m.

A 2 bladed propeller at 200 rpm and 14 knots, requires only 1500 hp, but the propeller diameter is increased to 3,76.

A 30% reduction in power here calls for a 30-40% increase in propeller diameter.

For very slow speeds and low power (longlining etc.) a "second" gear may be fitted to allow the propeller to run at very low rpm.

8. MORE FLEXIBLE MACHINERY SYSTEMS

Economical speed and power is determined by balancing the cost of fuel against cost of time. The time cost is a function of fish prices and catch rates.

A fishing vessel may therefore steam at reduced power for long periods of time.

In some fisheries there is a great difference in the engine power neccesary when steaming and when fishing (longlining, nettfishing, purse-seining).

Lightly loaded diesel engine often have very poor fuel consumption rates.

To ensure proper specific consumption, we must ensure that the engine is properly loaded.

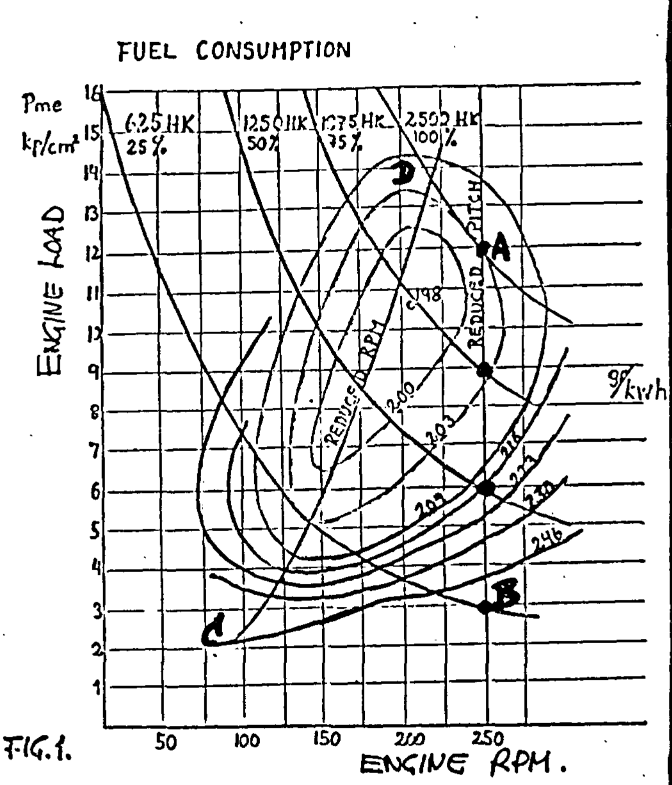


FIG.1.

Fuel consumption curves in grams pr Kwh

This may be achieved by a twin engine installation, as shown in fig. 2.

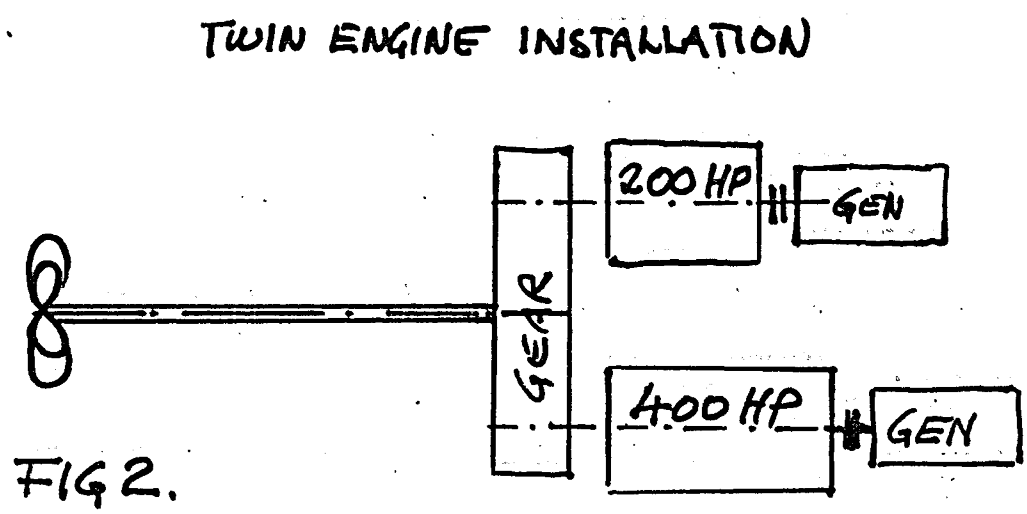


FIG 2.

Longlining is a type of fishing where only a fraction of main engine hp is used.

For such fishing a twin engine installation may give a reduction of fuel consumption from 4-8% depending in pattern of fishing.

An installation as indicated on fig. 2 would give 3 power ranges 2, 4 and 600 hp, which would allow full advantages to be gained from economical speed conciderations.

Additional savings may by achivied in longlining by introducing a 2-speed propeller arrangement, allowing both the engine and propeller to run under optimum conditions at low vessel speeds.

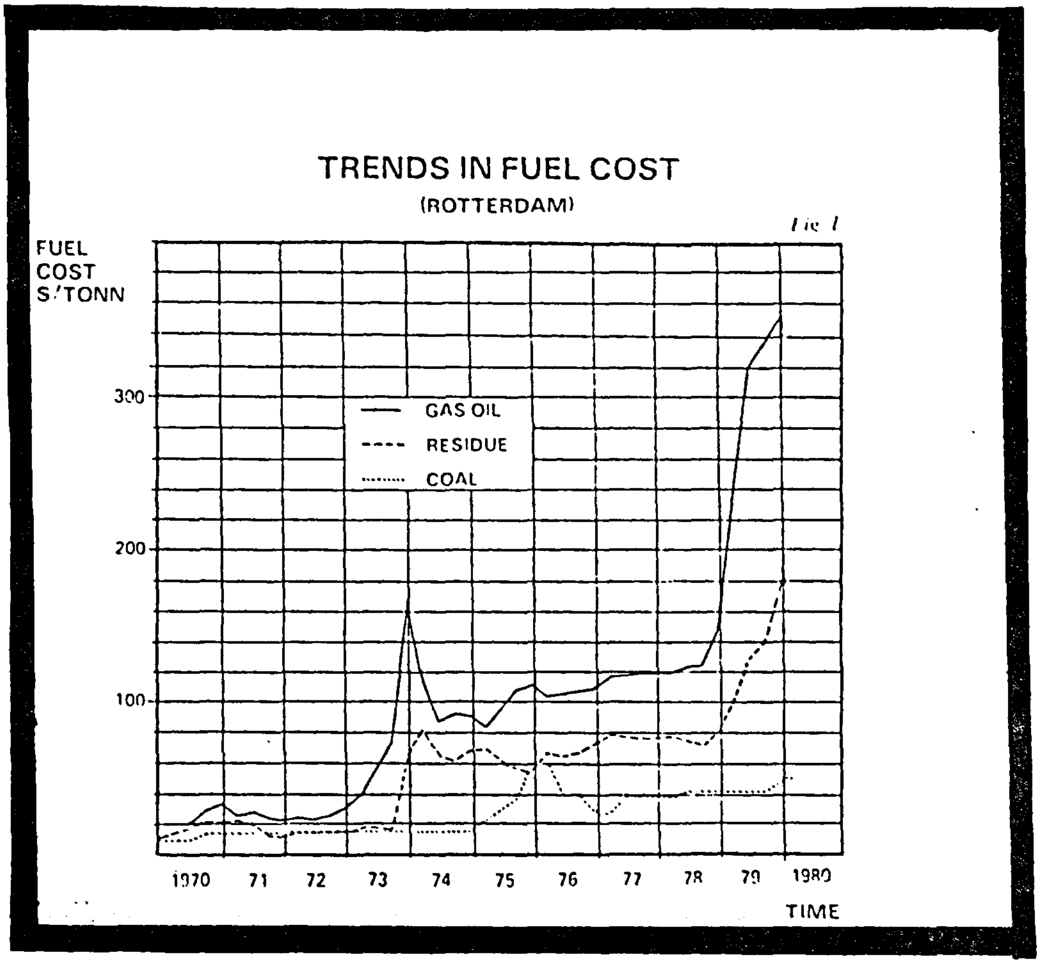
9. USE OF HEAVY FUELS

To burn heavy fuels, present technology requires main engines with a speed of less than 750 rpm.

Almost all of our large seiners and trawlers may be converted to heavy fuel, using a dual fuel system, where marine diesel oil and heavy fuel are mixed in an emulsifier in proportiones to suit the engine load.

The only attraction with heavy fuel is its cheapness, compared with marine diesel fuel.

The price of 1500 sec redwood marine fuel is normally 50-60% of diesel fuel.



The curves in fig. 3 shows price development for fuel.

On the other hand, the use of heavy fuel will lead to increased maintenance and trouble which will off-set fuel savings.

Estimated cost saving potential 25%.

10. IMPROVED AUXILLARY POWER SYSTEMS

Electrical power systems on fishing vessels were grossly underdesigned 20 years ago. Designers overreacted and a lot of oversized inflexible power systems were installed. Lightly loaded generators, depending on type of engine, may have extremely poow fuel efficiency.

A lot of shaft generators were installed, driven by the main engine at full rpm, using C.P. propellers for vessel speed control.

This is an extremely fuel-wasting method of producing electric power.

Modern shaft generator systems allows change in main engine speed, and electric power produced by the main engine may then be 15% cheaper, due to lower fuel consumption.

Modern main engine driven generating systems make it possible to produce electricity using heavy fuel, with a potential reduction in the fuel cost pr KwH of 50%.

Savings potential for a typical Norwegian trawler would be:

N. kr 50-100.000 pr year, and half that for a middle water longliner.

11. IMPROVED HULL FORMS

The importance of hull forms probably plays an exaggerated role in the minds of naval architects.

As economical speed is reduced by increasing fuel cost, so is the importance of hull form on fuel economy.

Introduction of bulbous bows may have some effects at higher speeds. Fuel saving potential over best current practice 2-3 %.

There is, however need for much work on very beamy vessels, with special benefit for the near water and coastal fleet.

12. WASTE HEAT RECOVERY

Over 60% of the energy in the fuel oil is lost in exhaust gas and cooling water.

This energy may be used for heating, for cooling and for production of electric power.

Suitable technology is not developed for fishing vessels in this field.

Annual expence for auxilliary power on a Norwegian trawler may amount to N. kr 180.000 or 15% of the total fuel bill.

If suitable technology is developed (exhaust boilers, turbo-generators), 120-150.000 may be saved on electric power production.

13. ENGINE DE-RATING

Economical power will be reduced as fuel prices increase.

As a result, esisting engines will be too big as time goes on, with poor fuel efficiency as a result.

Changes may be made to timing, turboblowers and injection nozzles, that may improve fuel consumption 2-5%.

14. IMPROVED USE OF CONTROLLABLE PITCH PROPELLERS

The CP propeller is extremely popular in the Norwegian fleet, and is fitted to an estimated 95% of uor vessels.

We suspect that a considerable amount of fuel is wasted by improper practices when operating the propeller.

Properly used, the CP propeller is an asset in fuel conservation, improper use may turn it into a heavy liability.

The best fuel consumption is obtained by maintaining design pitch, and keeping the engine loaded for maximum fuel efficiency.

When reducing vessel speed this should be done by reducing rpm, not by reducing pitch.

Reducing the load to 25% by constant rpm from A to B, (Fig.1) gives poor fuel consumption. Reduction along the constant pitch line DC gives a much better result.

The efficiency of the propeller is benefitted by the same procedure, as can be seen from the diagram below.

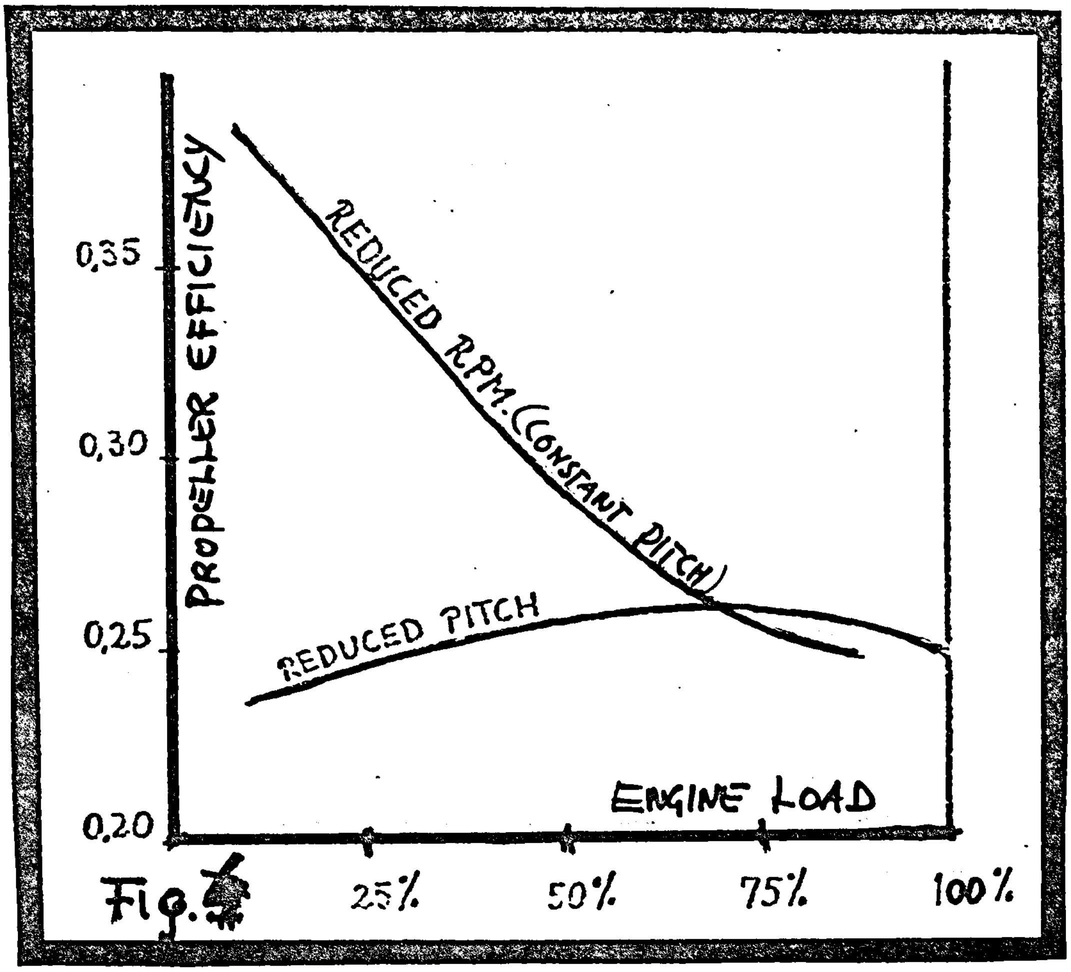


Fig. 4

To achieve maximum preformance is a matter of education and instrumentation.

Savings potential from 0-15%, depending on present practice.

15. IMPROVED FISHING GEAR

Reduction of trawl resistance will effect fuel consumption, and improved catshrates on longlines will affect the fuel ratio.

Preliminary figures for possible improvement is a 30% reduction in resistance for trawls, and 50% increase in catch rates for longlining.

16. ALTERNATIVE ENERGY SCOURCES

A complete return to sailing vessels in fishing is rather unlikely, but a substantial part of the energy may eventually again be taken from the wind and waves.
It is however very difficult to estimate the saving potential, our best quess at the moment is that for longliners 15-25% of the fuel may be saved by wind and wave power.

17. FISH FORECASTING

A substantial amount of fuel is spent looking for fish.

A systematic collection and processing of information on catches, catchrates, observations etc. may serve as basis for fish forecasting in the future.

We are presently unable to even quess what effect such a system would have on fuel consumption, but we are working on it.

This paper represents our institute's first attempt at putting figures on the savings potential of various actions that may be taken.

Some of the figures given are fairly accurate and realistic, others are more or less guesswork.

My hope is that the paper will stimulate discussions on these matters, discussions that will provide additional insights into the field of fuelsaving.