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Fuel Efficient Propellers

A boon to the Indian fishing industry

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IN India, energy security issues assume greater significance on account of increasing demand-supply gap and escalating dependence on imports. In fisheries sector, annual consumption of fuel by the mechanized and motorized fishing fleet of India has been estimated at about 1220 million litres. The small pelagic fishes(fishes seen in the top layer of the sea) like oil sardine, mackerel, lesser sardines, anchovies and Bombay duck caught by ring seiner boats contribute more than 30% of the marine fish production. It is estimated that the pelagic fishery sector of the country alone consume around 200 million litres of fuel per annum. The trend of increasing engine power to achieve more speed to reach the fishing ground faster aggravates the issue of wastage of fuel and leads to great loss to fishers and gives rise to environmental problems like increased carbon emission. Due to unscientific design propellers, this loss increases and also causes huge expenditure on maintenance/ frequent replacement of propellers.

Background

Fuel efficiency is the quantity of fuel necessary to catch and land one tonne of fish. This varies greatly with the fishing method used and the fish resource sought. In earlier days, when cost of fuel was not a matter of serious concern, a trend of incessantly increasing engine power in fishing boats was visible among fishers all around the world, especially in developed countries. This is often done based on illogical grounds like reaching fishing ground slightly faster than other fishers. Often, it will be a matter of prestige. But for this slight increase in speed, when engine power was increased steadily, the fuel usage increased many folds.

The predicament

With the recent rapid escalation in fuel prices, the operational cost of the fishing boats became very high. The rise in operational costs cannot be compensated by increasing the price of fish. Fisherfolk started demanding for fuel subsidy from government to survive in the industry. Moreover, there is a greater awareness of the effects that the use of combustion engines has on the climate. Hence, saving fuel turned up as a complex but workable solution.

Identifying the technology gap

In India, energy security issues assume greater significance on account of increasing demand-supply gap and escalating dependence on imports. In fisheries sector, annual consumption of fuel by the mechanized and motorized fishing fleet of India has been estimated at about 1220 million litres. The small pelagic fishes(fishes seen in the top layer of the sea) like oil sardine, mackerel, lesser sardines, anchovies and Bombay duck caught by ring seiner boats contribute more than 30% of the marine fish production. The pelagic sector is characterised by bulk landings, high cost of operation, poor value realisation due to apparently no value addition and thereby very poor income to the fishermen who belong to the lowest socio-economic strata of the society. It is estimated that the pelagic fishery sector of the country alone consume around 270 million litres of fuel per annum worth around ₹ 891 crore.

Amidst the different operational costs involved in fishing, the cost of fuel alone accounts for 67-73% (Table 1). Increased fuel use clubbed with the tremendous increase in number of boats created an atmosphere of aggressive competition and decreased per capita catch, especially from marine sector. Another serious issue was that the fisherfolk were advised to repair or change propeller in case of poor performance and almost 40% of boat owners were spending ₹ 60,000/- to 90,000/- per year towards this. A survey among

An effort made to systematically analyse the problem of fuel efficiency in motorized fishing fleet and to improve the blade element design of propellers proved fuel saving in ring seiners by 18-21% and a comparatively low cost and practicable solution. With these improved propellers, a fuel saving of average minimum 750 liters of diesel per month per boat can be obtained in fishing. The logical steps taken to commercialise the technology through equipping the traditional propeller manufacturers in the sector augmented the effort.

Table 1. Average operational expenses of different sizes of fishing craft

Operational Expenses (%)	Outboard thanguvallom (Choodavala)			Inboard thanguvallom		
	42 ft	52 ft	60 ft	60 ft	70 ft	80 ft
Fuel	66.28	74.1	61.9	69.8	80.38	70.99
Bata	11.9	11.36	21.87	10.27	11.8	15.95
Transportation	14.25	9	12.8	8.33	5.71	5.8
Ration	Nil	Nil	Nil	3.88	6.9	4.35
Others	7.6	5	3.76	7.77	5.71	2.9

Table 2. Reasons for changing propeller by fisherfolk (N=120)

Reasons for changing propeller	Priority ranks based on response of fishers
Poor speed & pull	I
Exorbitant increase in fuel use	I
Cavitation	III
Cracks developed in blade	III
Physical damage hitting on some hard objects	V

ringseine fisherfolk to study their general perception about the technical problems in fishing and the issues in the sector revealed many interesting information. The reasons for repeated maintenance/replacement were rated by fisherfolk in the priority order given in Table 2.

Among the operational problems identified, the first four listed were due to poor quality of propellers traditionally crafted. In ring seine sector, a fisherman earns only in the range of ₹ 14,000/- to ₹ 20,000/- per annum on an average (Table 3). The fact that more than 60% of active fishermen in marine sector depend on pelagics sector for their livelihood indicates the significance of the issue.

The ring siene fleet at present consists of more than 450 medium and large units and is increasing in size every year. The diesel fuel consumption in this sector alone at present exceeds 27,000 tonnes of diesel annually. Hence, any effort towards conserving fuel is very critical in this sector, as even a 20 per cent increase in fuel efficiency could lead to savings of roughly ₹ 1500 a day by each boat. Assuming that a boat on an average worked for 200 days a year, each boat would thus be able to save ₹ 3 lakh a year. Thus, it is obvious that fuel conservation initiatives should take centrestage in developmental efforts, considering its non-renewable nature, limited availability and effects of its use on environment.

Table 3. Average fuel consumption and total revenue for single day operation in ring seiners

Operational cost	OBM (Choodavala)	IBM (Thanguvala)
Fuel cost	₹ 9,570	₹ 10,270
Vehicle	₹ 1,000	₹ 1,000
Bata	₹ 875	₹ 875
Ration		₹ 700
A. Total Operational cost/ Day	₹ 11,445	₹ 12,845
Total catch	3,500 Kg	6,000 Kg
B. Gross returns	₹ 17,500	₹ 30,000
Total Revenue (B-A)	₹ 1,400	₹ 17,155

The technology intervention

To address the different technological lacunae in the production, processing and marketing of pelagic and fresh water fishes in India, a project aided by World Bank was taken up by the Central Institute of Fisheries Technology (CIFT), namely, "Responsible harvesting and utilisation of selected small pelagic and fresh water fishes". Under the project, efforts were made for reduction of fuel usage in pelagic sector through modified propulsion techniques.

Development of modified propeller system for fuel saving

Non-availability of suitable blade element designs specific to pelagic fishing vessel operations for developing fuel efficient propellers as well as time consuming and inaccurate hull form measurements for propeller matching are the major hindrances for commercial application of the solution. No design standardization exists for hull which makes it difficult to evolve a uniform solution for this problem. A practical solution to reduce this cost is to replace exisiting propellers with fuel efficient propellers. Hence, the designs in vogue were studied and grouped based on resistance profiling.

High efficiency propeller blade element designs developed

Special blade element designs for propellers were developed employing CFD simulation to match the performance characteristics and operational behavior of ring seine fishing system. Flow conditions around standardized hull design groups were established through full scale experiments and CFD simulations.

Fuel-efficient propellers designed for different hull-power combinations

The hull design features and

New design propeller being fitted in a boat for field trial

power characteristics of various groups were established through extensive full scale trials and hull mapping. Flow conditions around these representative digital hull forms were created under sea conditions using advanced CFD tool, Shipflow and 9 basic blade element designs derived through a parametric deviation methodology to suit the flow conditions were analysed. Physical model tests were carried out in IIT, Madras and IIT, Kharagpur before commercial trials. Using this extensive design-analysis-validation exercise spanning over seven months, 12 designs were refined for ringseiner hulls. The propellers developed based on these selected blade elements on simulation clocked 19-28% higher thrust efficiency for differing operational speeds which will be translated to saving in fuel as increase in thrust efficiencies leads to reduced power requirement for the same operational parameters. The prototypes of the twelve fuel efficient propeller designs were manufactured and tested under full scale trials.

Propellers ready for distribution at the production unit at M/s Bright Metals, Kollam

Demonstration for fisherfolk

The new propellers were demonstrated for its fuel saving efficiency to the stakeholders. A series of awareness programmes for stakeholders on the benefit of the technology in selected locations in the coastal villages of Kerala like Calicut, Thrissur, Kollam etc in association with MATSYAFED, the apex body of fisheries co-operatives, Department of fisheries, Kerala.

Later, validation of 12 propellers were carried out by field trials on commercial fishing vessels owned by fisherfolk. Propeller selection method was validated in association with engine manufactures and propeller manufacturers. When the field trials gave encouraging results, the new propellers were welcomed by fishers, or rather became a indispensable requirement.

Commercialisation and scaling up

Supply of fuel efficient propellers for engines upto 200 Hp on commercial mode has been demonstrated through M/s Sree Muruga Propeller Works, Kozhikode, Kerala. The business model equips the manufacturer and the boat owner to select propeller based on identified design groups without need for any extensive pre-vessel-testing.

The first level commercial trial made on 12 vessels using seven commercially released designs helped to reduce fuel consumption of around 18-21%. A fuel saving of average minimum 750 liters of diesel per month (₹ 4,20,000 per annum at present prices) per boat can be obtained in fishing. Speed was improved by 10-15% on an average.

Average earning per vessel was clocked at around ₹ 52000 per month. Cost involved in propeller change is found to be easily recover-able within 3 months of vessel ope-ration. M/s Sree Muruga Propeller Works has switched over to the fuel efficient propellers, once commercial release of designs became successful. At present the firm is equipped to supply as many number of propellers as required for the sector.

Leading engine manufacturers for ring-siene boats, M/s Bright Metals, Kollam have started production and marketing of fuel optimised propulsion systems according to hull designs. The adoption rate is slowly increasing and in Kollam alone, more than 40 boats are now fitted with new design propeller. M/s Mahindra and Mahindra Ltd. Powerol Division has come forward to try modified versions of these designs on trawlers in Bhatkal, Karnataka.

SUMMARY

The pelagic fishery sector of the country alone consume around 200 million litres of fuel per annum. The trend of increasing engine power to achieve more speed to reach the fishing ground faster aggravates the issue of wastage of fuel and leads to great loss to fishers and environmental problems like increased carbon emission. Due to unscientific design propellers, this loss increases and also causes huge expenditure on maintenance / frequent replacement of propellers. The improved blade element design of propellers proved fuel saving in ring seiners by 18-21%. This intervention can benefit the sector consisting of about 1100 vessels and could save around 14-19 million litres of diesel per annum worth around 63-78 crore rupees. It will also help to reduce 51,000 tonnes of CO_2 emission per annum. The techniques developed for this sector can be customized for creating appropriate designs for other sectors like trawlers to achieve still higher fuel saving.

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