

Energy Efficient Fishing Vessels and use of Alternate Energy for Fishing

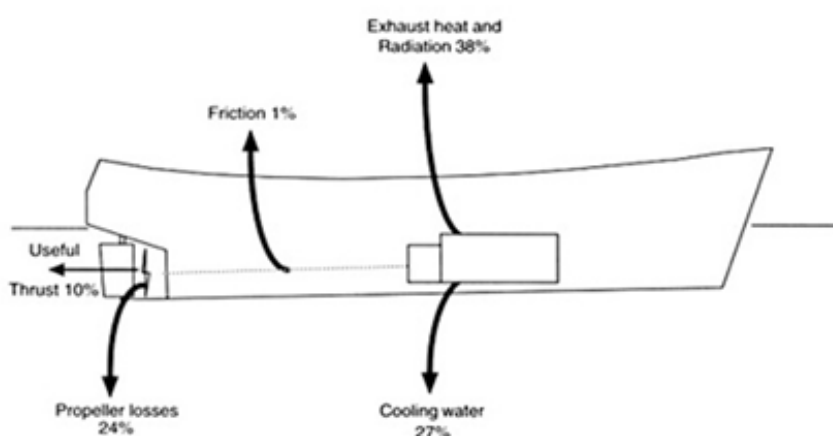
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The annual fuel consumption by the mechanized and motorized fishing fleet of India has been estimated at 1220 million litres which formed about 1% of the total fossil fuel consumption in the country in 2000 releasing an estimated 3.17 million tonnes of CO₂ in to the atmosphere at an average rate of 1.13 tonnes of CO₂ per tonne of live weight of marine fish landed. The increasing fuel cost causes substantial loss to the fishery industry eating away fisherman's income. Thus the need of Green fishing systems with energy efficient hull form and utilization of renewable and non-polluting energy started spreading around the globe.

In the context of the harmful impacts of burning fossil fuel and the cost involved, the need for fuel efficient fishing vessels in the commercial sector is gaining importance. ICAR-CIFT is conducting extensive research in this field for the past several years. Combination or multipurpose fishing is one of the methods to save fuel. Improving hull efficiency is another step. The hull is the most important part of a fishing vessel as it has direct contact with water. The shape of hull determines the amount of drag pull and how the vessel will respond/perform at different speeds and in different water conditions. An efficient hull has less drag and uses less fuel. Use of light materials for the construction of fishing vessel is also experimented by CIFT. The following diagram explains the energy distribution in a fishing vessel.



The main engine delivers power to the propeller through a reduction gear box. The energy available from the propeller shaft (27%) rotates the propeller; to overcome skin friction (18%), wake resistance, propeller wash against the hull (17%) and air resistance (3%). Advanced designs in fishing vessel hull and fuel innovations reduced the fuel consumption significantly.

Factors affecting hull resistance

Appendage resistance contributes to about 1 – 3 percent of the total resistance for a vessel in calm water condition. Roughly about half the appendage resistance is attributed by the bilge keels and the other half to the rudder. Fig.1 shows the bilge keel and Fig 2 shows the rudder which are projecting outside the hull.



Fig.1. Bilge keel fitted to the under water hull

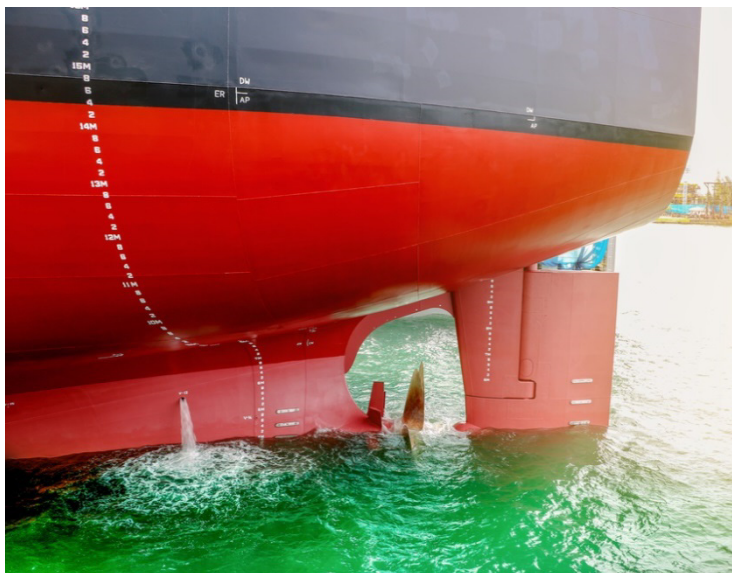


Fig. 2. Rudder

Two aspects of hull design that directly affect the fuel efficiency of a fishing vessel are

- (i) The underwater hull form at the stern, in particular the area around and forward of the propeller aperture, affects operational efficiency of the propeller in the wake.
- (ii) The overall hull form, in particular the slenderness of the hull, affects the vessel's resistance and, therefore, its power requirement and fuel consumption.

The bare hull of a fishing vessel is considered to have three hydrodynamic resistance components in calm water

- (1) Skin friction resistance: The effect of viscous friction between the water and the ship's hull.
- (2) Viscous pressure resistance: The result of the distribution of pressure around the hull that is related to the thickness of the boundary layer and wake (separated flow) in the flow pattern. It is Often called form drag.
- (3) Wave making resistance: Is caused by water pressure on the hull, and is associated with generating a pattern of waves on the water surface as vessel moves along. The resistance is due to the energy required to create these waves. Fig. 3 shows the wave making pattern of a vessel and Fig.4- shows the components of resistance of a vessel at sea.

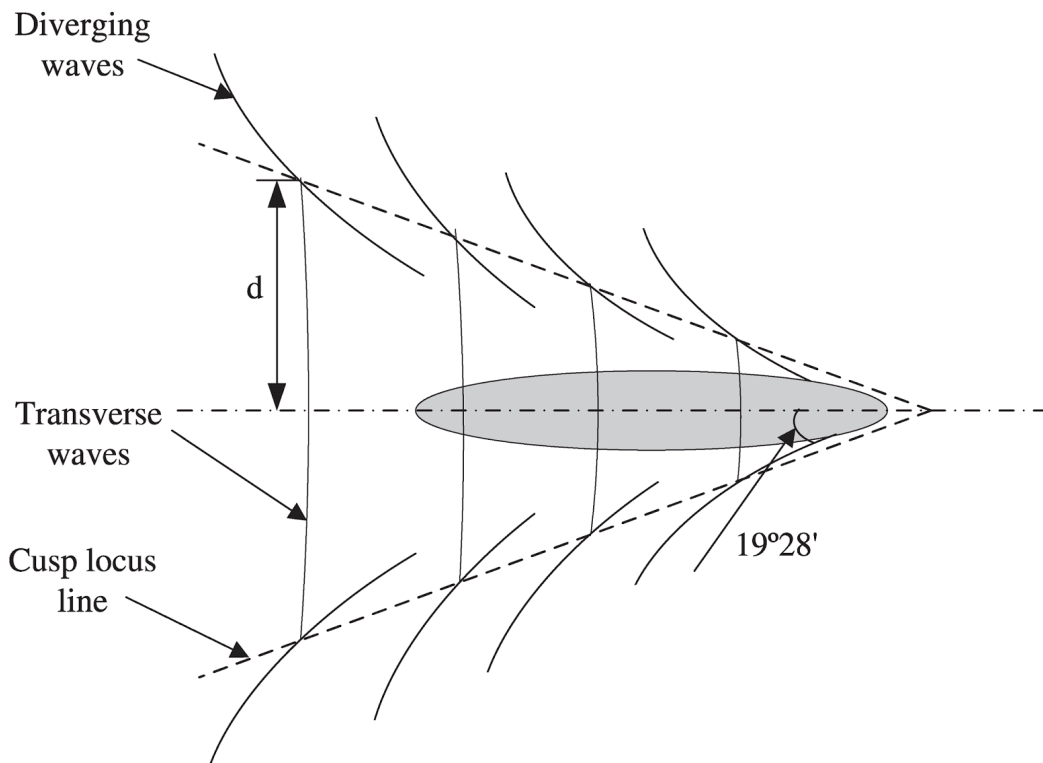


Fig. 3. Wave making pattern

At low speeds, the waves made by a vessel are very small and the resistance is almost wholly viscous. As speed increases the viscous resistance increases moderately with speed. However, the wave making resistance increases greatly with speed.

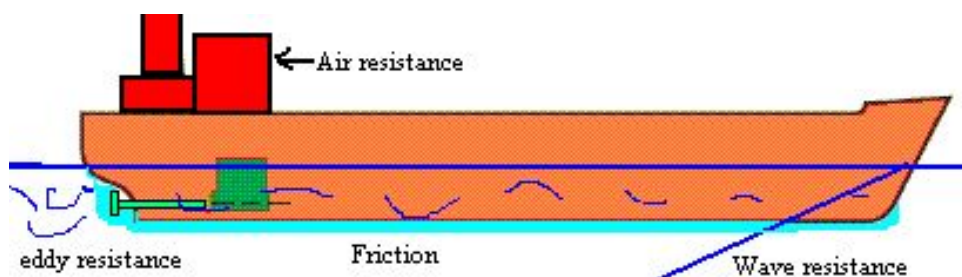


Fig. 4. Components of resistance of a vessel at sea

The most important method for reducing fuel consumption is to travel to the fishing grounds at reduced speed. Excessive weed or barnacles that grows on the hull will result in increase of friction up to by 50%.

The drag due to appendages such as rudder, bilge keels, transducer mounts and cooling water pipes etc. can add up to 20% of the total hull drag. Where the design of appendages focuses on simplicity, low capital cost and robustness, excessive drag may exist. For a typical 15m vessel travelling at 10 knots, an aero foil rudder consumes nearly 6kW (4%) less engine power than a flat plate rudder. If the rudder is turned to 10 degrees, the aero foil rudder consumes about 4kW (3%) less than the flat plate rudder. Other parameters such as the selection of main engine, reduction gear, propeller, introduction of bulbous bow to the hull, and use of alternate source of power for auxiliary purposes also results in improving the efficiency. Use of nozzle propeller increases the thrust by 5 to 10 % in a trawler.

Methods to improve the efficiency of fishing vessel hull form

Hull for optimization: To minimise hull resistance we can optimize the fore body and aft body optimization.

Minimize the appendage resistance: The conventional method of hull form analysis is by conducting a model test in a towing tank. Appendages such as bilge keel should be avoided, if not possible the shape should be model tested in a towing tank or analysed in CFD so that the resistance will be minimum. The advantages of CFD analysis are the saving in cost compared to model testing. Also the CFD analysis is very much faster compared to model testing. Refining a hull model in CFD is easier than in a model testing.

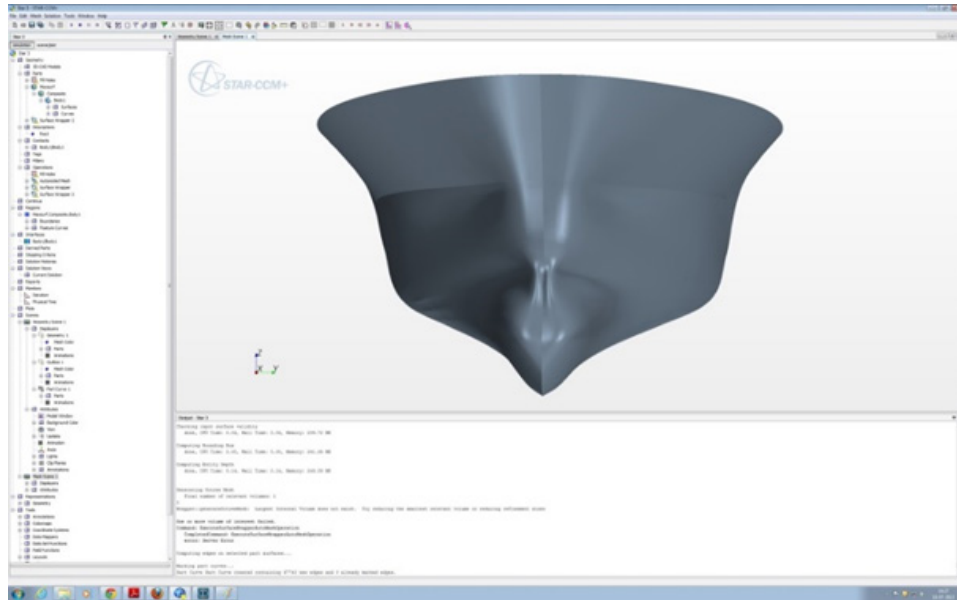


Fig. 5. CFD model of a fishing vessel

Proper selection of speed of vessel: The economical speed range for fishing vessels is decided using the Froude number which falls between 1.0 to 1.3 for fishing vessels. Higher values will lead to higher consumption of fuel due to increased resistance.

As shown in the Fig. 6, the resistance increases exponentially with increase in speed. So choosing higher speeds will reduce the efficiency of the vessel.

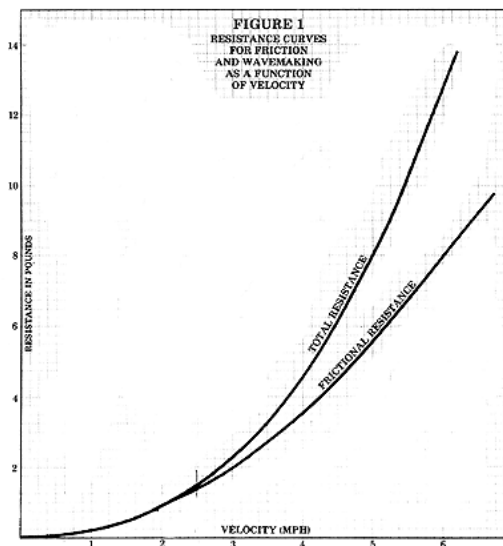


Fig. 6. Resistance versus speed.

Design of efficient propulsion system: The power generated by the main engine is transmitted to the propeller through a reverse reduction gear box and shaft. There will be frictional losses in this process. So an efficient combination of propeller and shaft system will improve the efficiency

Minimising the weight of the total fishing vessel: This can be achieved by selecting light materials for construction of different parts of the vessel. A vessel with wheel house and cabin built in FRP saves around 10 % weight. This will naturally lead to lower resistance. While selecting the main engine, gear box, winch, etc care is to be given for higher brands.

Use of nozzle for trawlers: The increase in thrust of trawler by fitting a nozzle around the propeller is estimated as 5 % approximately.

Bulbous bow: A bulbous bow can yield a significant reduction in drag (> 10%) on displacement craft moving at Froude number greater than 0.3. For a 15m vessel this corresponds to >7 knots. Excessive form drag often occurs if a vessel with a transom stern is trimmed by the stern. Proper trim adjustment is important, even extra weight (ballast) in the bow to achieve level trim might reduce total drag.

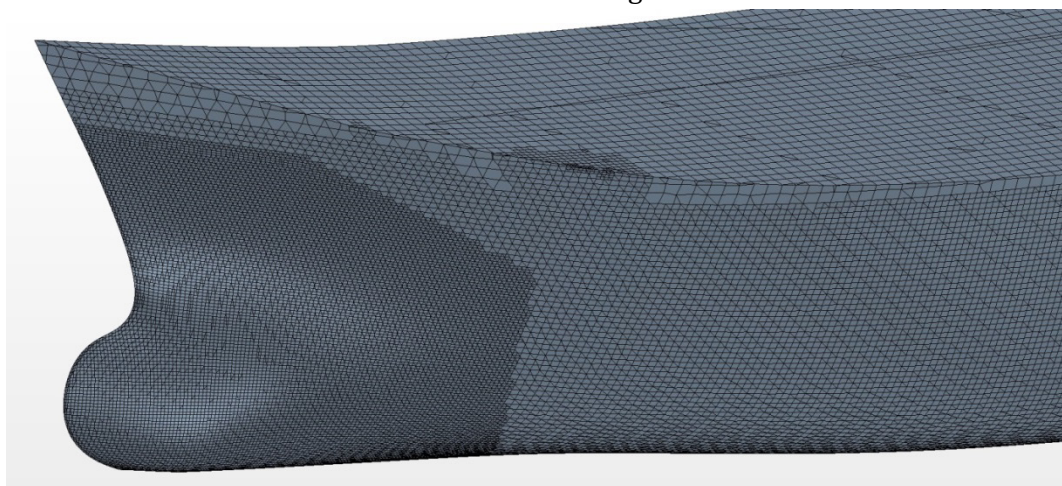


Fig.7. Bulbous bow in the forward of the hull

Solar power for light and fan: The application of solar power for cabin lights, navigational light and fan can save on the fuel consumption.

Alternate energy for fishing vessels

Solar powered boats: Solar powered boats get their energy from the sun. Using electric motors and storage batteries charged by solar panels and photovoltaic cells, solar powered boats can significantly eliminate their use of fossil fuels. Solar boats are uniquely suited to transform light energy into movement. ICAR-CIFT has developed the designs of solar powered fishing vessels for fishing in the inland, back waters and rivers. First vessel 3.63 m Loa FRP solar boat can run continuously for 4 hours in the day time which is highly useful for the fishers. This is used by the tribal fishers at Malampuzha reservoir. The second boat 8.0 m Loa solar boat can run for 4 hours continuously in the day time and is in use at Fish farm, MATSYAFED, Njarakkal. Also solar power can be very effectively utilized to power the light, fan, navigational equipment and other small power applications onboard mechanized fishing vessels. This will reduce the quantity of diesel burned and will in turn reduce the GHG emission. The main advantages are:

1. No fuel cost
2. No pollution from the burning of fuel
3. Less carbon footprint
4. Clean FRP surface
5. Wider boat and low rolling during fishing
6. More deck area
7. Suitable for shallow waters
8. No sound pollution
9. Canopy for protection from rain and sun.



Fig. 8. ICAR-CIFT Sunboat-I



Fig.9. ICAR-CIFT Sunboat-II

LNG powered fishing vessels

The use of liquefied natural gas (LNG) as ship fuel has recently gained more attention in Europe, but also in Asia and the USA. A marine LNG engine is a dual fuel engine that uses natural gas and bunker fuel to convert chemical energy in to mechanical energy. Due to the burning properties of

natural gas which is cleaner, the use of natural gas in ship propulsion plants is becoming an option for companies in order to comply with IMO and MARPOL environmental regulations. The natural gas is stored in liquid state (LNG) and the boil-off gas is routed to and burned in dual fuel engines. There are three benefits which, taken together, make LNG as ship fuel one of the most promising new technologies for shipping. The use of LNG as ship fuel will reduce sulphur oxide (SO_x) emissions by 90- 95%. This reduction level will also be mandated within the so- called Emission Control Areas (ECAs) by 2015. A similar reduction will be enforced for worldwide shipping by 2020. „ A lower carbon content of LNG compared to traditional ship fuels enables a 20-25% reduction of carbon dioxide (CO₂) emissions. Any slip of methane during bunkering or usage needs to be avoided to maintain this advantage. LNG is expected to be less costly than marine gas oil (MGO) which will be required to be used within the ECAs if no other technical measures are implemented to reduce the Sox emissions. Current low LNG prices in Europe and the USA suggest that a price – based on energy content – comparable to heavy fuel oil (HFO) seems possible, even when taking into account the small scale distribution of the LNG. ICAR-CIFT has already initiated research actions in this field along with Petronet Kochi LNG terminal.