Fishery Technology 57 (2020) : 98 - 100

Development of Low Drag Trawls for Energy Efficient Fishing

M. P. Remesan[1]*, K. A. Sayana[1], V. R. Madhu[1], P. Pravin[2], Saly N. Thomas[1] and Leela Edwin[1]
[1] *ICAR-Central Institute of Fisheries Technology, P. O. Matsyapuri, Cochin - 682 029, India*
[2] *Indian Council of Agricultural Research, Krishi Anusandhan Bhawan, New Delhi - 110 012, India*

Abstract

Trawl drag is an important factor determining the energy efficiency and profitability of trawling. Drag experienced during trawling depends on the design, rigging, accessories of the net, hydrographic and dragging conditions and has a direct bearing on fuel consumption. Fuel cost can alone constitute up to 75% of the operational expenditure of a trawler. Stronger materials will permit the use of thinner twines to reduce twine surface area and hence drag. Empirical estimations of drag of different commercial trawl nets in Kerala showed it to range from 1.37 to 48.94 kN. Comparative fishing trials were carried out with 24 m trawls made of HDPE twine and ultra-high molecular weight polyethylene (UHMWPE). Study revealed that average fuel consumption of HDPE trawls was 31.86±1.25 l^{-h} whereas it was 25.31±1.38 l^{-h} for UHMWPE trawl. CPUE were 8.1 kg h^{-1} and 7.9 kg h^{-1} for UHMWPE trawl and HDPE trawl respectively. Results shows that material substitution, coupled with improvement in trawl design, appropriate gear accessories and towing speed can help significantly in reducing the drag and concurrent reduction in fuel use.

Keywords: Low drag trawl, energy efficiency, UHMWPE, twine surface area

Introduction

Trawling is the most important fishing method in India with regard to fleet size and quantum of marine catch and is popular in all the maritime states of the country. Scofield (1984) stated that for capturing demersal populations, trawling is the best method in terms of yield and investment. Huge quantity of bycatch, high fuel consumption resulting in emission of CO_2 and impact on benthic ecosystem are major issues associated with trawling. Increase in the size of trawlers coupled with use of high speed engines has escalated the fuel consumption significantly. Trawling on an average consumes 0.8 kg of fuel to catch one kilogram of fish (Gulbradson, 1986). Fuel consumption per hour among all category of trawlers in Kerala ranges 6.12 l to 52.8 l (Sayana, 2018).

The resistance offered by gear systems under tow has a large effect on overall fuel consumption. According to Wileman (1984), the warp contributes 5%, sweeps 4%, otterboards 20%, floats 3%, foot rope 10% and netting 58% to the total drag. Drag of trawl depends on design and rigging of the net, speed of trawling, length of warps and direction and speed of water current. There are several methods suggested to reduce the drag and fuel consumption of trawling. Use of smaller otterboards with additional weights, towing speed optimization, adoption of thinner twines and large mesh size to reduce twine surface area can bring down the drag and thereby consumption of fuel. Design improvement and material substitution for drag reduction in trawls operated along Indian coast have been reported by Madhu et al. (2015); Sayana et al. (2015); Remesan et al. (2017).

Trawls made of twines with higher breaking strength and smaller diameter will reduce drag and improve the energy efficiency (Ward et al., 2005). Studies have proved the drag reduction potential of ultra-high molecular weight polyethylene (UHMWPE) webbings (Lowe, 1996; Hansen & TØrring, 2012; Sayana et al., 2018). The objectives of the present study was to substitute HDPE netting with UHMWPE netting for trawl fabrication and to study the drag, fuel consumption and capture efficiency of the two net designs.

Received 29 June 2019; Revised 08 October 2019; Accepted 10 October 2019

*E-mail: mpremesan@gmail.com

© 2020 Society of Fisheries Technologists (India)

Materials and Methods

Experimental fishing has been carried out off Cochin (09°54′N, 76°05′E and 10°59′N, 76°10′E) on onboard ICAR-CIFT departmental vessel RV. Matsyakumari-II, a 17.7 m steel trawler with 325 hp diesel engine. Forty hauls each of 1 h duration, were made with 24 m HDPE fish trawl and 24 m UHMWPE fish trawl respectively (Fig. 1). UHMWPE ropes of 12mm diameter were used as towing warps. Depth of operation ranged from 10 to 20 m, fishing speed from 3 to 4 kn and warp length from 40 to 100 m.

Gigasense^{TM} Warp Tension Meter of maximum 20 ton capacity was used to measure the drag acting on the towing warp. Tension Meter was attached on to the port and starboard side towing warps alternatively, about 50 cm away from the gallows, after shooting and the net got stabilized. Readings were recorded every two minutes interval during towing. Fuel consumption for each operation was recorded using Fuel flow meter (Aquametro)^{TM} fitted to the fuel line of the vessel. Regression analysis was used to assess drag in relation to different parameters.

Results and Discussion

Maximum drag shown by UHMWPE trawls was 9.13 kN at 3.0 kn speed and the minimum value of 3.21 kN at 3.6 kn and the average reduction in drag for UHMWPE trawl was estimated as 17%. For every 9.28% increase in towing speed a 1% increase in drag of UHMWPE trawl was recorded and a 10.11% increase in towing speed icreased the drag of HDPE trawl by 1%. Average drag recorded against towing speed was plotted (Fig. 2) which showed a positive relationship (R^2 = 0.805). Drag of the experimental nets increased proportionately with speed and it was more for the HDPE trawl.

Sala et al. (2011), assessing energy utilization of fishing vessels under different operating conditions, have reported reduction in drag by reducing speed of vessel. Manjarres-Martinez et al. (2015) and Madhu & Panda (2009) studied the effect of tow duration and towing speed on capture efficiency of bottom trawl.

Length of warp released during entire operation ranged from 40 to 100 m and drag ranged from 9.4 to 13.7 kN respectively. The length of warp released was positively correlated to drag (Fig. 3). The increase in drag was comparatively higher in HDPE trawl, when compared to UHMWPE trawl ($p>0.05$).

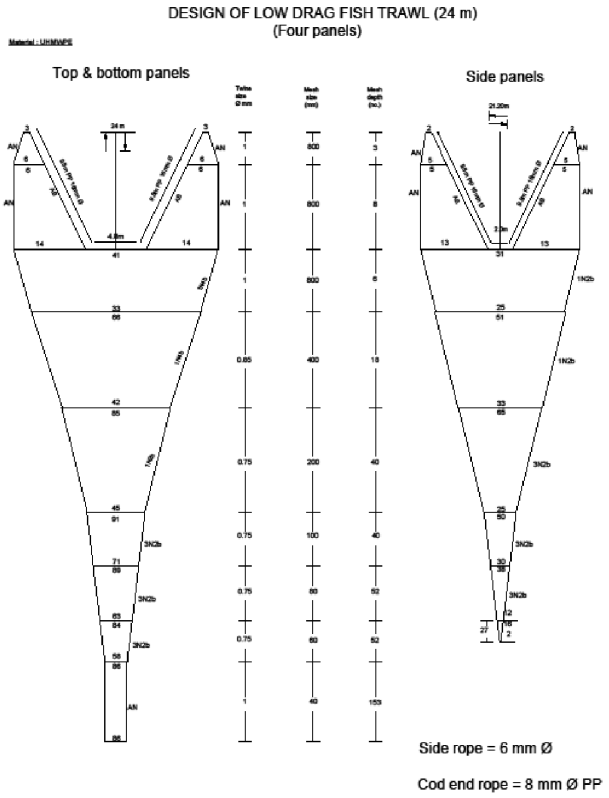

Fig. 1. Design of experimental trawl

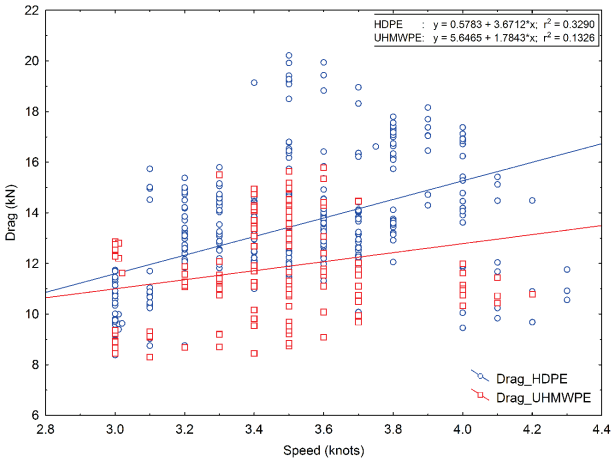

Fig. 2. Drag of experiemental nets in relation to towing speed

It was estimated that a 1.94% decrease in drag of HDPE trawl and 2.17% decrease in drag of UHMWPE trawl brought about 1.0% decrease in fuel consumption. Average fuel consumption estimate revealed that HDPE trawls consumed 31.86±1.25 litres of fuel per hour of towing time whereas it was only 25.31+1.38 l for UHMWPE trawls (Fig. 4). Catch per unit towing time of

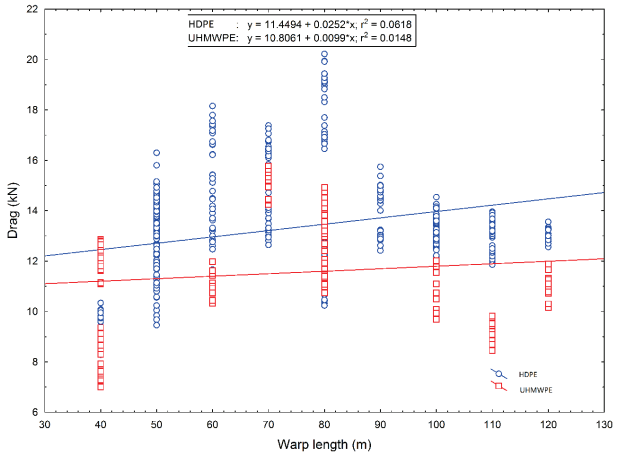

Fig. 3. Drag in relation to warp length

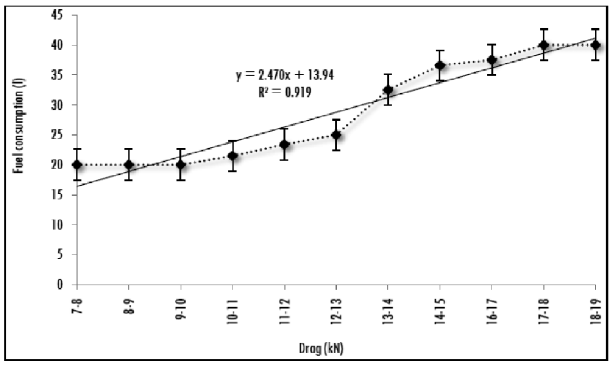

Fig. 4. Relation between drag and fuel consumption

UHMWPE trawl was 8.1 kg and 7.9 kg in HDPE trawl showing a 2.5% improvement. However, the difference in CPUE of both trawls was not statistically significant ($p< 0.063$). The average fuel consumption per kilogram of fish caught for HDPE and UHMWPE trawls were 2.9 liters and 1.9 liters, respectively. A significant reduction in drag, with concurrent decrease in fuel consumption and no significant increase in capturing efficiency was recorded when using UHMWPE trawl. The average reduction in drag was 17% with 10% average reduction in fuel consumption.

Factors like the towing time, current and wind direction, weight of catch in the codend and other factors, which affect the drag, were not taken into consideration. However, from the results it can, be determined that material substitution, coupled with changes in the design of the trawls and adopting optimum speed and warp lengths can help in reducing the fuel consumption during trawling. Since fuel alone contributes more than 60% of the operational expenses in trawling, any reduction in fuel will have significant effect on the operational cost of trawling apart from additional benefits of reduction of CO_2 emission.

Acknowledgements

Authors wish to express sincere thanks to the Director, ICAR-Central Institute of Fisheries Technology, Kochi for permission to carry out the wok and publish the article. The support of skipper and crew of ICAR-CIFT departmental vessel R. V. Matsyakumari-II is duly acknowledged. Financial support from ICAR- National Agricultural Science Fund is also gratefully acknowledged.

References

Hansen, U. J. and Tørring, P. (2012) Best available technology makes drastic cuts in fuel expenses in trawl fisheries, E-Fishing, Vigo, Spain

Lowe, T. (1996) An Analysis of the Gains in Engineering Performance Achieved by Constructing Australian Prawn Trawls from Spectra Netting, B.Sc. thesis, Australian Maritime College

Madhu, V. R. and Panda, S. K. (2009) Effect of tow duration and speed on the capture efficiency of bottom trawl. Fish. Technol. 46(1): 25-32

Madhu, V. R., Remesan, M. P., Pravin, P. and Boopendranath, M. R. (2015) Cut away top belly trawl – A new eco-friendly shrimp trawl design. Book of Abstracts. World Ocean Science Congress. 39p

Manjarrés-Martínez, L. M., Gutiérrez-Estrada, J. C. and Hernando, J. A. (2015) Effects of mesh size and towing speed on the multispecies catch rates of historical swept area surveys. Fish. Res. 164(0): 143-152

Remesan, M. P., Madhu, V. R., Sayana, K. A., Prabeeshkumar, M. V., Harikrishnan, K. R. and Edwin, L. (2017) Fuel saving through material substitution in trawls. Fish Tech Reporter 3(1): 3-5

Sayana, K. A., Dhiju Das, P.H., Remesan, M. P. and Leela Edwin (2015) Estimation of drag of commercial trawls along Indian coast and an arithmetical study on drag reduction. Book of Abstracts. World Ocean Science Congress. 39p

Sayana, K. A., Remesan, M. P. and Leela Edwin (2018) Impact of operational parameters on drag of trawl nets. Fish.Technol. 55: 295-297

Scofield, W. L. (1948) Trawling gear in California. State of California, Dept. of National Resources, Division of Fish and Game. Fish. Bull. 72: 60p

Ward, N., Montgomerie, M. and Lart, W (2005) Fuel efficiency trails using Jakson trawls with reduced twine diameter on MFV Challenge II Seafish Report No.SR 578, 31p

Wileman, D. (1984) Project "Oilfish". Investigation of the Resistance of Trawl Gear. The Danish Institute of Fisheries Technology. 42p