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Research Note

Impact of Operational Parameters on Drag of Trawl Nets

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Many of the world's fisheries are facing multiple challenges in the form of over capacity, resource depletion and high investment, while rising fuel prices is worsening the situation. Trawls are the most energy intensive fishing systems consuming more fuel than purse seining, long lining and gillnetting (Gulbrandsen, 1986; Tyedmers et al., 2005; Muir, 2015; Parker & Tyedmers, 2015; Parker et al., 2015). Hence maximum scope for fuel conservation among fishing sector exists in trawling. During calm weather, large quantity of fuel is used to overcome the trawl drag compared to that used for vessel propulsion in trawlers. In trawling operation, a sizeable time is also spent for towing the gear and 10-20% fuel consumed is spent to overcome the resistance (drag) during towing time (Montgomerie, 2009). Hence it is understood that gear has a large effect on fuel consumption during towing because drag due to vessel is insignificant at the time of towing when compared to drag due to gear (Boopendranath, 2002) and a reduction in drag can lead to a substantial reduction in fuel consumption. Studies on drag and its influencing factors will be helpful to those who are associated with designing of trawl to effectively accommodate the design and operational parameters for fuel conservation. Impact of towing speed on drag and fuel consumption of trawlers have been studied by Priour (1999), Curtis et al. (2006), Khaled & Priour (2010), Sala et al. (2011), Khaled et al. (2013) and Balash & Sterling (2012). The present study was conducted to assess the impact of operational parameters on drag of trawl nets.

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The study was carried out onboard ICAR-Central Institute of Fisheries Technology, Departmental fishing vessel Matsyakumari II (17.75m L_{OA}) using two trawl nets of 24.0 m head rope length. One of the trawl nets is fabricated with high density polyethylene (HDPE) webbing and second with ultra high molecular weight polyethylene (UHMWPE) as reported by Remesan et al. (2017). Ultra high molecular weight polyethylene (UHMWPE) material is an advanced form of polyethylene delivering superior strength and performance over conventional polyethylene webbing and has proved its suitability as a material for trawl net fabrication (Sendlak et al., 2001; Sala et al., 2008; Balash et al., 2009; Anon, 2009; Balash, 2012). The trials were conducted during February to April, 2017. Total of 80 hauls, 40 hauls for each net were made and data on towing speed, warp length, depth of operation and drag were recorded. Depth of operation ranged from 10 to 15 m, towing speed varied from 2.3 to 4 kn and length of warp released varied from 40 to 100 m according to the depth of the fishing ground. Impact of operational parameters on drag of trawl nets is assessed by multiple regression analysis where operational parameters such as depth of operation, warp length and towing speed were taken as independent variables and drag was taken as dependant variable.

Results of the experiment were analysed using multiple regression analysis separately for HDPE trawl and UHMWPE trawl. Operational parameters like depth of operation, length of warp released, towing speed of the vessel and material of fabrication of trawl net were found to have a linear relationship with drag. Among the parameters tested, depth of operation had least variation as the range was kept between 10 and 15 m.

The length of warp released during entire operation ranged from 40 to 100 m for which regression analysis revealed that warp length had a positive impact on drag which mean there is a linear relationship between length and drag, but statistically there is no significant effect which may be due to the short range of values. Plotting the average drag at different warp lengths (Fig. 1) also proved the impact of warp length on drag (R^2= 0.59).

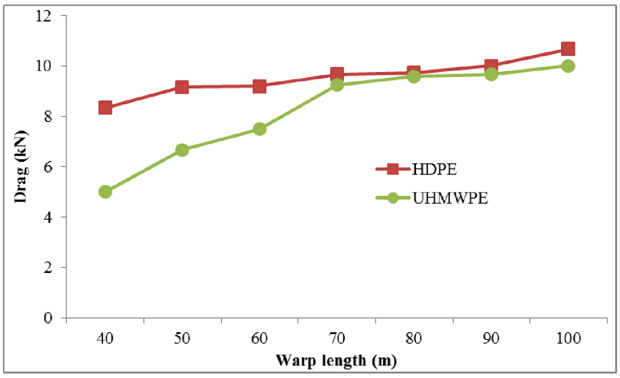

Fig. 1. Average drag of trawl nets at different warp lengths

Towing speed is found to be a decisive factor in determining the drag of trawl nets and fuel consumption of trawlers. Towing speed of commercial trawlers ranged from 2.0 to 6 kn depending on the target species and type of trawl nets operated. From regression analysis, the impact of towing speed on drag of trawl nets is established even within the short range of values. The impact of towing speed on drag is statistically significant for both trawl nets; ($p<0.019$) for HDPE trawl and ($p<0.002$) for UHMWPE trawl. When towing speed increased by 0.1 kn, there was an increase of 0.34+ 0.63 kN drag. Results of ANOVA revealed that every 9.28% increase in towing speed made 1% increase in drag of UHMWPE trawl and 10.11% increase in towing speed made 1% increase in drag of HDPE trawl. Average drag at every towing speed is plotted (Fig. 2) and from the graph, the impact of towing speed on drag of trawl nets is very clear (R^2 = 0.805).

As drag of trawl nets and fuel consumption of trawlers are linearly related, it can be used to explain and support the impact of towing speed on drag. Results of the present study are in accordance with the study carried out by Seafish, which showed that reducing towing and steaming speeds can provide fuel savings up to 50%, whilst still working at 70% of the maximum capacity (Curtis et al., 2006). Balash & Sterling (2012) tested model trawl nets fabricated with different materials in flume tank and significant increase in drag with increase in towing speed was observed in all materials. Sala et al. (2011) assessed energy performance of fishing vessels under different operating conditions and 15% reduction in fuel consumption was obtained by reducing half a knot speed. Studies conducted by Priour (1999); Khaled & Priour (2010); Khaled et al. (2013) also throw light on impact of towing speed on fuel consumption of trawlers. Madhu & Panda (2009) studied the effect of tow duration and towing speed on capture efficiency of bottom trawl and concluded that towing speed has less impact on capturing efficiency of trawls. Manjarrés-Martínez et al. (2015) investigated effect of mesh size and towing speed on the multispecies catch rates of historical swept area surveys during 1988-2001 in Colombian Carribean Sea and found that towing speed doesn't have significant impact on catch rate.

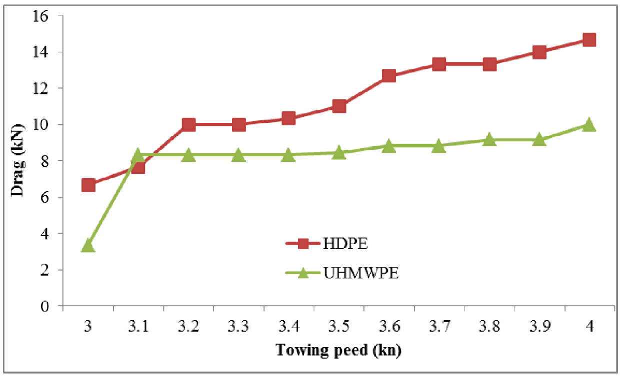

Fig. 2. Graph showing change in drag (kN) of trawl nets with respect to change in towing speed (kn)

By analyzing the impact of operational parameters effect of length of warp and towing speed on drag of trawl nets have been proved. Among these factors, effect of towing speed on drag of trawl nets is quantified and it is concluded that 10.11% decrease in towing speed of HDPE trawl and 9.28% decrease in towing speed of UHMWPE trawl will impact 1% reduction in drag of trawl nets.

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