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Riga Polytechnical Institute / RTU Alumni

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Efficiency of Energy Efficient Ship: Use of Spinnaker

Ilze Stelpa (*Institute of Aeronautics, RTU*), Gunārs Šteinerts (*Latvian Maritime Academy*)

Keywords **– wind power, spinnaker, fuel reduction, trading routes**

I. Introduction

This paper analyses effectiveness of wind power and spinnaker use in order to reduce significantly fuel consumption, CO2, NOx emissions.

II. Spinnaker principles

In order to reduce significantly CO2, NOx emissions, as well as gain independence from dwindling oil resources, the maritime industry is searching for various alternative energy uses.

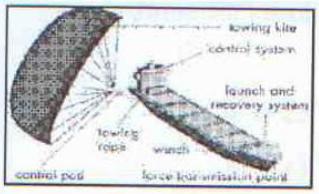

Fig.1 Spinnaker components [1]

As one of the solution is spinnaker or kite sail (See Fig.1), which is much more flexible in maintenance, because it can be easily added to an existing ship or moved from one vessel to another. When towing rope rises above 213 m, where the surface friction does not affect the operation of spinnaker, it's use is very effective. Previous test results indicate that fuel savings can be of between 10-20%.

III. Advantage of spinnaker

Advantage of commercial spinnaker is that it can be used up to 500 to wind at the wind velocity 12-74km / h (7-40 knots) or 3 - 8 points on the Beaufort scale. Besides it can be used by almost all wind directions relative to ships course – even 50 degrees and 310 degrees upwind. At altitude exceeding 200m, winds are stronger and last longer than on the land, as on sea surface friction has negligible impact to the operation of the wind – so called stable wind gradient.

Although spinnaker can be used only 3 nautical miles off obstacles and outside Traffic separation schemes, there are no other restrictions and regulations that concern spinnaker. The most effective use of spinnaker is in the main shipping routes, in both directions from Europe to North America, North America to East Asia, because of the highest potential for wind energy.

As calculations [2] have proved the most effective spinnakers nowadays are 160m^2 and 320m^2 size spinnakers and the most efficient use of them is on the multipurpose heavy lifts or general cargo vessels with maximum length up to 130 m and main propulsion output up to 3800kW. With such parameters vessels can save ~20% of fuel.

IV. Spinnaker system components

The spinnaker system components (See Fig.1) can be divided into 3 large groups:

1. Double wall spinnaker as paraglider with high strength and weatherproof towing line;
2. Launch and recovery system including dynamically operating winch, force transmission point, rope stowage box. Complete spinnaker launch and recovery can take up to 20 minutes;
3. Automatic control system including control pod on towing line, on board computer, autopilot programme, programmable logic controller for launch and recovery system.

As a minimum the following sensors must be installed on the ship for spinnakers: GPS, wind direction gauge, anemometer, rudder position, course. The ship's sensors must comply with the NMEA standard, because data are transmitted via RS 232 or RS 422.

V. Amortization period for existing spinnakers

Tractive force of spinnaker can be calculated as:

$$Fa = c * \frac{p}{2} * v^2 * A$$

where:

c – lift coefficient of the towing kite;
p – density of the air;
v – airflow velocity of the kite;
A – surface area of the kite.

Consequently it means that not only spinnaker size is important but trading area with prevailing winds – small multipurpose heavy lift feeder operating in North Atlantic trading route can cut amortization time twice in comparison with the same size and type vessel. Differences in fuel prices affect amortization time, as well. Amortization time for existing spinnakers (calculated in 2009) is not less than 2.1 year in favourable wind route up to 5 years.

As one of disadvantages can be mentioned extra crew training that is not included in amortization costs.

VI. Conclusions

Growth of spinnaker use on merchant vessels is relatively slow, mainly because of long amortization and industry been waiting for final results of first maintained spinnakers, rigged in 2007. However since 2007, when first spinnaker was installed on cargo ship, this technology has been recovered in another breath. In 2012 in the world's fleet less than 10 vessels are equipped with spinnaker still indicating that use of spinnaker can be much wider. Calculations show that the currently widely available 2 size spinnakers with size 160m^2, 320 m^2 can be fitted on ~ 60 000 world merchant vessels reducing CO2 emissions by 150 million tonnes every year and saving million of fuel tonnes, as well.

VII. References

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