Steerprop
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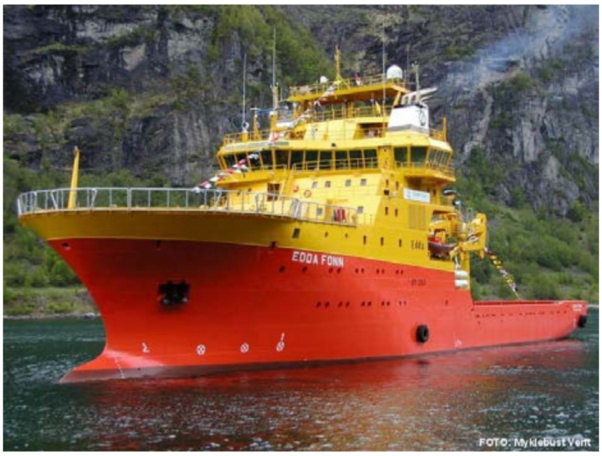
Unsurpassed Efficiency

Dual-End CRP Technology

Steerprop Ltd., founded in 2000, is a company specialized in designing and producing azimuth propulsors for demanding applications and operating conditions across the globe. Since its founding, Steerprop Ltd. has made the utilization of dual-end Contra-Rotating Propellers an important part of its product line. The first propulsors Steerprop Ltd. produced were 800 kW / 1073 Hp SP 10 CRP propulsors to river cruise vessels currently operating in the rivers of continental Europe.

In 2003, the first 2300 kW / 3084 Hp SP 35 CRP propulsors were delivered to vessels that operate in the demanding conditions of the Norwegian Sea oil fields. To date, Steerprop Ltd. has been contracted to deliver over 45 dual-end CRP main propulsion units. In 2008, Steerprop Ltd. delivered the most powerful mechanical azimuth propulsors – 8400 kW / 11265 Hp – in the world to an icebreaker operating in the Arctic Sea.



i ROV Survey Vessel Edda Fonn, equipped with two Steerprop SP 35 CRP 2200 kW propulsors

The basic concept behind Contra-Rotating Propellers was conceived as early as 1824 and the first models were built in 1836. However, it wasn't until the 1980's that it became technically and economically feasible to use CRP technology on a larger scale. The basic theory is that by dividing the propulsive load between two propellers and torque between two gearwheels, slower and larger propellers can be used. Thereby not only decreasing cavitation but also increasing the total propeller disk area to roughly 150 % of that of a single propeller design.

By placing these two propellers on the same axis and by rotating them in opposite directions, the rear propeller collects the rotational energy from the forward propeller's swirling slipstream - further increasing efficiency. Model tests and calculations have shown that in comparison to an open propeller design CRP designs are roughly 15-17 % more efficient; thus consuming roughly 15-17 % less fuel and generating less emissions.

The use of CR propellers also practically eliminates the crabbing effect that two propellers rotating in the same direction have on a vessel. This in turn enables same-handed underwater propulsion components to be used on all propulsors – something that is highly advantageous from a spare part and service point of view.

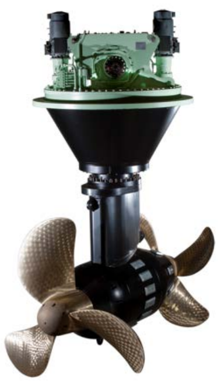
For this reason, CRP technology has been utilized most commonly in situations where fuel efficiency is a critical factor or in situations where operating conditions demand both high performance and smaller propellers, such as shallow rivers or ice-going applications. Because the propulsion load is divided between two propellers, smaller or reinforced propellers may also be used without compromising efficiency.

In technical execution, contra-rotating propeller solutions tend to fall in one of four categories.

- a conventional pushing CR propeller
- a pushing CR propeller azimuth propulsor
- a contra-rotating podded propulsor behind a conventional propeller
- or a dual-end CRP solution.

The pushing CRP solution is the oldest design which has proven its efficiency in calculations, model tests and practice. However, experience and tests have also indicated that the pushing CRP has certain challenges and limitations, especially in applications that require high speed and power. The basic concept of the Dual-End CRP was formed as a way to evolve the CRP azimuth propulsor past these limitations.

The dual-end CRP uses the fact that both propellers are located on a propulsor housing extending from under a ship's hull to its advantage. By placing the front propeller in front and the rear propeller behind the housing, the efficiency granted by CRP technology would be enhanced by the advantages of a pulling propeller. And by hydrodynamically optimizing the underwater housing to form a positive interaction with the pulling propeller's flow, the propulsor's efficiency could be further increased.



ii Steerprop SP 35 CRP 2200 kW azimuth propulsor

Unlike a pushing CRP's front propeller, a pulling propeller has constant access to uninterrupted water flow. This makes even larger and slower propellers with less blades optimal for a dual-end CRP. Lesser number of propeller blades and lower propeller speed cut cavitation down to virtually nothing in normal operating conditions. Noise and vibration are also reduced.

The underwater propulsor body's interaction with the pulling propeller's flow forms a positive wake field in front of the body. This positive interaction in practice cancels out the hydrodynamic drag caused by underwater propulsor body. The power and speed range limitation imposed on pushing CRP propulsors by drag beginning to mount at roughly 20 knots was removed.

"The propulsor's underwater body was designed to utilize the same positive hydrodynamic principles as a rudder with a bulb," says Mr. Hannu Jukola, M.Sc. Naval Architect specialized in hydrodynamics.

In total it was calculated that by combining the efficiency of the CRP with the advantages of a pulling propeller and a hydrodynamically optimized body that the total efficiency of a CRP azimuth propulsor could be raised by 3-5 %. Model tests at the Krylov Shipbuilding Research Institute in 2002 confirmed these calculations. In model tests the efficiency of the forward pulling propeller was measured to be over 0.9 and the efficiency for the entire propulsor was measured to be well above 0.7 in open water tests. It was also noted that as the propulsive force is divided between both ends of the underwater body that the dual-end CRP required less torque to change and maintain heading than a pushing CRP azimuth propulsor in normal operating conditions.

In technical execution, the dual-end CRP has a simple and robust design. In the lower propulsor housing, the power is divided to two relatively

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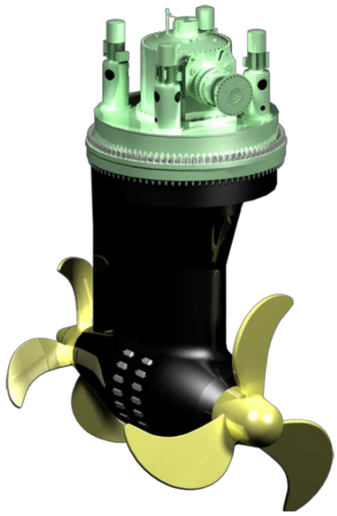
short co-axial propeller shafts pointing in opposite directions by a gear set with two gearwheels. In effect, an inverted T-gear. In this design, both propeller shafts have their own bearings and seals which thanks to the reduced velocities resulting from lower propeller RPM have longer calculated lifetimes than the bearings and seals that have higher operational velocities. As a result, the dual-end CRP requires maintenance less often than more complex technical designs. This simple construction is also more easily maintained and serviced than a more complex system. The robust construction can also prove advantageous in rough operating conditions.



iii 3D-model of a Steerprop ECO CRP 20,000 kW azimuth propulsor

As a conclusion, the dual-end contra-rotating propeller design offers unsurpassed efficiency in comparison to other available propulsion solutions. with the improvement in efficiency and thus fuel and emission savings ranging from 3 to 10 % in comparison to other solutions applicable to similar applications.

“Evolving the CRP azimuth propulsor past its earlier limitations means that the propulsor can now be built in higher power and speed ranges – up to 20 MW or 27 000 Hp with current technology in fact,” Mr. Jukola continues, “this means that the CRP azimuth propulsor is now a feasible solution for large powerful ships that need high speed, maneuverability and fuel-efficient running – such as cruise ships or cargo vessels.”