Return to Session Directory

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Thrusters

Contra-Rotating Propellers – Combination of DP Capability, Fuel Economy and Environment

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1. Overall economy of DP-capable vessels

When selecting propulsion equipment for DP-applications the focus has traditionally been on the high bollard thrust and poor free running efficiency has been neglected. As fuel prices have sky-rocketed and environmental issued have become more and more important, the overall economy and environment friendliness of the propulsion systems needs to be re-examined.

Many offshore vessels, such as supply vessels and ROV support vessels operate typically only a part of time in DP with fairly low power levels. The overall fuel economy is a combination of high free running efficiency and high specific bollard thrust.

Operation profiles vary from 75%/25% of time in DP/transit typical for maintenance vessels, intervention vessels and diving support vessels to 25%/75% found in deep water supply vessels.

The tendency of oil field operation moving into deeper waters further offshore leads also to longer transit distances at higher speeds.

Contra-Rotating Propellers – or CRP's – are commonly accepted as the propulsion device giving the highest efficiency in several fields of marine industry. Their efficiency has made them very attractive also for several types of DP-capable offshore vessels in the North Sea.

2. Contra-Rotating Azimuth Propulsor

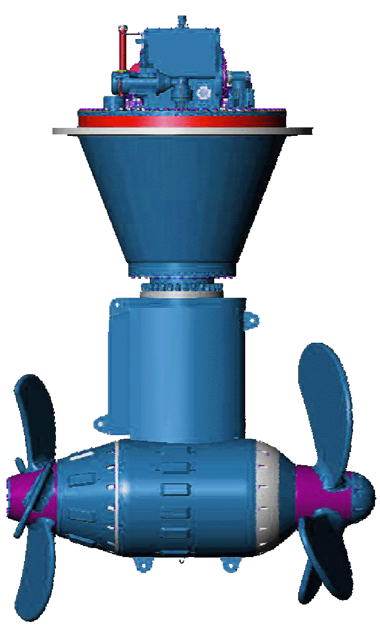


Figure 1 Steerprop CRP Azimuth Propulsor

2.1. Application

The propeller combinations of Steerprop CRP Azimuth propulsors are tailored for each individual set of operational requirements. The double contact of the main bevel gears enables torque capability beyond any other azimuth configuration. This feature provides freedom to choose propeller sizes on larger variety than what is the case with the ordinary azimuth propulsors and thrusters.

There are two fundamentally different usages for CRP solutions:

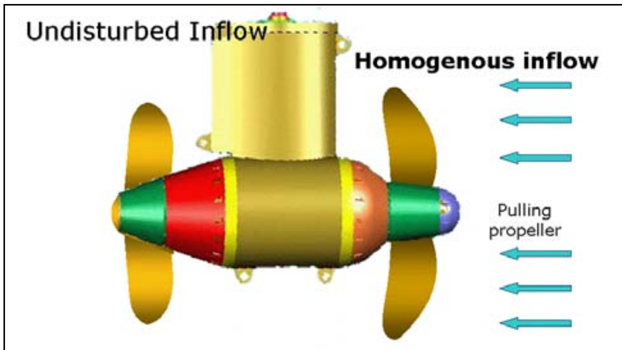
1. The applications exploiting high hydrodynamic efficiency resulting in low fuel consumption and environmentally sound and low emission.
    - CRP solution enables large lightly loaded propellers to maximize efficiency.
    - In order to utilize the full performance capability of the CRP propulsors the system requirement is speed controlled electric motor drive.

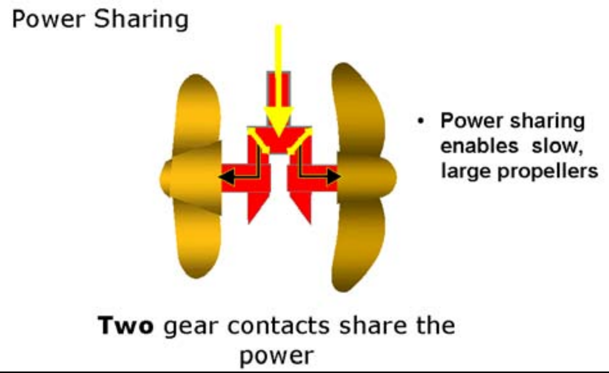
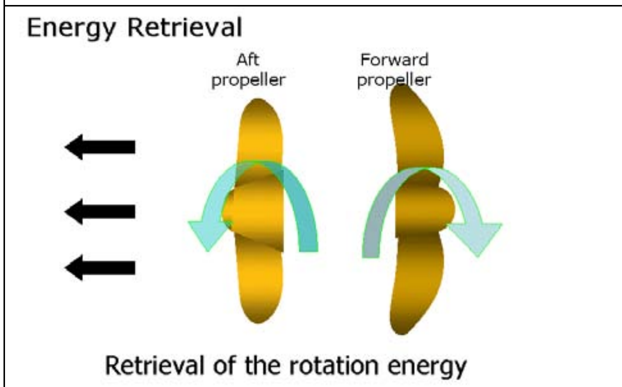
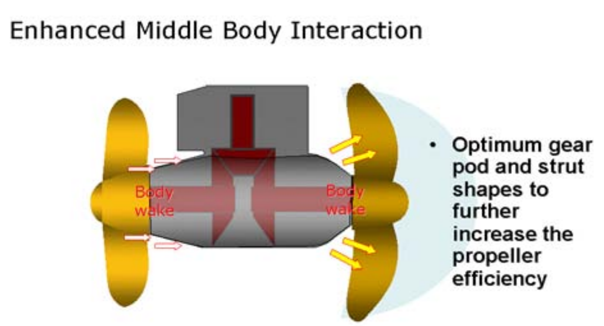
2. The applications that require high power rating with restricted propeller size
    - For ultra shallow water applications the double propeller allow small diameter propellers in relation to transmitted power
    - For ice classed propulsors the high power – propeller diameter ratio is very practicable.

2.2. Efficiency of dual end CRP Azimuth Propulsors

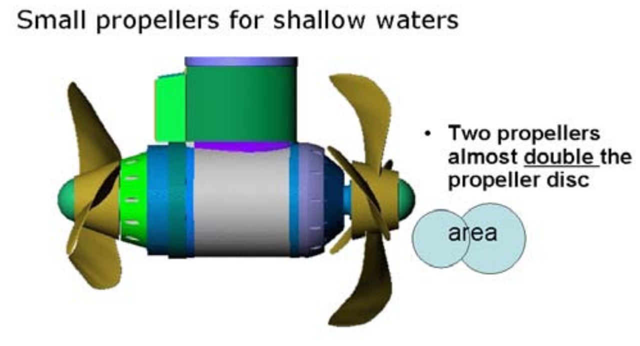
CRP Azimuth Propulsors are designed for the applications requesting high propulsion efficiency, low noise and vibration, and Omni directional manoeuvrability.

The CRP performance factors are described in the following illustration:

	Pulling propeller operates in undisturbed in-flow field.

	The dual contact gear transmission shares the torque resulting in the freedom to apply large and slow propellers.
	The rear propeller recovers the rotational energy induced in the wake of the front propeller.
	A propulsor body with a special form behind the propeller creates a back pressure which acts like an additional wake, thus increasing the propeller thrust. This increase in thrust can overcome the drag of the propulsor body, which means that the efficiency of the complete propulsor is significantly increased. The relatively large pod diameter provides necessary space for the sufficiently dimensioned gear transmission

2.3. Restricted Propeller Diameter CRP Azimuth Propulsor

	The added disc area of twin propellers enables high power throughput needed for shallow water and ice classed units.

2.4. Bollard pull of CRP Azimuth Propulsors

The specific bollard pull of a CRP falls between open and ducted propeller. With slow, large propellers the bollard pull of CRP is about 25%-30% better than a single open propeller, and about 15-20% lower than that of a nozzle propeller.

2.5. Designed by Means of CFD (Computational Fluid Dynamics) Calculation

A novel combination of lifting-line- and actuator disk programs for the propellers and surface vorticity model for the propulsor body makes it possible to optimize the complete propulsor.

2.6. Model tests

	As a part of the ongoing research and development process of the Steerprop propulsors, a series of model tests has been conducted at Krylov Shipbuilding Research Institute in St. Petersburg, Russia. The dual-end contra-rotating propulsor configuration was tested in both the towing tank (open water tests) and in the cavitation tank. The test series clearly showed the benefits of the dual-ended configuration and thus also proved the claims for high efficiency of CRP.

	The efficiency of the forward propeller was measured to be close to 0.9. This is mainly a result of the interaction between the pulling propeller and the underwater-body, a phenomenon utilised in the dual-end CRP concept.
	During the cavitation tests it was proved that thanks to the wide non-cavitating operating range offered by the good inflow quality of the pulling propeller, the propellers of dual-end CRP can be designed to be free of cavitation in normal operating conditions.

The tests done in the cavitation tunnel and the open water tests verifies the calculation procedure produces correct and realistic results giving a solid basis for case to case application estimates.

3. Case study – DP-capable Offshore Supply Vessel

3.1. Case Vessels - Operation profile

Two hypothetical offshore supply vessels are chosen to examine the overall efficiency of different types of propulsors: moderate speed PSV for shallow water operation and high speed PSV for deep water. The vessels are assumed to operate constantly; 14 hours loading on dockside, 16 hours discharging on platforms on DP and the rest of the time sailing in and out.

In DP the average power utilization of the reference vessel equipped with standard 19A-type nozzle propellers is assumed to be 15% of power. For transit speed 10knots at 50% MCR is used for the low speed PSV and 15 knots with 90% of power is used for the high speed PSV.

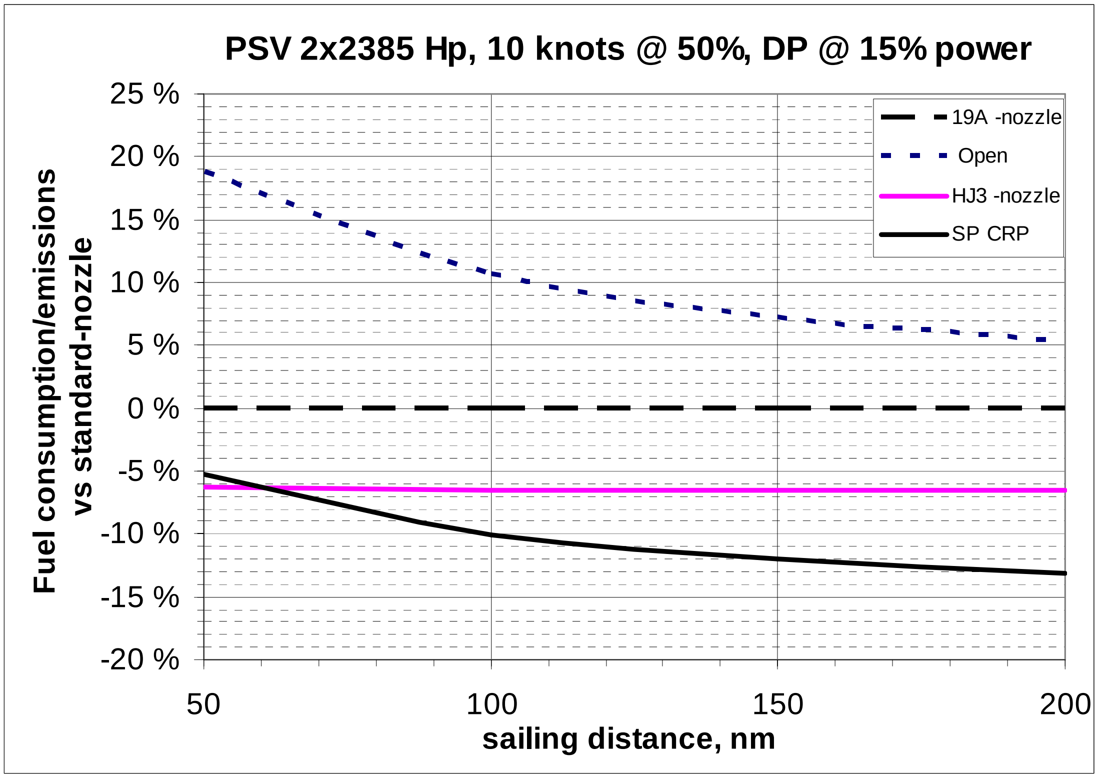
Other propulsion alternatives considered are: Open propeller, high efficiency nozzle and CRP.

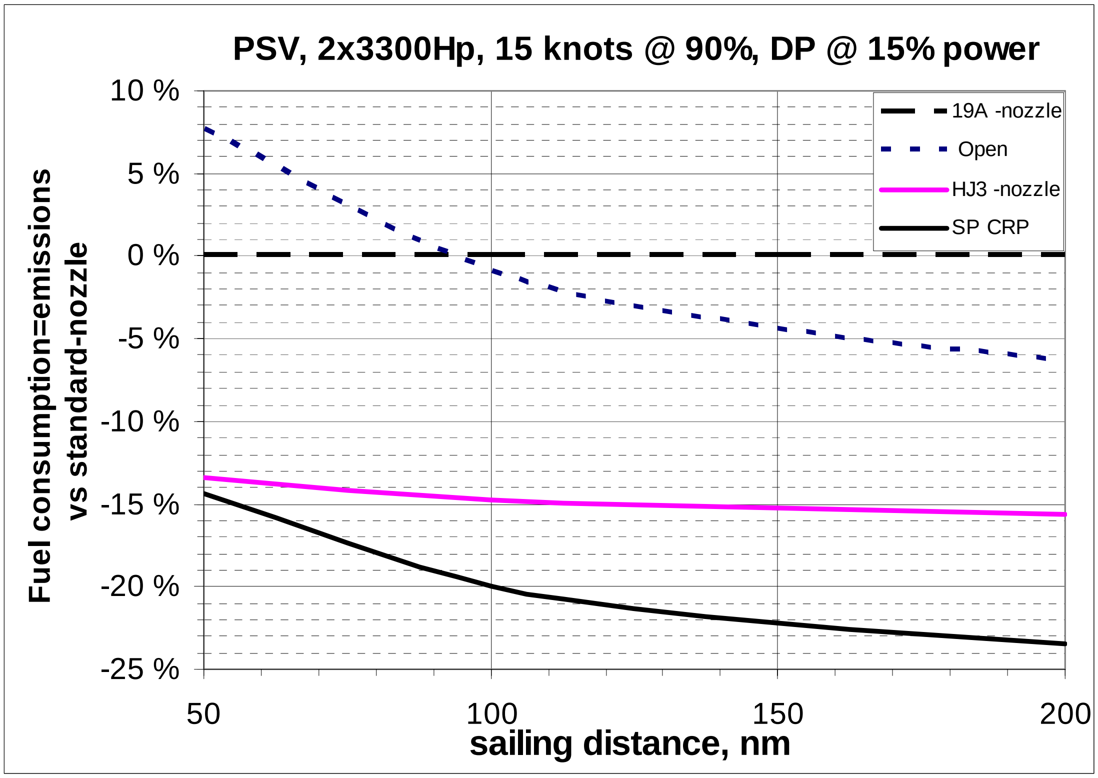
3.2. Fuel economy = Environmental friendliness

In DP a thrust augmenting nozzle naturally yields best performance. For equal thrust about 20% more power is required with CRP. With open propeller the power demand is almost 60% higher.

In transit the poor efficiency of standard nozzle shows: power demand with equally good open propeller and high efficiency nozzle is about 15-20% lower. With CRP the same speed can be reached with 35-40% less power.

The chart below shows the overall fuel economy and emissions compared to standard 19A-type nozzle as a function of transit distance of the vessel.





4. Conclusion

Significant fuel savings and reduction of emissions can be obtained, when the choice of propulsion device for a DP-capable offshore vessel is based on comprehensive survey of overall economics taking into account the operational profile of the vessel.

Steerprop CRP offers good fuel economy with adequate DP-capability for a wide variety of DP vessels.

Figure 2 Steerprop 35 CRP installed in a ROV vessel