MAN Alpha
Unique Kappel Propellers – Radical Fuel Savings

Engineering the Future – since 1758.
MAN Diesel & Turbo
Highest Propulsive Efficiency
Larger Fuel Savings
Enhanced Ship Value
Reduced Pressure Pulses
Increased Comfort
Lowest EEDI/EEOI

Odfjell chemical tanker – nineteen 37,000/40,000 DWT vessels are retrofit upgraded with Kappel propeller blades
**MAN Alpha Kappel Propellers**
Unique FPP and CPP designs for higher efficiencies

MAN Diesel & Turbo is proud to present the fuel-saving Kappel propeller programme, which has been developed on the basis of J. J. Kappels unique blade tip design. As a result, the state-of-the-art MAN Alpha Kappel series are efficiently covering propulsion power requirements of the full controllable pitch propeller (CPPs) range and fixed pitch propellers (FPPs) from 4 MW and upwards.

Tailored designs and optimised blade configurations combined and integrated with e.g. rudder bulbs, fairing cones, ducts and flow guiding devices contribute even further to energy-efficient operation with reduced impact on the environment.

Our propeller and propulsion experience accumulates to more than 7,000 delivered units. Today’s Kappel design benchmark, which was originally inspired by nature – and adapted by aviation – is now sailing the seven seas.

Geometrically, the Kappel propeller design is characterised by non-planar lifting surfaces and blade geometry with curved mid-chord line, by which the blade profile can be better aligned to the complex flow patterns in the wake field. MAN Diesel & Turbo has thus taken the full mastering step into advanced 3D design processes.
Kappel Designs Increase Propulsive Efficiency
Hydrodynamic competences take the lead

For maintaining and developing MAN Diesel & Turbo's position in the propulsion forefront, many resources are invested and the latest advanced design tools including special hydrodynamic codes, CFD (Computational Fluid Dynamics) and FEM (Finite Element Methods) are deployed. To verify our calculations and prognoses, we cooperate with the world's leading test tanks and research institutes.

Operational advantages
Increased propulsive efficiency is converted into savings via lower fuel consumption, reduced exhaust gas emissions – or might be exploited as higher thrust for increased ship speed at a given engine output.

Hard benefits of the Kappel propellers alone
- Efficiency increased by up to 3-6% – (higher values on retrofit upgrades).
- Lower propeller-induced pressure impulses.
- Better performance in off-design (CPP).

Hydrodynamic design characteristics
- Reduced tip vortex and energy loss due to the Kappel blade geometry.
- Maximised efficiency with due respect to controlled cavitation, pressure impulses, vibration and noise.
- Wake-adapted designs with pitch, skew, rake, inclination, area-ratio and blade number parameters are balanced and optimised.
- The shape of the hub is also flow-optimised and reduced in size – resulting in a low drag.
- As always, the propeller designs are customised to the individual ship application and mission profile.
- Propeller fluid flow, pressures and velocities are calculated in the '3D room'.

Fuel saving indications with reduced emissions
- Panamax bulk carrier (65,000-82,000 DWT)
  14.5 knots ~ 380 tonne/year.
- Aframax tanker (85,000-105,000 DWT)
  15 knots ~ 540 tonne/year.
- Ro-Ro vessel (5,000 -6,200 lane mtr)
  22 knots ~ 1,290 tonne/year.
- Container vessel (10,000 TEU)
  24 knots ~ 2,330 tonne/year.

Retrofit and upgrade solutions often offer even larger fuel saving potential.

Kappel propeller surface pressure distribution and streamlines
Tank testing
Model testing of specific hull and propeller models is still a crucial tool for developing ships and propellers, optimising and verifying their performance e.g. by means of towing tests, self-propulsion tests and cavitation tunnel tests.

Scaling method
Scaling of unconventional propeller designs is not standardised, but we apply scaling according to the ITTC and actual test tank recommendations, validating the unique benefits of the Kappel design.
High Propeller Performance and Low Noise
Kappel designs reduce the trade-off

Compared to conventional propeller designs laid out aggressively for increased efficiency with acceptance of some noise, the advanced and unique Kappel tip geometry rewards both on high efficiency and low pressure pulses.

Kappel blade geometry – reduce tip loss
Tip vortices are formed due to the difference in pressure between the pressure and suction sides of the propeller as the water will move from the high pressure area to the low pressure area. The pressure on both sides near the tip will therefore equalise, and the efficiency of the tip region will decrease.

Small tip vortices – create less drag
Tip vortices are tubes of circulating water that are formed at the tip when the propeller generates thrust. Compared to a conventional propeller – a Kappel propeller’s reduced flow over the tip and smaller tip vortices reduce the drag.

Increased efficiency and performance
The minimised flow over the blade tip and the outer region of the Kappel propeller geometry retain high efficiency – increasing the total efficiency of the Kappel propeller compared to conventional propellers.

Pressure pulses reduced – low noise
In addition to higher efficiency, especially for high-loaded propeller blades, the Kappel designs generally ensure reduced noise levels. For similar reasons, silent Kappel propellers are also applied for submarines with lowest acoustic signatures and surface ships employing stealth technology.
Front Njord – one of six 156,840 DWT Suezmax tankers retrofit upgraded and propelled by 9-metre three-bladed Kappel propellers

Very low pressure pulses for Kappel CP propelled RoPax ferry

CFD visualisation – Kappel propeller self-propulsion simulation

Hull pressure amplitudes – Delta P [kPa]

P1 | P2 | P3 | P4
---|---|---|---
0.5 | | | |
0.4 | | | |
0.3 | | | |
0.2 | | | |
0.1 | | | |
0.0 | | | |

Sturdy Kappel Propeller Designs
Mechanical robustness and safe handling

The proven MAN Alpha propeller reliability and durability have always been very high, and the Kappel generation of CPPs and FPPs follow that philosophy. The hubs and blades are designed and optimised with due consideration to impact loading, torque, material properties and weight.

Mechanical design characteristics

- Robust approach – with ample design margins.
- The specified standard propeller material is G-CuAl-10Ni. Other materials are available upon request.
- Material fatigue levels are calculated for a 30-year lifetime, considering all possible external loadings in service.
- Designed for ice operation according to the newest IACS and FSICR ice class notations.
- Ice loadings include the influence of ice milling on the complete system’s torsional response.
- Compact hub/blade root design and low weight ensures well-balanced load distribution.
- Optimised for reduced material stresses during normal operation and extreme loads.
- Shock resistant component designs may be analysed and documented to military standards.
Hub design and shipyard handling
For retrofit upgrading, propeller hubs can be designed and customised to fit the existing tail shafts with respect to blue-fitting standards, push-up dimensions and use of the existing propeller shaft nut and cover cap.

For both newbuilding and retrofit installations, customised flange-to-flange assembly solutions are available for propellers and tail shafts. In case of restricted space and limited distance to rudder and aft ship equipment, this concept offers fast and easy shipyard handling of propeller hub and shaft assembly and disassembly.

Kappel fixed pitch propeller
– 6.9-metre diameter for a 105,000 DWT crude oil carrier
Tailored aft ship systems and optimised Kappel propellers can be designed in combination with MAN Alpha rudder bulbs, fairing cones and propeller hub cap fins – for integration with special rudder designs and flow-guiding devices.

**Kappel design – for perfect synergy with Efficiency Improving Devices (EIDs)**

MAN Diesel & Turbo masters a vast number of disciplines in relation to optimisation of aft ship parameters and special installation requirements. The perfected layout and hydrodynamic propeller integration are always optimised with the ship’s hull and any flow-guiding devices placed before the propeller, e.g. pre-swirl and wake equalising ducts, pre-swirl fins and vortex generators. At the propeller hub, a fairing cone or propeller hub cap fins can be deployed. Aft of the propeller, the optimisation can include high-efficiency rudders, integrated rudder bulbs, post-swirl fins or similar.

Tank test results and real-life operations show that the integration of Kappel propeller designs perform in beneficial synergy with Efficiency Improving Devices.

**Nature of propeller optimisation parameters**

- Lower rotational speed and larger diameter.
- Propeller blade number optimisation.
- Lower pressure impulses allow smaller clearance to the ship’s hull – and offer the deployment of an even larger propeller.

**Efficiency benefits of Kappel propellers and EID combinations**

- Kappel propeller alone
  – efficiency increased by up to 6%.
- Kappel propeller with MAN Alpha Rudder Bulb
  – efficiency increased by up to 9%.
- Kappel propeller with Mewis Duct
  – efficiency increased by up to 11%.
- Kappel propeller with Mewis Duct and MAN Alpha Rudder Bulb – efficiency increased by up to 12%.

– and even more for retrofit upgrade solutions.

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*Flow separation between rudder and propeller hub creates drag
Uniform flow without separation creates improved thrust ahead*
Kappel FPP with propeller hub cap fins. Application example: Bulk carriers and similar ‘medium-body’ vessels operating at medium service speeds.

Kappel FPP, pre-swirl and wake equalizing duct. Application example: Suezmax tankers and similar ‘full-body’ vessels operating at slow to medium service speeds.

Kappel CPP, pre-swirl and wake equalizing duct, rudder bulb and fairing cone: Chemical tankers and similar ‘medium-body’ vessels operating at medium to higher service speeds.

Höegh Target – world’s largest and one of six +8,500ceu Pure Car and Truck Carriers propelled by 7.2-metre three-bladed Kappel propellers.
Propeller manufacturing accuracy
The International Standard Organisation has introduced a series of manufacturing standards according to ISO 484, from which different accuracy classes can be selected by the customer. As per MAN Diesel & Turbo standard, propellers will be manufactured and customised with ‘high accuracy’ class I tolerances and finished with a surface roughness according to class S ‘very high accuracy’. Extra dimensional checks will be performed for Kappel propellers.

Highest MAN standards
Like the extensive and advanced production of MAN Diesel & Turbo’s diesel, gas and dual-fuel engines, turbomachinery, gas turbines, steam turbines, compressors and turbochargers – including the genuine after-sales spare parts – the MAN Alpha Kappel propellers are also produced only by high-end foundries and propeller manufacturers. The specialist supply of MAN Alpha Kappel propellers is characterised by:

- Class approval by all major classification societies.
- A thoroughly monitored pattern-building and casting process from start to finish.
- High-quality castings – finished machined.
- A selected bronze-alloy material – G-CuAl10Ni with perfect casting, machining and fatigue properties.
Propeller and shaft connection

The installation with propeller and shaft taper connection, fitting procedure and ‘blue fit test’ are core competencies of skilled and experienced shipyard specialists. When it comes to general procedures and handling requirements, Kappel FPPs are similar to other conventionally designed fixed pitch propellers. Basic instructions for the propeller and shaft fitting are available both for the horizontal shaft method and the vertical shaft method.

For both methods, general recommendations are given on personal safety precautions – including necessary tools, instruments, gauges, crane and lifting gear – and the actual grinding procedures, ‘blue fit test’ and the acceptance criteria of MAN Diesel & Turbo and major classification societies. Documentation material for the actual plant will be delivered, including propeller lifting instructions, pull-up diagrams and marking instructions.

For Kappel CPP blades similar detailed installation instructions will be delivered on lifting tools, fitting of blade seals, lifting and fitting of blades – and blade bolt tensioning procedures.

Partners for propeller manufacturing

From the pool of MAN Diesel & Turbo’s selected suppliers and manufacturing partners, we are cooperating with proven and well-established organisations mainly in Europe and Asia. To ensure the highest level of safety, availability and continuity, all suppliers are quality-screened, audited and approved via MAN Diesel & Turbo’s extensive supplier verification system.
Kappel Propeller Upgrade, Retrofit and Repair
Worldwide after-sales service

Kappel propeller upgrade and retrofit solutions
Take advantage of new high-efficient propeller designs, matching e.g. new requirements or changed operating profiles for your ships. Kappel solutions are offered also for non-MAN Diesel & Turbo designed CPP and FPP equipment. Attractive investments are available ranging from relative simple propeller upgrades to more advanced integration of further aft ship Efficiency Improving Devices and complete derating and slow steaming packages with e.g. re-gearing of shaft alternators or Variable Frequency Drive.

Fuel savings and short payback time
In retrofit situations with derating and slow steaming packages including upgrading from older or conventional propeller designs to new Kappel designs – large gains up to and above 20% have been realised. As a result, the effective payback time is short and may be shortened further when existing propeller materials can be part of an exchange agreement.

Tailored exchange deals
Exchange agreements with blades only for CPPs and complete FPP mono-blocks are offered. Everything designed and manufactured to match existing propeller hubs and shafts – and scheduled vessel dockings.

Derating and slow-steaming packages
Complete solutions jointly optimised with new engine power/speed layout:
- New Kappel propeller blade designs.
- Possible reduced blade number – for higher efficiency.
- Engine performance optimisation and turbocharger matching at new operating area.
- Upgrade and re-gearing of shaft alternator systems or Variable Frequency Drive installation.
- Possible modified shafting and shaft alignment.
- New torsional vibration calculations (TVCs).
- Check of possible barred ranges.
- New technical files.
Retrofit and upgrade – feedback from operation

“A fuel saving of 15-20 kg per nautical mile is nice when you are sailing 1,400 miles per week” says Richard Berg-Larsen, Director – Fleet Management, DFDS Seaways.

PrimeServ’s worldwide service support

With more than 150 PrimeServ service stations and service partners worldwide, plus a growing network of PrimeServ Academies, the MAN Diesel & Turbo organisation is highly committed to expanding and developing the most efficient and accessible after-sales organisation in the business.

The PrimeServ competence is characterised by
- Delivery of high-demand spares within 24 hours.
- Fast, reliable and competent customer support.
- Ongoing training and qualification of personnel.
- Global service, open 24/7, 365 days a year.

Repair of Kappel propeller blades

The stress pattern for Kappel blades is similar to ordinary blade designs and allows for repair in the tip region according to the IACS W24 repair norm.