

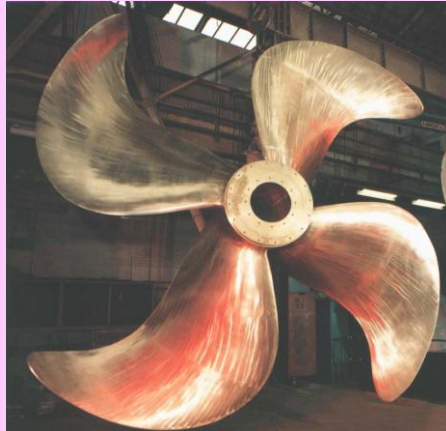
Advanced Propulsion System
GEM 423E

Week12: Kappel Propellers

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KAPPEL Propeller

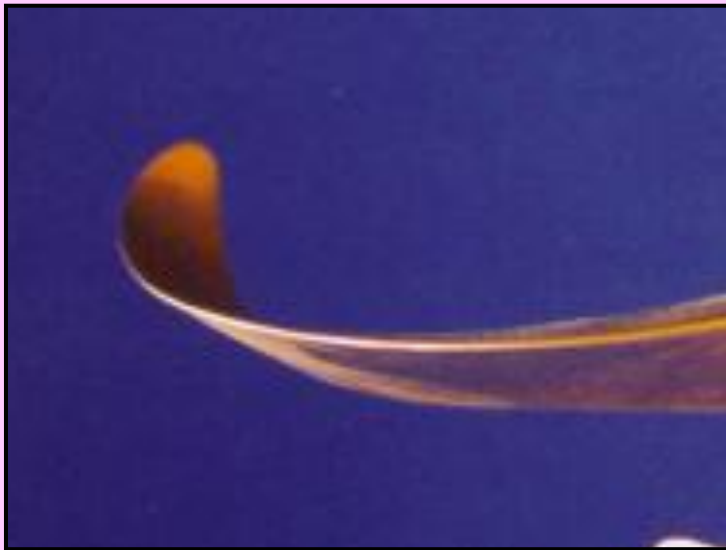
Development of Marine Propellers and Aircraft Wings

- 1920 'ies Load distribution for propellers and wings by Prandtl and Betz.
- Wing end-plates investigated by Prandtl and Betz
- 1960 ies Investigation of non-planar lifting surfaces by Cone Jr.
- 1970ies Investigations of aircraft winglets by Whitcomb (NASA).
- Hydrodynamic design and analysis procedures have been formulated and redefined by J. J. KAPPEL.
- 1980ies Winglets applied to airplanes.
- End plates applied to propellers.
- Experiments with tip modified propellers.
- Load distribution for new propellers by Andersen and Andersen.
- 1990ies Theoretical and experimental work to develop the KAPPEL propeller
- 2002 Full-scale trial and application of the KAPPEL propeller

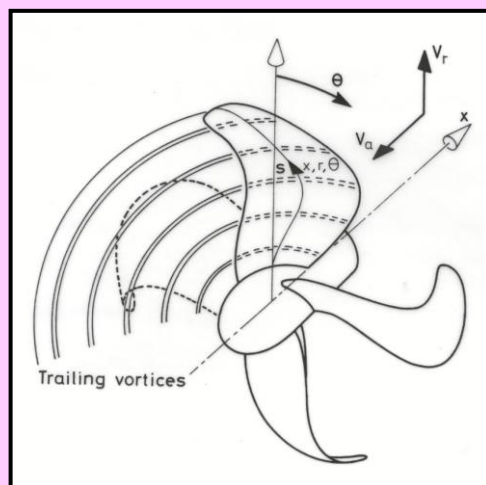
Kappel Popeller

- The KAPPEL propeller is based on the theory of non-planar lifting surfaces, also applied in the design of modern aircraft wings in the form of winglets at the wing tips.
- The KAPPEL propeller has blades curved towards the suction side in particular towards the tip to reduce the energy losses inevitably present at the ends or tips of any lifting surface.





**Geometry of
KAPPEL
propeller with
lattice of free
trailing
vortices**



THE ADVANTAGES OF KAPPEL PROPELLERS

- The reduced losses of the KAPPEL propeller in addition to fuel saving
- Important factors in designing propellers with lower levels of propeller
- Induced noise and vibration.
- Hydrodynamic design and analysis procedures have been formulated and are being refined by J. J. KAPPEL Marine Concept in association with the Technical University of Denmark.

FULL SCALE APPLICATION OF THE KAPPEL PROPELLER - 1

- The EU funded KAPRICCIO project has now been brought to a satisfactory conclusion with the successful sea trials of the first full scale KAPPEL propeller on the vessel M.T. North America owned by D/S Norden A/S of Copenhagen.
- A first set of trials was carried out with the conventional propeller fitted. Prior to these trials the vessel was dry-docked for hull cleaning and propeller polishing.
- A second set of trials was carried out immediately after re-docking the ship to exchange the conventional propeller for the KAPPEL propeller.

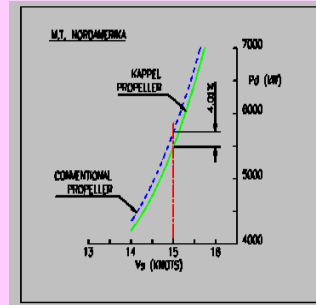
FULL SCALE APPLICATION OF THE KAPPEL PROPELLER - 2

- Both sets of trials were carried out under the supervision of HSVA in good weather conditions and included a comprehensive range of double run speed trials plus turning circles.
- The vessel was fitted with a differential GPS system for measurement of ship speed and track, together with instrumentation for the accurate measurement of shaft powers and speeds.

- In addition, windows were installed in the hull to permit full scale cavitation observation, whilst pressure transducers and accelerometers were used to monitor pressure impulses on the hull and local structural vibrations



- At the 15 knot condition the vessel's power requirement was reduced by approximately 4%. This will result in a corresponding reduction in fuel consumption, fuel costs and exhaust emissions.
- The observed cavitation phenomena showed a marked improvement compared with the conventional propeller, and excitation forces arising from the action of the propeller were similarly much improved.



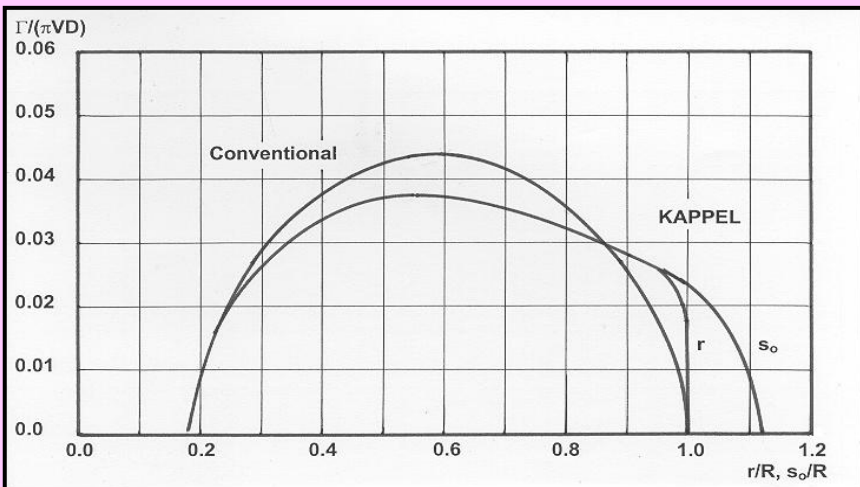
KAPRICCIO PROGRAM

- The daily fuel savings could amount to over six tonnes.
- A saving of approximately USD 900 per day at today's rate (June 2000).
- The world-wide potential fuel saving if new and existing ships were to be fitted with KAPPEL propellers would be 19 million tonnes per year.

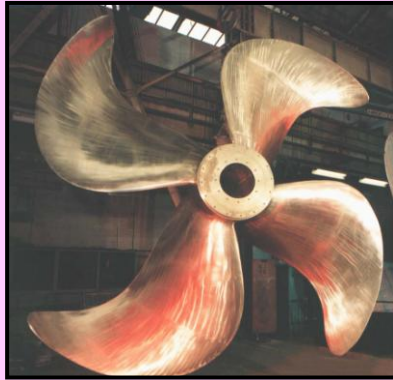
KAPRICCIO TECHNICAL & SCIENTIFIC OBJECTIVES

- Higher efficiency, lower fuel consumption
- Reduced noise and vibration levels
- Improved accuracy of full scale prognosis
- Improved Finite Element Analysis (FEM)
- Improved foundry technology

Optimum load distribution for a conventional and a KAPPEL propeller



Full-scale KAPPEL Propeller at the works of SMM Birkenhead



Weight 13.4 ton
diameter 5.8m

Companies of Trying Kappel Propeller

- J. J. Kappel Marine Concept Denmark
- Damskibsselskabet NORDEN Denmark
- Kværner Warnow Werft Germany
- Stone Manganese Marine UK
- Hamburgische Schiffbau-Versuchsanstalt
Germany
- Danish Maritime Institute Denmark
- Tech. University of Denmark Denmark

Development of a Marine Propeller with Non-planar Lifting Surfaces

- Propeller with non-planar lifting surfaces is realized
- Higher propulsion efficiency (model test)
- Lower pressure pulse levels (model test)
- The tip fin (or Kappel) propeller offers an increase in propulsive efficiency in comparison with a conventional propeller.
- This is achieved by means of an unconventional tip geometry based upon aero-dynamic winglet theory adapted to suit the marine environment.

Non-Linear Theory for Plane Wings

