

RETROFIT PROPULSION IMPROVEMENT



BEFORE

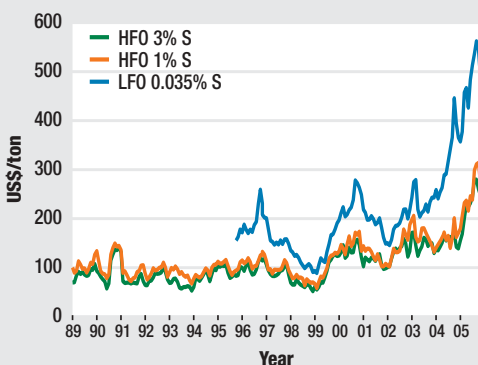


AFTER

SAVE UP TO 15% ON FUEL COSTS

The fuel prices have risen considerably the last years, resulting in an increase of ship operating costs. To maintain the economic profitability of the vessel, a large focus is nowadays on fuel saving devices in the broadest sense of the word.

A number of options is available to improve the efficiency of the propulsion system, depending on the type of propeller and vessel. In this leaflet we explain the propulsion improvements through retrofits and the economic effects by means of the Return On Investment (ROI).



Increase in fuel prices.

HYDRODYNAMICS

The total propulsion efficiency of a propeller varies between 50% and 70%. The losses for an average propeller can be traced to 3 physical phenomena:

AXIAL LOSSES

A propeller generates thrust, due to the acceleration of the incoming water. Behind the vessel, the out coming flow mixes with the environmental flow. Due to turbulence, energy will be lost.



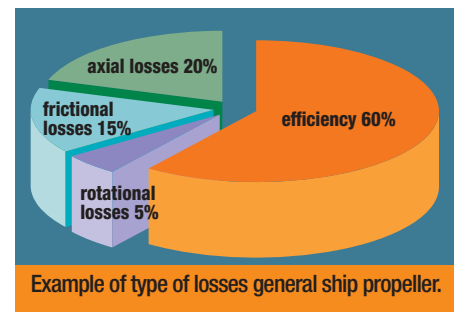
Visualization of axial losses.

FRictional LOSSES

Water in contact with the propeller blade surface causes friction, and thus losses. The total blade surface, speed of rotation and surface roughness are the dominating factors concerning frictional losses.

ROTATIONAL LOSSES

Rotation of the blade causes a rotation in the wake too; consequently this energy is lost to generate a thrust in axial direction.



Example of type of losses general ship propeller.

- ■ ■ Fuel saving devices are categorized on percentage of efficiency improvement: up to 5%, up to 10% and up to 15%.

UP TO 5% IMPROVEMENT PROPELLER POLISHING AND/OR REPAIR OF EDGE DAMAGE

Propeller polishing in combination with repair of edge damage easily increases the propeller's operating efficiency with 2% to 4%. The Return On Investment (ROI) period is quite short. After 1 to 3 months, the maintenance costs are already paid back.

MODERN DESIGN PROPELLER

A redesign of the current propeller, based on the state-of-the-art, without optimizing the boundary conditions like propeller speed and diameter, can lead to an improvement of approximately 5%.

Tip rake reduces the local rotation around the tip. For large fixed pitch propellers the positive effect can be up to 3%. The ROI is

4-5 years, since a new propeller is required.

With the help of modern hydrodynamic software, more reliable cavitation predictions are made. This way higher power densities can be allowed, and thus a lower blade area can be applied. A reduction in frictional losses can result in efficiency improvements up to 3%.

With the combination of tip rake and a lower blade area it is possible to realize fuel savings up to 5%. Payback period is 3 years.

UP TO 10% IMPROVEMENT MODERN DESIGN PROPELLER WITH INCREASED DIAMETER AND LOW SPEED

In general a larger propeller diameter in combination with a low rotational speed leads to an improvement in efficiency. The axial losses will be reduced. Basically we can apply this for all ship/propeller types.

In case the diameter can not be increased, sometimes a larger number of blades (5 or 6) provides a solution for further optimization. Payback period is 1.5 to 2.5 years.

EFFICIENCY RUDDER

The efficiency rudder is a successful new development. Axial and rotational losses in the slip stream of the hub are eliminated by the torpedo, which is fitted in between the propeller and the rudder. Highly loaded propellers and ships with speeds exceeding 15-20 knots, can benefit from an efficiency rudder. For new building vessels it can be attractive since a rudder and propeller is needed anyway. For the retrofit market the investment is quite large, and therefore the Return On Investment exceeds a period of 5 years.

PROPELLER - ENGINE INTERACTION

Vessels equipped with a fixed pitch propeller can suffer from a so called heavy running propeller. The terminology is somewhat misleading; the propeller loading and engine characteristics are not matching. The propeller curve crosses the load limit of the engine before full power is reached. As a consequence the engine is overloaded, leading to increased fuel consumption as well as increased wear of internal engine parts.

A pitch modification of the propeller can be conducted. This way the same power is

absorbed at a higher rpm, and the engine operation is shifted out of the "red" area.

Fuel savings, after trailing edge cutting, of 6% to 8% are reported. Payback period is 2 months.

UP TO 15% IMPROVEMENT

By conversion of an open propeller to a ducted propeller, efficiency gains up to 15% are established.

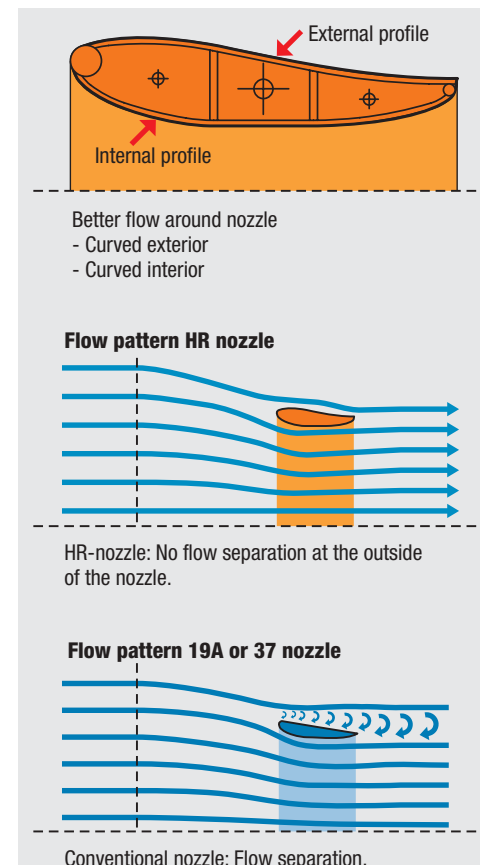
The idea of surrounding a propeller by a nozzle is already very old. Today about 25% of all Wärtsilä controllable pitch propellers are running in a nozzle.

In an accelerating nozzle the water speed at the propeller is higher than that of the open propeller. The increase in axial velocity reduces the propeller load especially for heavily loaded propellers. This then leads to an increase in overall performance of the propeller and nozzle compared to that of a propeller alone. Additionally, the nozzle generates forward thrust caused by the



Conventional propeller design.

LIPS tip rake propeller design.

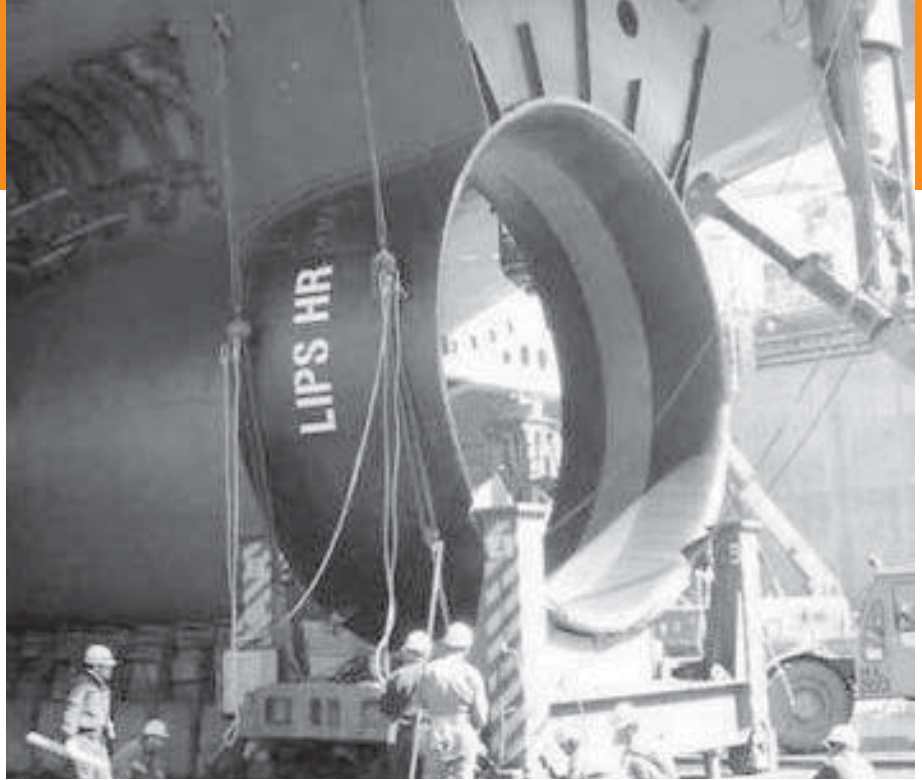


Advantage of LIPS high efficiency (HR) nozzle.

pressure distribution round the nozzle, resulting in a force in the forward direction.

To extend the application of ducted propellers towards higher ship speeds in combination with a larger bollard pull, Wärtsilä has introduced the high efficiency nozzle (HR-nozzle). The HR-nozzle has a curved exterior and interior, leading to absence of flow separation and consequently a higher efficiency.

Replacing an open propeller with an HR ducted propeller, the bollard pull can be increased with about 25%, while the free running efficiency can be increased with 10% to 15%. This mainly depends on the power density of the propeller and the sailing speed of the vessel.



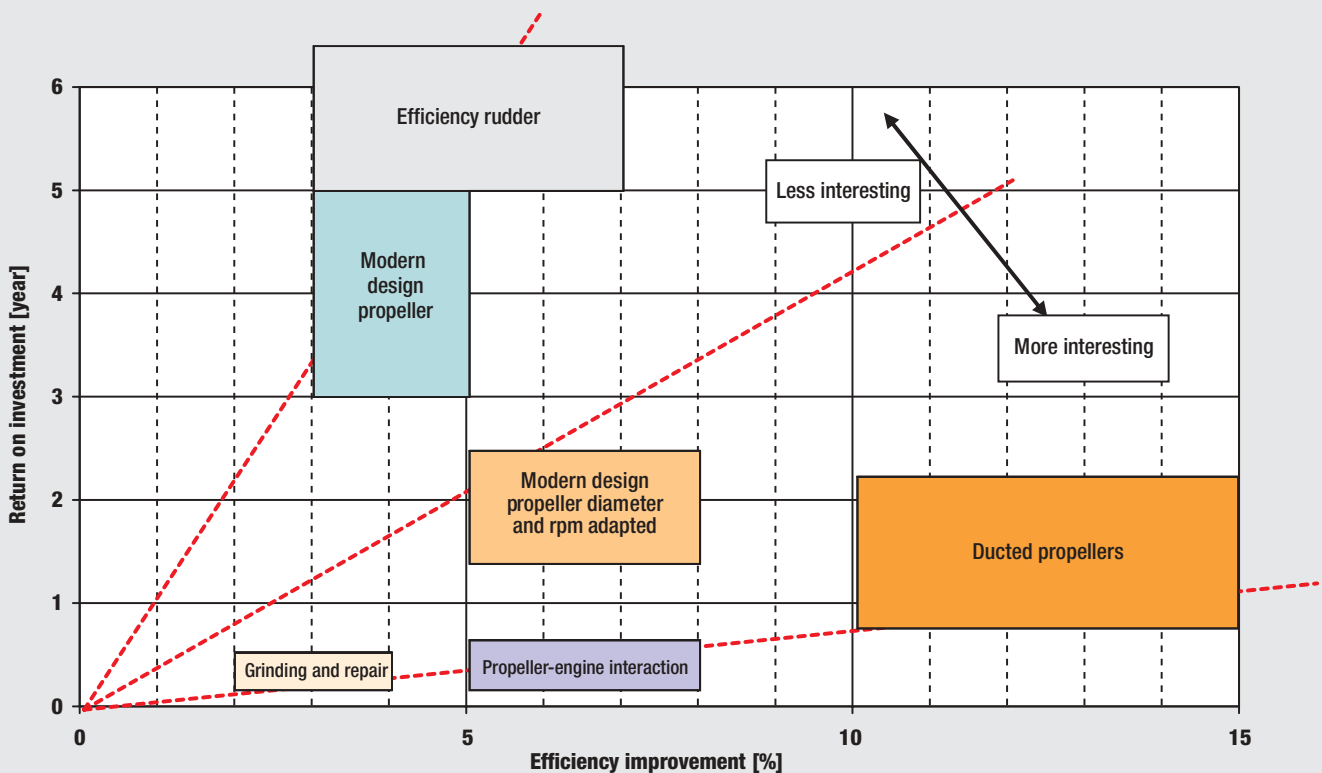
ECONOMICS OF RETROFITS

To judge the profitability of a propulsion improvement, the increase in hydrodynamic efficiency needs to be known in relation with investment or total costs.

A number of conducted retrofits were reviewed with respect to investment and fuel savings. Data for the fuel consumption were supplied by the ship operator, or otherwise estimated based on the mission profile.

Figure below shows the estimated Return On Investment of each discussed propulsion

improvement device. Each type of device has a wide field of application, depending on ship type, size, engine, type of fuel etc. Therefore an envelope is sketched in the chart, identifying a range of hydrodynamic improvements and pay back time.





SUMMARY AND CONCLUSION

Due to the focus on environmental issues and the increasing fuel prices, ship owners are more and more interested in solutions to save fuel. Wärtsilä can offer several different options for fuel savings.

With modern design propellers, grinding and repair and modification of heavy running propellers considerable hydrodynamic improvement can be established, with attractive Return On Investments.

By the application of ducted propellers however, and especially the Lips high efficiency nozzle, an increase of free running propeller efficiency of 15% can be reached, with a payback period of 1 to 1.5 years.



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