IMPROVING ENGINE FUEL AND OPERATIONAL EFFICIENCY

Fuel costs account for roughly 75% of a ship's operating expenses. As fuel prices remain high and environmental regulations get more stringent, improving fuel efficiency is the logical way to keep operating costs in control. The choice of fuel matters, but regardless of what fuel is used, smart maintenance and ensuring the optimal operating profile are the starting points for fuel efficient engine operation. Optimising engine and propulsion performance for more efficient operation is an area in which an expert partner can offer valuable support.

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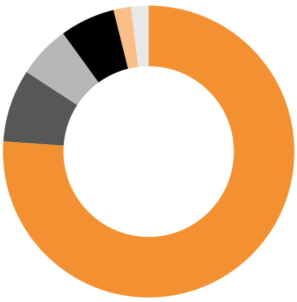
THE GROWING IMPORTANCE OF FUEL EFFICIENCY

The marine industry is finding the question of fuel efficiency more pressing than ever. As the share of fuel costs of the total operating costs is on average roughly 75%, improving fuel efficiency is the most effective and most feasible way to achieve savings in operating costs.

What is engine fuel efficiency?

Fuel efficiency can be defined as the efficiency of a process that converts chemical potential energy contained in a carrier fuel into kinetic energy or work. A reciprocating engine is currently the most efficient way to convert liquid or gaseous fuels into power. And, as far as we can see, its position will not be contested in the near future.

Operating costs - the share of fuel



Source: Wärtsilä, 2013

However, apart from fuel choice, the design and condition of the engine and how it is operated are essential for achieving the best efficiency. Proper maintenance and optimisation of the engine as well as the propulsion system for better fuel efficiency are factors that should not be overlooked.

The groundwork for an engine's fuel efficiency is laid at the installation design stage, when things like application type, cooling water system design, fuel oil and propulsion system design are determined, as well as with the configuration of the equipment, including specifications such as turbocharger type, cylinder configuration, cooler types, thermostatic valve set points and rated output.

Operational parameters having an effect on efficiency include liquid inputs, such as fuel quality (e.g. water content, heat value, sulphur content, ash content), lubrication oil quality and cooling water quality, as well as measured parameters involving dynamic input, such as load on the equipment, ambient conditions and air intake temperature.

There are differences in the efficiencies achieved between different fuels. Natural gas is the most efficiently burning and most environmentally efficient alternative. A dual or multifuel solution offers additional efficiency through fuel flexibility. The ability to burn various liquid or gas fuels can help to drastically reduce the cost of fuel when fuel prices and availability fluctuate. These technologies allow the engines to be run on crude oil and other liquid fuels as well as gas of varying quality.

MAIN FACTORS AFFECTING ENGINE FUEL EFFICIENCY

Installation design	Equipment configuration	Liquid inputs	Measured parameters
• application type • cooling water system design • fuel oil system design • propulsion system design	• turbocharger type • cylinder configuration • cooler types • thermostatic valve set points • rated output	• fuel quality • lubrication oil quality • cooling water quality	• load on the equipment • ambient conditions • air intake temperature

IMPROVING ENGINE FUEL EFFICIENCY

Engine fuel efficiency can be measured by the engine's Specific Fuel Oil Consumption (SFOC), which measures the amount of fuel needed to provide one horsepower for a period of one hour.

There are several ways to improve SFOC. To ensure that the engine always runs optimally, a condition-based maintenance system can be implemented instead of the traditional hour-based way of scheduling maintenance. Engine and propulsion system performance can be optimised for changing requirements or upgraded to utilise the latest technologies. Engines can also be converted to be able to use different fuels, including gas.

Correctly timed service will ensure optimum engine performance and fuel consumption.

Optimised maintenance

Ensuring the correct operating profile is important. This is why condition based maintenance (CBM) gives better results than a traditional system based rigidly on operating hours.

CBM allows planning maintenance according to actual performance records, and helps extend service intervals and avoid unplanned downtime. All maintenance is based on fresh and relevant information received through communication with the actual equipment, and the evaluation of this information by experts. Correctly timed service will ensure optimum engine performance and fuel consumption. Depending on equipment condition, fuel consumption can be reduced up to 5%. The constant monitoring and analysis of engine information also means that approaching premature failures can be discovered at an early stage before they occur, and the worse can be avoided.

It is possible to improve efficiency and lower costs, while also extending the time between stops for maintenance.

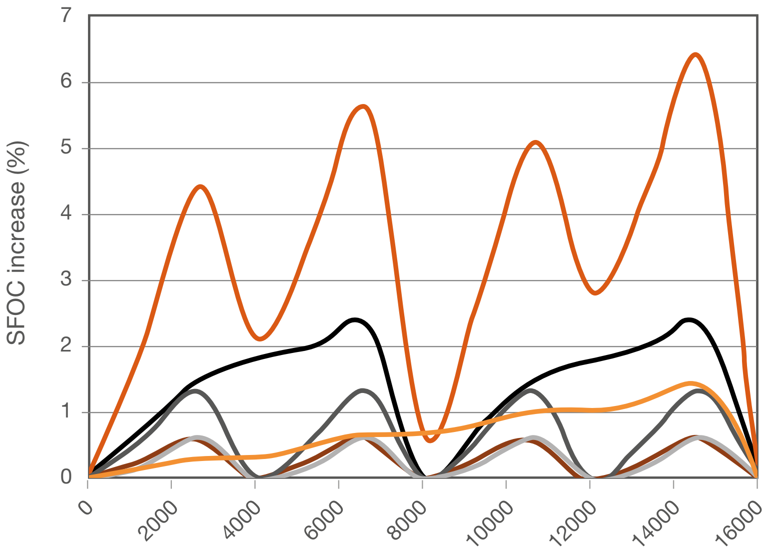
Performance optimisation

By knowing and fully understanding the operating equipment and its condition, it is possible to improve efficiciency and lower fuel and maintenance costs, while also extending the time between stops for maintenance.

Engine performance can be optimised by upgrading the engine and propulsion components to newer technology that can offer efficiency and performance benefits that easily justify the investment. The main components having an effect on engine SFOC (see graph and table on page 4) are the turbocharger, intake air filters, charge air coolers, injection pumps and nozzles and the exhaust gas pipe, which has an effect on exhaust gas back pressure. This causes the turbo charger speed to drop, leading to a lower power output, which is then compensated on the diesel engines by increased fuel feed.

Fuel quality and flow are also factors that have a significant effect on efficiency. Sometimes a conversion to another fuel type altogether or to a multifuel solution can be performed to improve the engine's fuel efficiency and flexibility.

SFOC OVER 16,000 HOUR OVERHAUL INTERVAL



The graph shows the increase in specific fuel oil consumption taking into account normal scheduled overhauls.

Source: Wärtsilä, 2013

SFOC EXAMPLE CALCULATIONS

Cost calculations of increases in specific fuel oil consumption caused by various factors.

All examples are maximum loss of fuel calculations for 6000 operating hours and 5000 kW output. Fuel price: IFO 180 $647.00 (Bunkerworld 26.6.2014).

Effect of equipment condition on SFOC	Loss of fuel	Increased costs
Turbocharger: partly blocked or dirty nozzle ring, turbine or compressor Increased fuel consumption ~3g/kWh	90,000 kg	US$ 58,000
Dirty intake air filters Δp /diff press increase 50 mm H2O Increased consumption ~2g/kWh	60,000 kg	US$ 39,000
Partly blocked charged air coolers Δp increase 100 mm H2O Increased consumption ~2g/kWh	60,000 kg	US$ 39,000
Worn injection pump elements Increased fuel consumption ~5g/kWh	150,000 kg	US$ 97,000
Worn injection nozzles Increased fuel consumption ~2g/kWh	60,000 kg	US$ 39,000
Increased exhaust gas back pressure Back pressure increase 100 mm H2O Increased fuel consumption 0.3g/kWh	9,000 kg	US$ 6,000
Effect of fuel quality on SFOC		
Fuel water content Water in the fuel 1% Increased consumption 1%	60,000 kg	US$ 39,000
Low fuel heat value Reduced heat value 500kJ/kg	75,000 kg	US$ 49,000
Fuel sulphur content For every 1% increase of Sulphur in the fuel the net heat value will decrease 0.8% => SFOC increase 1.5 g/kWh	45,000 kg	US$ 29,000
Fuel ash content For every 0.10 % of ash content in the fuel the net heat value will loose 0.04 MJ/kg => SFOC increase 0.2 g/kWh	6000 kg	US$ 4000

Source: Wärtsilä, 2013

Fuel conversions to improve operation efficiency

Fuel conversions can be a way to achieve lower costs and fuel flexibility. Fuel type has an effect on fuel efficiency, not only through fuel costs, but also increasingly due to the effects of environmental regulations and the consequent costs related to emission levels.

Generally speaking, converting an existing engine is economically more feasible than installing a new one - especially when keeping in mind that a conversion basically brings the same benefits as a new engine. For example, the same warranty is granted as for a brand new engine, in addition to which there are also savings to be made on maintenance costs since the running hours are reset. However, with smaller generating sets, say below 2 MW, it might be more cost effective to install new ones.

Converting a combustion engine to operate on natural gas improves fuel efficiency in three ways.

- Natural gas burns efficiently, and has the highest energy content of all fossil fuels
- Natural gas burns cleanly resulting in lower maintenance costs and emissions
- Natural gas is attractively priced offering more power for the same money

The ability to burn various liquid or gas fuels can help to drastically reduce the cost of fuel when fuel prices and availability fluctuate.

A dual or multifuel conversion offers additional efficiency through fuel flexibility. These solutions allow the engines to be run on crude oil and other liquid fuels as well as gas of varying quality. The ability to burn various liquid or gas fuels can help to drastically reduce the cost of fuel when fuel prices and availability fluctuate.

Propulsion optimisation

There are a number of measures regarding the propeller, that can be taken to improve fuel efficiency. Proper maintenance, again, is very cost-effective. Often a drop in performance by up to 5% is observed as the result of fouling on the blades, damaged edges and roughened surfaces. With the current knowledge and state of the art Computational Fluid Dynamic software, modern propeller design, without optimizing the boundary conditions like propeller speed and diameter, can boost efficiency by up to 3%.

Conversions from open to ducted propeller are best suited for vessels sailing below 15 knots. There are reported increases in bollard pull of up to 25%, and sailing efficiency improvements of up to 15%. Trawlers, dredgers and coasters are typical examples of vessels that could benefit from such retrofits. Even bigger improvements may occasionally be possible if the propeller speed is fine tuned. This is, however, fixed and limited by engine tuning.

Application of energy saving devices, i.e. hydrodynamic appendages in the area of a propeller, offers additional measures to optimize propeller efficiency and thus reduce fuel consumption of the vessel at a given sailing speed.

Improvements can also be achieved by evaluating the required ship speed, which may differ from the original requirements.

Improvements can also be achieved by evaluating the required ship speed, which may differ from the original requirements. This may lead to a possibility to modify the propulsion system to allow the engine to operate in an output/speed zone with lower fuel consumption and/or retune the engine to allow the propulsion system to run at a more efficient propeller speed for a significant reduction in fuel consumption.

QUESTIONS TO CONSIDER

1. Do you know the true condition of your engine and propulsion equipment?
2. Has your installation been surveyed by an expert?
3. Has your operating profile or vessel usage changed after commissioning?
4. Have your engine and propulsion systems been optimised for your current operating profile?
5. Are your maintenance routines based on the actual condition of the equipment?
6. Have your electronic and automation systems been checked for obsolesence?
7. Could you benefit from more fuel flexibility?
8. Are you operating on the most economical fuel type?
9. Could your operating routines be improved?
10. Do you have a partner that fully understands your systems and can make recommendations on improving fuel efficiency and reducing OPEX?

EXPERT ADVICE FOR IMPROVING EFFICIENCY

Optimising engine fuel efficiency is worth the effort. The best way to get started is a site survey by an expert to establish the current situation. Wärtsilä's survey team has been established for this purpose.

The survey team determines the condition 'on arrival' of engine equipment on board along with the electrical and mechanical operation and performance. Auxiliary equipment can also be inspected and tested, and a database of the findings compiled, including suggestions for further actions and improvements. Operating routines will also be investigated, reviewed and improvements, where appropriate, will be suggested. Impending equipment failure can also be anticipated before actual damage to the operation will occur.

Please contact us: **www.wartsila.com/services**

Ensuring your lifecycle operations

Wärtsilä is an experienced operator, with a proven track record in operation and maintenance services since the 1990's. Globally, more than 18,500 MW of generating capacity in both marine and land based installations – a total of more than 470 installations – is covered by Wärtsilä's service agreements.

Wärtsilä offers four types of standardized agreements ranging from supply agreements to technical management, as well as maintenance agreements and complete asset management. However, all agreements are customised to fulfill each customer's specific needs.

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Want to know more?

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