



Chief engineer's hands-on experience of slow steaming operation

Przemysław Kowalak
Maritime University of Szczecin
Poland

The presentation agenda

- Potential benefits of slow steaming
- Potential detriments of slow steaming
- Different modes of slow steaming
- Technical challenges for the main engine
- Technical challenges for auxiliaries
- Technical challenges for ship's hull
- Technical challenges for the crew
- Summary

Slow steaming beneficiaries



Charterer

- Lower ME fuel consumption per voyage
- Lower bunkering frequency per voyage

Technical operator

- Lower average engine load
- Lower yearly cylinder oil consumption

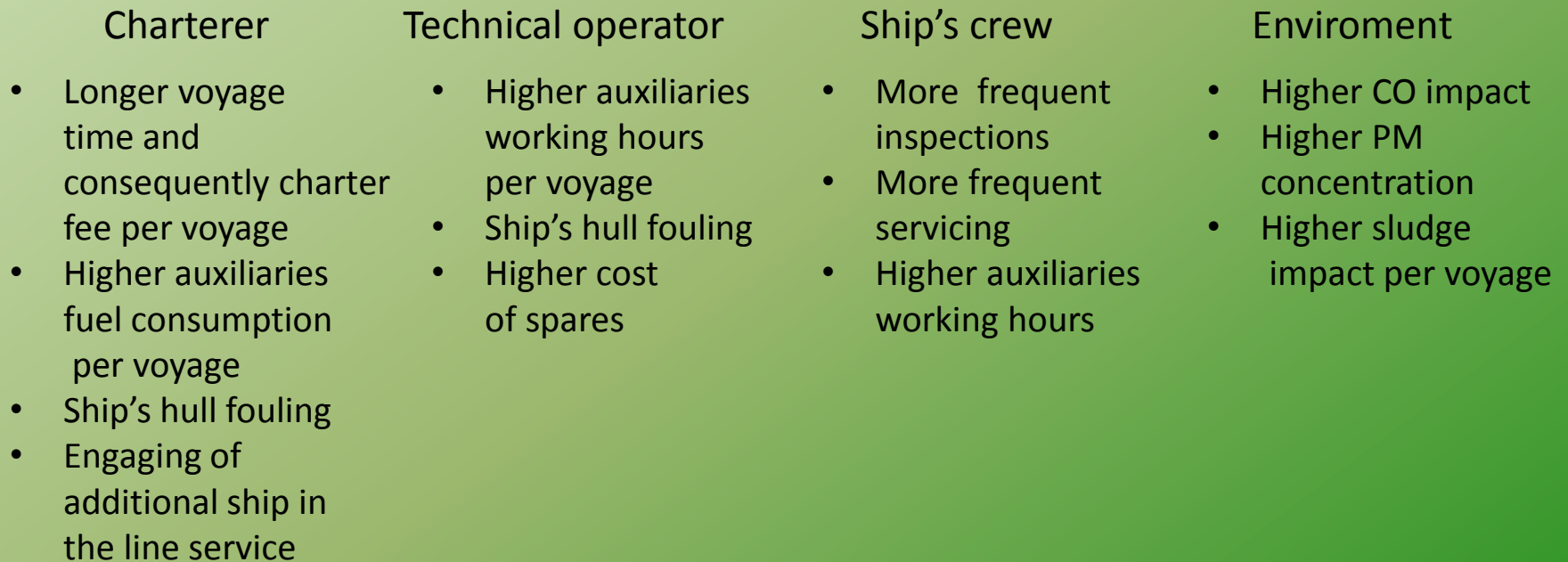
Ship's crew

- Lower bunkering frequency
- Lower average engine load
- Longer time between ports

Enviroment

- Lower NOx impact per voyage
- Lower CO2 impact per voyage
- Lower SOx impact per voyage
- Lower risk of fuel spillage per voyage

Slow steaming due detriments



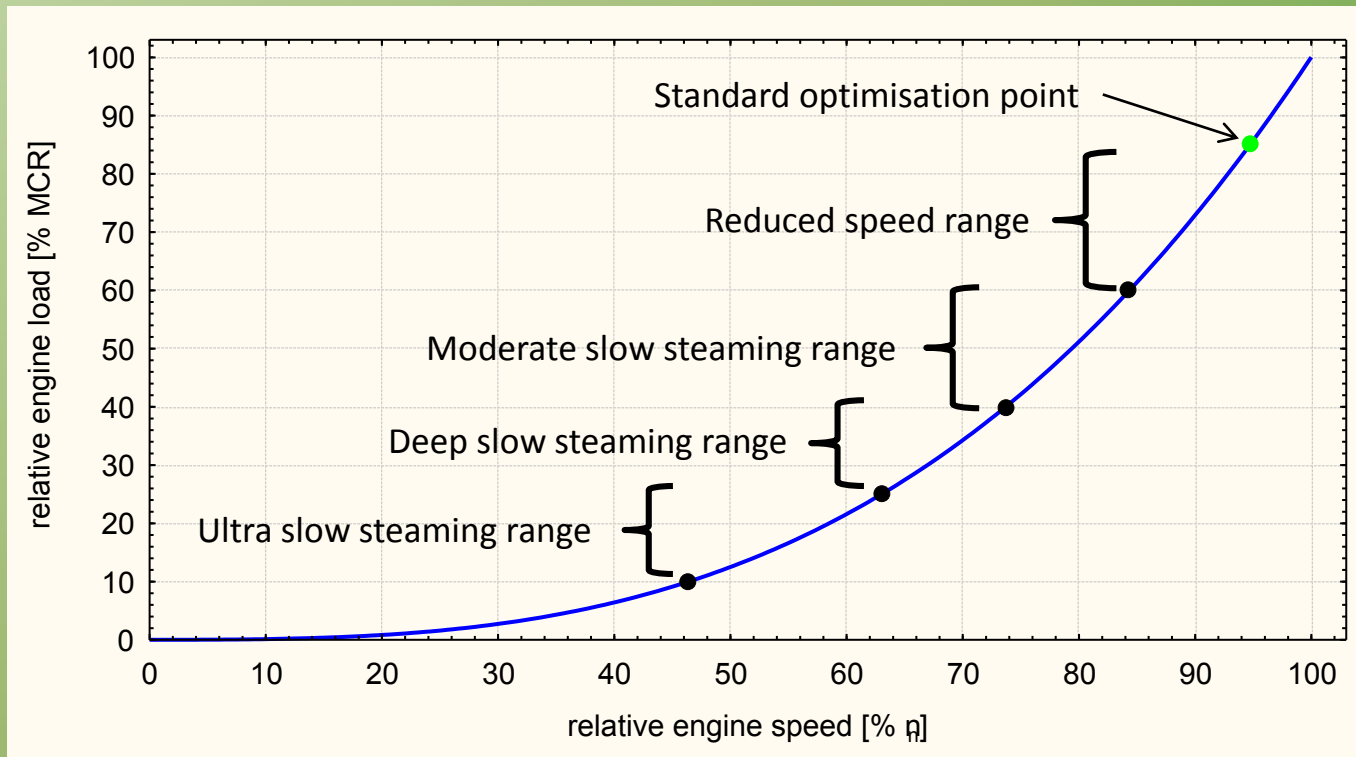
Different modes of slow steaming

- **Reduced speed.**

Range of main engine load below the optimisation point down to approx. 60% of load. Till the slow steaming era it used to be considered as a minimum limit of continuous low load operation for a large marine engines.

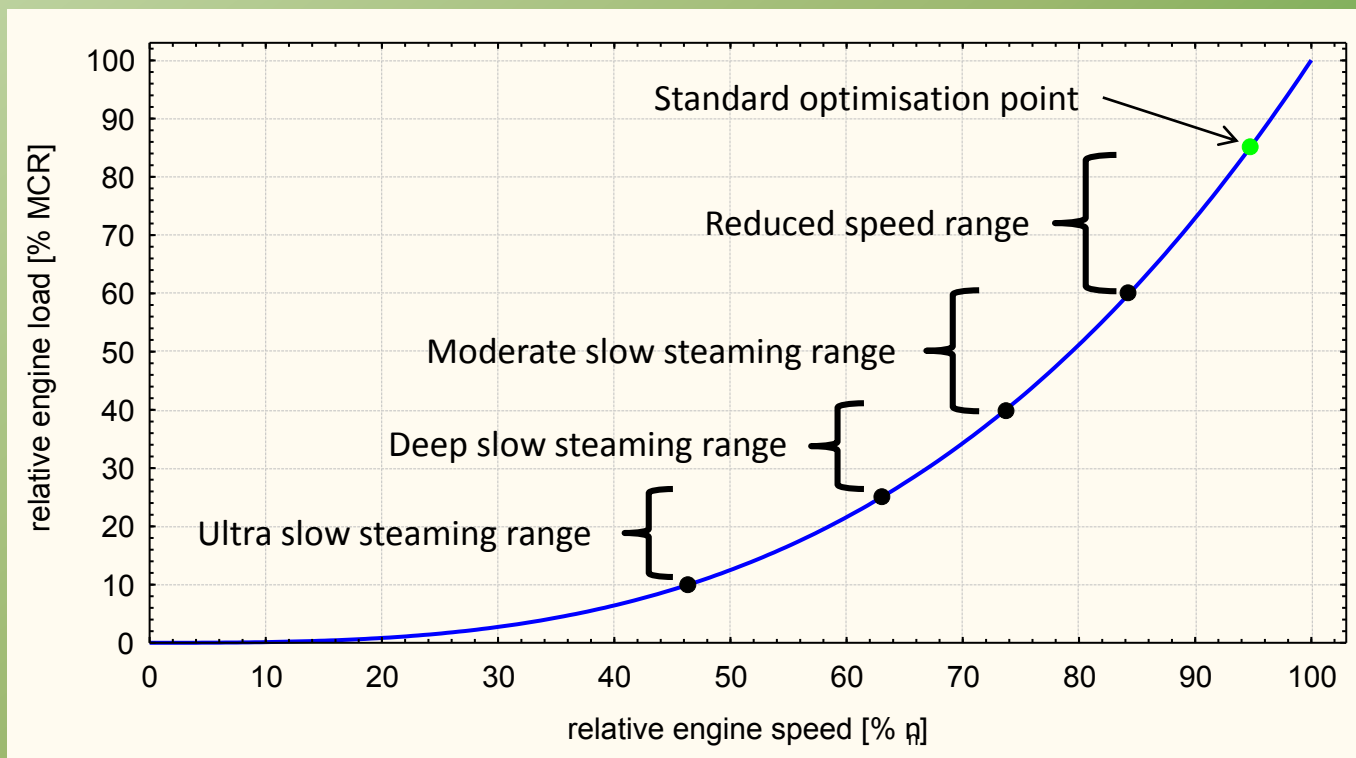
- **Moderate slow steaming.**

The auxiliary blowers may cut-in periodically for a short time when approaching to lower limit of this load range. The auxiliary boiler is cut-off. Typical load range 60-40 % of MCR.



Different modes of slow steaming

- **Deep slow steaming.**
The auxiliary blowers are in service and auxiliary boiler may frequently cut-in to boost poor performance of economiser. Load range approx. 40% of MCR down to 20-25% of MCR
- **Ultra slow steaming.**
The auxiliary blowers and auxiliary boiler are in service. Insufficient waste heat to operate fresh water generator. Load range below 20-25% of MCR down to approx. 10% of MCR



What on board can be affected by slow steaming?

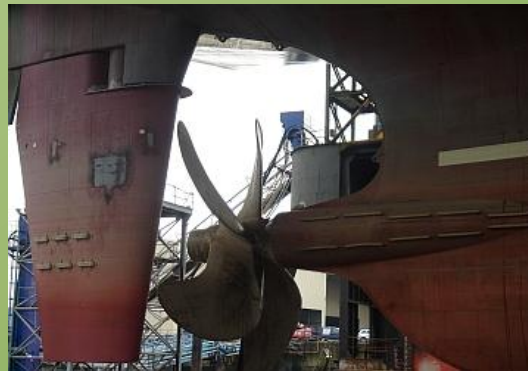
1) Main engine



2) Auxiliary machinery



3) Ship's hull



4) The crew



Main Engine

Cylinder oil dosage and consumption

As a rule of thumb all modern cylinder oil dosage systems relate amount of oil with the engine load and fuel sulfurisation based on general formula:

$$\text{CylOil} = S\% \cdot \%MCR \cdot k$$

Where:

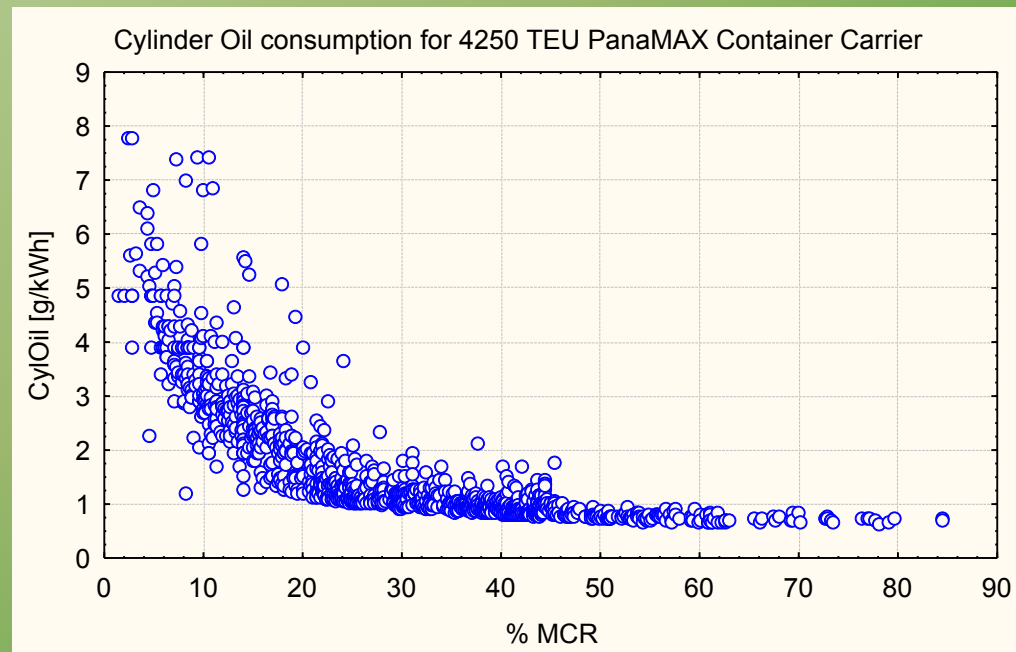
CylOil – cylinder oil dosage [g/kWh]

S% – percentage of sulphur in fuel

%MCR – relative engine load

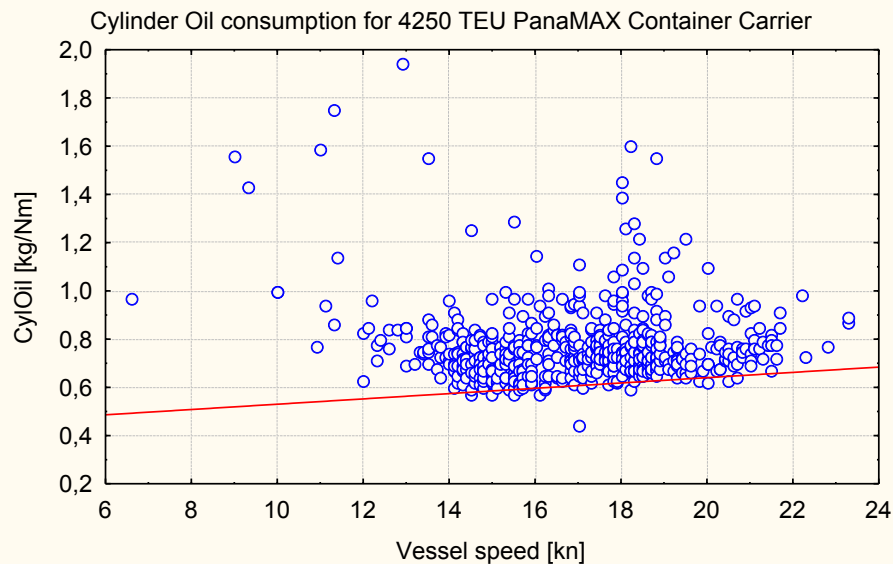
k – empirical dosage factor

The general expectation is that the cylinder oil consumption will decrease after slow steaming implementation.

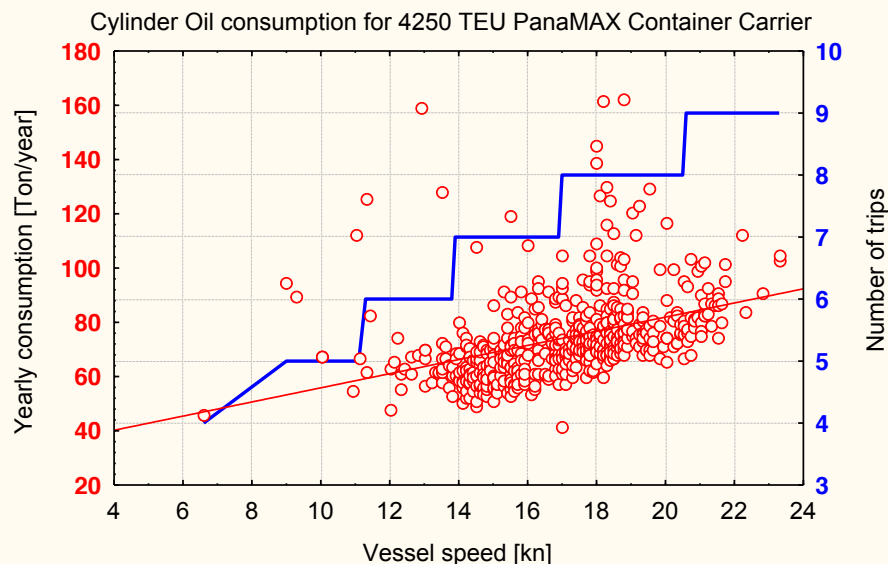


Main Engine

Cylinder oil dosage and consumption

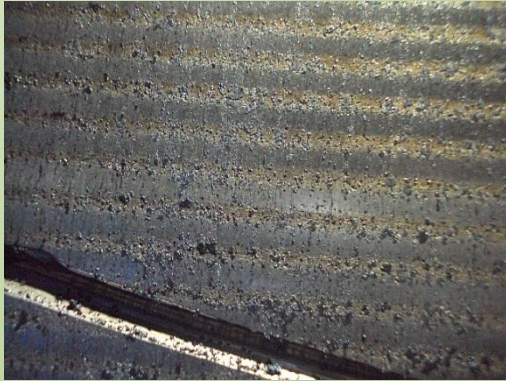


Let's simulate: vessel is employed on a South America – Europe trade with 11800 Nm distance per trip and total 8 ports, where she spends average 400 hrs per trip. The yearly cylinder oil consumption will depend on the vessel speed:



Main Engine

Cylinder oil overdosing – the consequences



Surplus oil burns into hard coke, resulting in fast



abrasive wear down of liner and piston rings.



Surplus unburnt oil flows down in a form of blackish sludge



resulting in piston rings clogging and blocking as well as increasing of fire in scavenge space risk.



Main Engine

low temperature corrosion

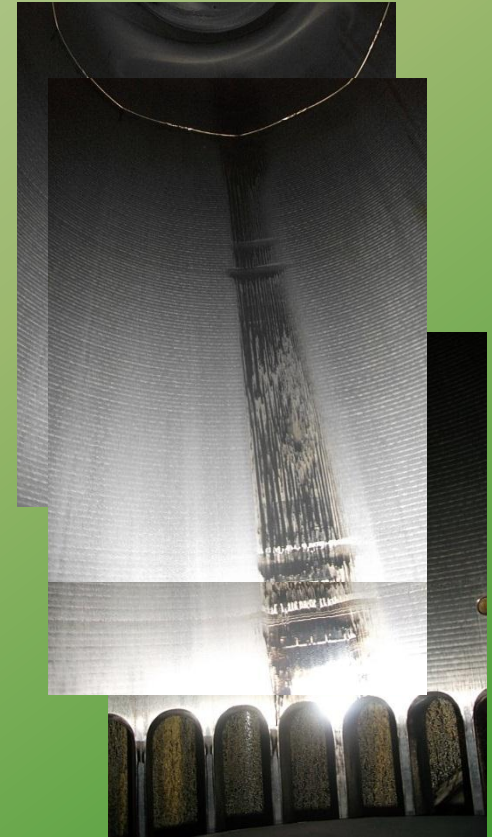
The main factors triggering low temperature corrosion:

- Low exhaust gas temperature
- High humidity of charging air
- Low HT cooling water temperature
- Low charging air temperature

Overcooled area of cylinder liner is exposed to water condensation and formation of acids.

How do we deal with it on board:

- Water mist catcher after charging air cooler inspections
- Rising cooling water temperature
- Rising charging air temperature
- Control of cylinder oil dosage

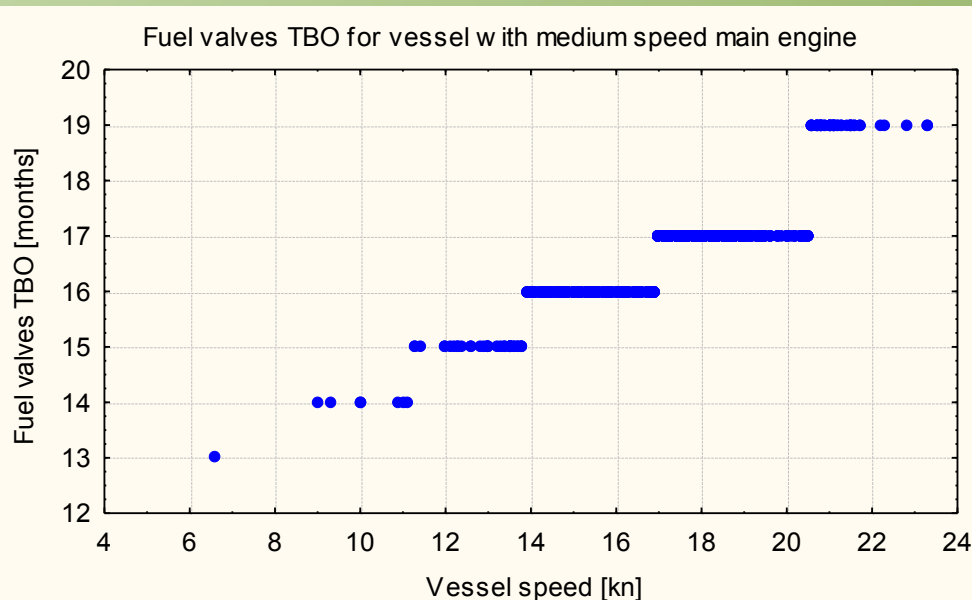


Main Engine

Fuel valve fouling



Typical TBO for 2-stroke engines is 16000 rh and for 4-stroke engines is 8000 rh. Due to contamination of the nozzle tip it may be reasonable to reduce it by 1000-4000 based on observations.

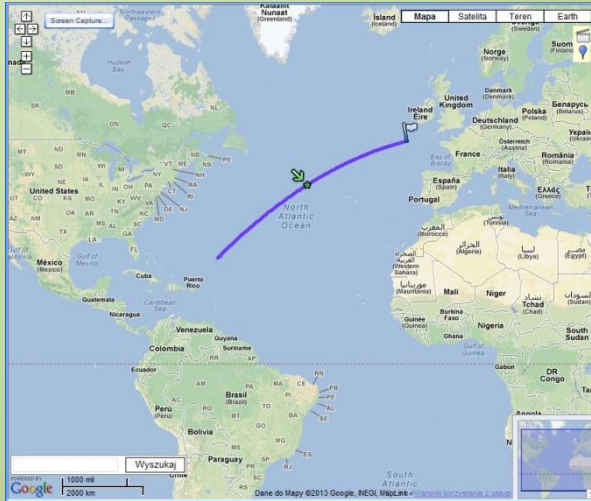


Due to longer time at sea when slow steaming, the overhauling frequency of some machinery will increase. It must be taken into account into a maintenance plan.

Also amount of work the crew is burden increase significantly.

Main Engine

Periodical engine's loading up



Advantages:

- Allows to blow away accumulated deposits
- Allows to burn soot
- Allows to test the engine readiness at higher load

Disadvantages:

- Increases daily average fuel consumption
- Causes additional thermal load
- Additionally consumes personnel time
- May lead to unexpected machinery failure during acceleration



Main Engine

Turbine washing

Two stroke engines:

- Dry or wet washing can be applied
- Usually conducted during sea passage
- Wet washing requires load reduction down to approx. 20-25 % MCR
- Dry washing requires loading up to approx. 70-80 % MCR

Four stroke engines:

- Wet washing can be applied only
- Usually conducted at berth prior departure
- Standard MAK recommendation: compressor every 24 RH at full load (minimum 50% MCR). Turbine every 150 RH at low load

Low engine load means either that the engine

- is running either, at zero pitch and rated speed
- or, on the grid at rated speed and a max. of 10 % load
- or, disengaged at rated speed.

In all cases the compressor side wet cleaning requires engine loading up.

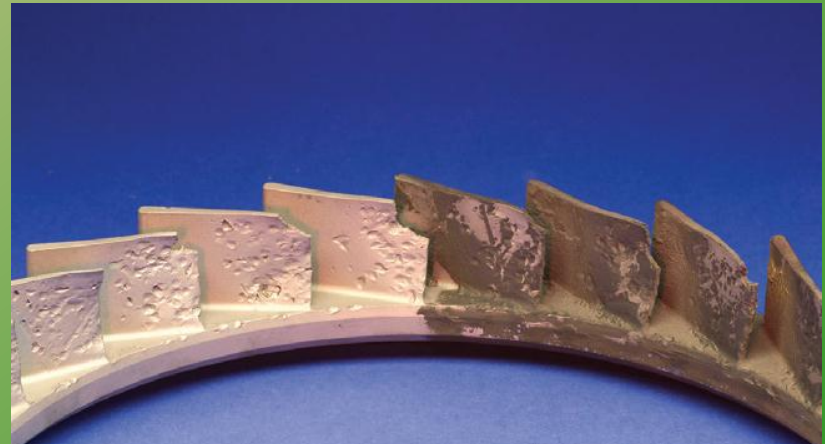
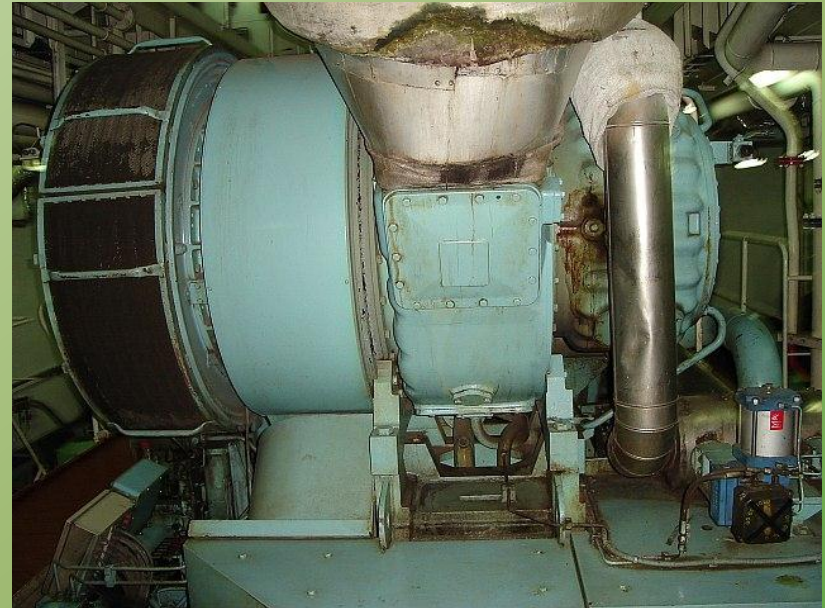


Main Engine

Turbine washing

The hazard:

- Corrosion of exhaust duct
- Abrasive wear of nozzle ring
- Thermal stress
- EU regulation for SOx emission at berth must be taken into account when planned in European port



Main Engine

Auxiliary blowers

The observations:

- Frequent cut-in/cut off at certain engine loads, usually close to 40 % MCR
- Continuous operation below approx. 40 % MCR

The following problems were defined:

- Electric motor and blower itself are not designed for continuous operation – risk of failure.
- Electric motor and blower itself are not designed for frequent starts – risk of failure.
- Due to size of motors their sudden start may cause nonessential consumers trip.
- Sudden change of weather condition, sea current, alteration of the vessel course or speed setting when engine room is not manned may lead to above mentioned.

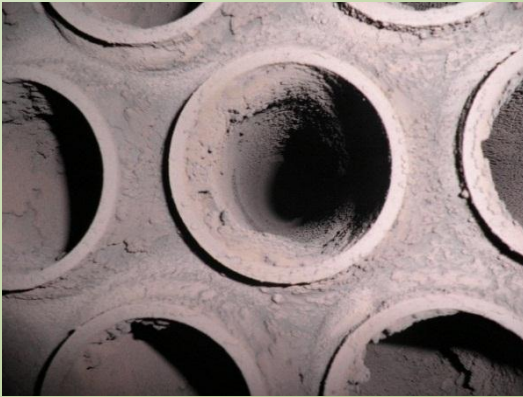
How do we deal with them on board:

- Set of spares and/or preferably complete blower with motor is to be kept on board.
- We avoid ~40 % MCR load for continuous operation.
- We set blowers in manual mode on.
- We agree with master 12 hrs operation at load above 40 % MCR and 12 hrs below this load.

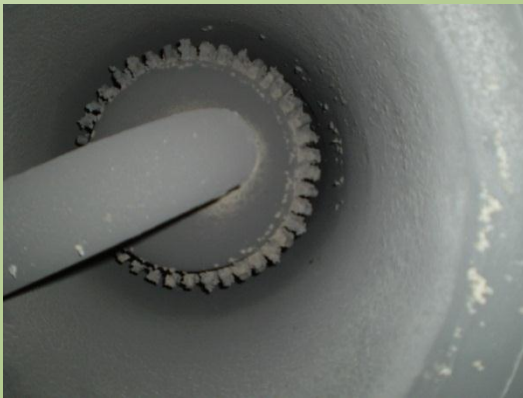


The heating plant

Boiler contamination



Due to low velocity of exhaust gas and poor atomization as well as combustion process, amount of deposits in smoke tubes increases drastically.



Under low ME load the economizer heating capacity becomes insufficient. In order to maintain steam pressure/thermal oil temperature the auxiliary boiler cuts-in usually below main engine's load 30 % to 40 % MCR when the economizer is clean. The auxiliary boiler cut-in set point reduction by 1-3 bar may be considered.



Dirty economizer brings the auxiliary boiler about to cut-in at higher main engine's load than 40 % MCR. Prolonged auxiliary boilers operation during sea voyage causes its additional contamination and consequently much higher fuel consumption.

High risk of soot ignition can not be underestimated in any case.

The heating plant

Contamination – how we deal with it



Installation and proper functioning of soot ignition catalyst dosing plant is essential.

However if exhaust gas temperature after turbine drops below 200-220°C their efficiency is disputable.

Frequent engine's loading up and boiler water washing seems to be most effective in reduction of deposits. However...



200-300 kg of deposits can be accumulated in smoke tubes over period of 4 months between washing (boiler's nominal steam output 1700kg/hr).

- Boiler plant has to be stopped for at least 12-16 hrs for proper cooling down, washing and heating up;
- It will be generated lots of garbage and dirty water
- Rinsing water is highly corrosive. Damage to the draining system is unavoidable even if neutralizers are being dosed.

Technical challenges for auxiliary machinery

Fresh water generation

The observation:

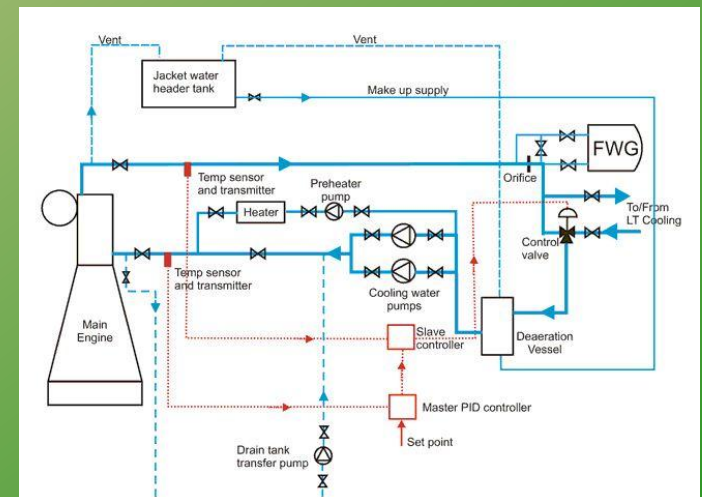
At deep and/or ultra slow steaming there is insufficient heat from main engine for fresh water generation.

How do we deal with it on board:

- Vessel has to take fresh water in ports what creates additional costs.
- In some systems it is possible to run ME cooling water preheaters as heating booster.

The disadvantages:

- Fresh water from shore is often of poor quality and harder than produced on board.
- Additional fuel consumption will be observed if auxiliary boiler cuts-in.



Technical challenges for auxiliary machinery

Sludge system

A few facts at beginning:

- The biggest source of sludge are fuel oil separators indeed.
- Modern separators activate desludging by detected contamination or by timer – what is first.
- Singular separator's capacity usually covers at least 60-70 % of entire ships maximum fuel consumption.
- Separator's throughput regulation is often impossible or difficult to achieve.

The observations:

- The charterers or owners pay for sludge collection so they expect minimum quantity of produced sludge.
- The previously used estimation that 1.5% of consumed fuel turns into sludge is not valid any more and this fact has to be accepted.

Amount of oily deposits related to fuel consumption, generated by slow steaming vessel, increase.



Technical challenges for ship's hull

Fouling

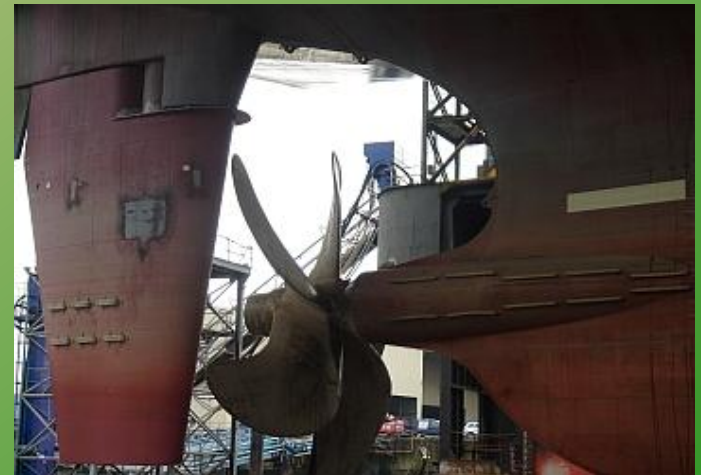
The observations:

- Ship's hull is coated with an antifouling painting designed for a specific range of speed.
- If the vessel's speed is prolonged time outside the designed range the protection may be not effective.
- Due to reduced rotation speed the propeller is more vulnerable to fouling as well.



How to deal with:

- The charterers or owners have to consider more frequent underwater surveys and surplus ships hull cleaning.
- Periodical propeller underwater polishing might be helpfull.



Challenges for the crew

Most of the ships is manned with a minimum crew. Very often not more than stated in Minimum Safe Manning Certificate.

Slow steaming demands more additional activities and attention from the crew, especially:

- More frequently inspections.
- More frequently cleaning and washing.
- More frequently servicing.
- Every day preventive activities.

There are advantages for the crew as well:

- Longer passage between ports (especial in west-east direction).
- Less frequent bunkers.
- Less frequent maneuverings.



Summary

Slow steaming became a widely utilized way of cost reduction in shipping and it has been accepted by major engine builders. Therefore it has to be accepted by engineers on board. However...

- Vessel operators has to understand that the additional maintenance requires an additional time.
- Some of maintenance procedures requires predictable prolonged berthing or safe anchorage.
- Some of preventive maintenance requires additional consumables (chemicals, spares etc.).
- In some cases, additional manpower might be required in order to conduct slow steaming related services together with standard service and running the ship.
- Prolonged slow steaming without intermittent periods with higher load will deteriorate the whole ships performance and will decrease initial profits.

The recommendations:

- Good cooperation between charterer, technical operator and well trained crew is essential.
- Whenever possible periodical short passages at higher vessel speed should be arranged.
- Vessel should be given necessary time for conducting maintenance.