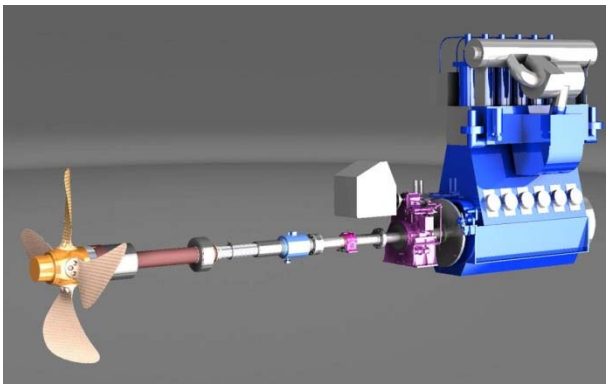
IMPORTANCE OF PROPULSION SYSTEM COMPONENTS SELECTION

The correct system components selection allows:

- Obtain higher efficiency, fuel saving.
- Avoid operation stops due to components break.
- Higher lifetime of propulsion system components.
- Avoid ship structure damage
- Avoid vibration

The propulsion system should be calculated on the design stage of a new ship, on a ship re-motorization, on vibration presence or when a break component should be replaced.

Generally, the principal components of a propulsion system are: propulsion engine, flexible coupling, gearbox, propulsion shaft, bearings and propeller.



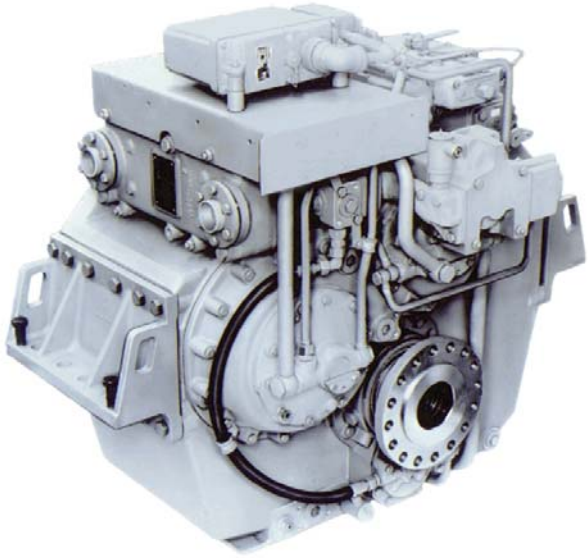
Typical ship propulsion system

The propulsion system is the element that generates the necessary torque to rotate the propeller. To select the propulsion engine should be considered: power, rotating speed, weight, dimensions, viscous damping, flexible supports an foundation structure.

This selection allows to select gearbox and propeller to obtain the best efficiency and to avoid vibrations or resonances with other ship elements

Flexible coupling

The flexible coupling is the element to join propulsion engine and gearbox, it allows a partial compensation of misalignments between engine and gearbox (Thermal growth, wear, etc.), protects the propulsion system of engine excitation and protects the propulsion engine from propeller overloads.



Gearbox

The gearbox ratio should be selected according to propulsion engine and ship operation, it should allow the load of power transmission between engine and propeller. The right selection of gearbox avoid gear hammering and avoid axial, lateral and torsional resonances.

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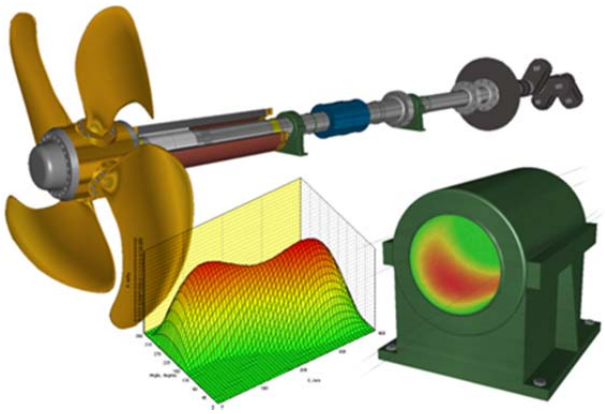
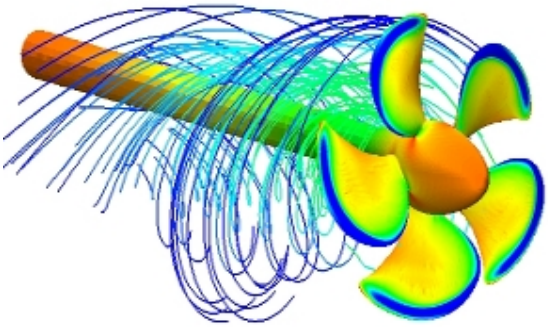
The propulsion shaft transmits torque from gearbox to the propeller, at selection should be considered the bearings location, shaft section variation, diameter, shaft material, flanges and joints.



Propulsion line model (shaft designer software.)

In the shaft bearings selection should be evaluated the design pressure limit (shaft alignment calculation), material, offsets limits, thermal dilatation, hygroscopic expansion and bearing slope.



Propeller model

In a propeller must be selected: principal dimensions (Blades Nº, diameter, pitch, type, D.A.R., rotation), Blades sections, material, rake, skew. A correct propeller selection is important to obtain higher efficiency, avoid elevated excitations and to avoid cavitation.

For a correct selection of this components, specialized calculations should be performed, to check that components are adequate to the generated stresses (nominal and vibratory) in the power transmission from the engine to the propeller to move the ship efficiently and without vibration.

For the propulsion system selection, recommendations and criteria's from Classification Societies and manufacturers must be followed.

The principal calculations for the components selections are:

- Vibrations theoretical study using specialized software (lateral, axial and torsional).
- Alignment calculation considering thermal deformations and hull deflections.
- Propulsive analysis (if possible, model test should be performed to obtain ship resistance).
- Transmissibility analysis to select engine flexible supports.
- Finite elements calculation for engine foundations.
- Propeller design.

Study example 1: Patrol vessel presents vibration and recurrent fractures of rudders after re-powering.

Following analysis were done:

- Axial and lateral vibration calculations.
- Analysis of measured vibration spectrums
- Propulsive calculations

An axial resonance was found with the new propulsion engine near 1800 engine RPM.

This resonance is due to an inadequate gearbox ratio and propeller blades selection.

Was recommended to modify the gearbox foundation

New rudder design with finite element calculation and assembly drawings for construction were done.

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Study example 2: 46 m patrol vessel design for Lloyd`s Register approval

Following calculations were done:

- Propulsion system vibration calculations (axial, lateral and torsional).
- Alignment calculation (thermal deformation and hull deflection).
- Hydro – elastic vibration using finite elements calculation for propeller excitation.
- Optimized structural calculation of the ship including structural drawings.
- Propulsive calculation
- Propulsion system design.

Adequate propulsion system components were determined with the vibrations calculations for Lloyd's Register approval.

On sea tests, the ship navigates to design speed and without vibrations.

Study example 3: tanker re-powering:

Owner purchase a new engine with higher power than original, for this reason the following calculations were done:

- Lateral and torsional vibration calculation for Lloyd's Register approval.
- New foundation structure design with finite elements calculation.
- Alignment calculation and procedure booklet
- Exhaust back pressure calculation.
- New engine connection systems design

From the torsional vibration analysis it is recommended not operate

Del análisis de Vibración torsional, se recomienda no operar a potencia elevada en caso de fallo de encendido de algún cilindro debido a exceso de torque vibratorio, se recomienda usar otro modelo de acople flexible para evitar dicha restricción

New engine connection systems (Fuel, cooling water, heat exchangers, lubrication oil, compressed air)

From exhaust back pressure calculation, it is determinate that the original system is adequate for the new engine according to manufacturer recommendations.

The alignment procedure guarantee the correct position and operation of propulsion engine, considering thermal deformation, hull deflection, SAG/GAP calculation, considering flexible coupling and gearbox manufacturers recommendations.

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