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THRUSTER SESSION

Preventive maintenance methods for heavy duty azimuthing thrusters

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Schottel

Abstract

The exploration and sourcing of natural resources takes place mainly in deep sea areas and will move to even more remote places in the future. Therefore DP vessels will increasingly operate under harsh conditions in regions where no dry docking possibilities are available.

Reliable systems that prevent unexpected breakdowns are therefore of increasing importance. Behind this background, the combination of station keeping azimuth thrusters and a condition monitoring system offers clear advantages for offshore DP operations.

These online diagnostic systems measure important parameters and help to forecast unexpected failures and enhance preventative maintenance. Analysed reports result in preventive actions on continuously demanded DP units. These actions can be performed even during the operation or at a convenient operation slot. By using preventive maintenance cost intensive and time absorbing dry-docking or downtimes can be avoided.

Introduction

DP-vessels place extreme demands on the equipment. Harsh environments require utmost precision at the highest level of safety. Especially for long-term DP jobs the propulsion system needs to be in optimum conditions. A necessity for all thrusters are scheduled maintenances and overhauls. But depending on the individual thruster loads and operation hours the wear and tear differs for similar units and applications.

(Photo: PSV Bourbon Mistral)

Smooth and economical operation methods as well as precautious design features help to ensure a long-lasting operation. Safety is an important issue for DP operations - a system failure might be fatal and could mean danger for life and for the environment. To avoid failures or unplanned downtimes, a condition monitoring like the S-COM diagnostic system measures various machine parameters of the propulsion system. All measured values from important components and parameters are recorded in a data logger at the vessel. Condition monitoring systems have to work autonomously from the standard thruster control mode to ensure an undisturbed safe thruster operation.

This paper will give you an overview about monitoring possibilities for azimuth thrusters used for DP applications and explains the benefits.

Wear and tear in general

Thrusters are designed for long lifetimes but as mentioned earlier scheduled maintenance is necessary. Lots of operational impacts interfere at the single thruster components.
For example, these could be:

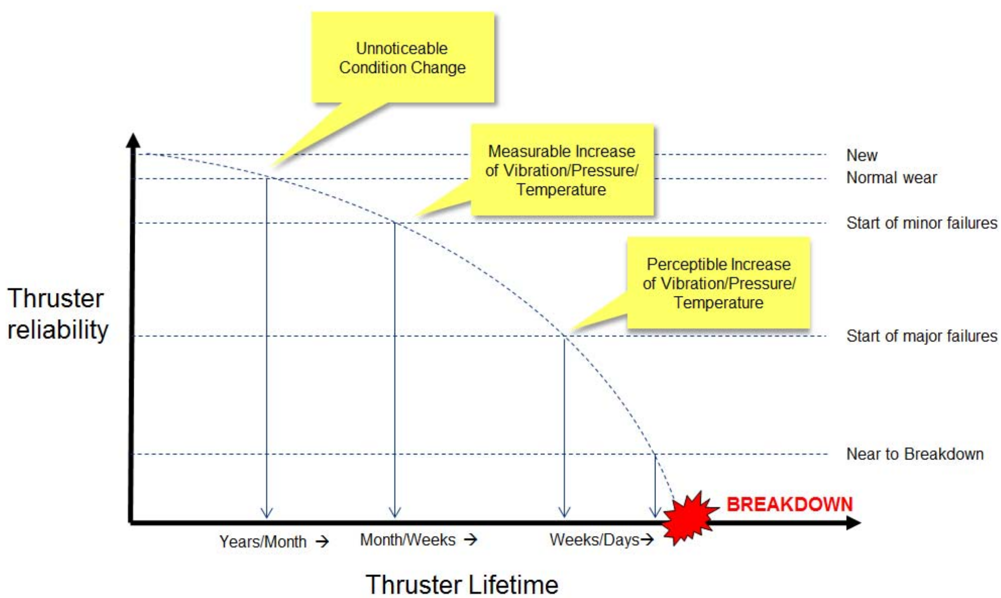
- Forces
- Loads
- Vibrations
- Thermal cycles
- Impacts
- Corrosion

Unfortunately, these impacts are not equivalent for each thruster type since nearly every vessel operates differently and even every thruster at the same vessel has got specific demands.

During their lifetime thruster are exposed to slight and continuous degradation beginning from first commissioning after manufacturing at factory and ends in worst case with the total breakdown.

There are in general different degradation steps which can be mentioned:

- Unnoticeable condition changes
- Measurable increase of conditions (vibrations, temperatures, pressures,…)
- Perceptible increase of these conditions



(Graph: Wear and tear during thrusters' lifetime)

Depending on the intensity of operation and taken maintenance measures it is a matter of time when the single steps, including the worst case scenario total thruster breakdown, are reached.

Preventive Actions

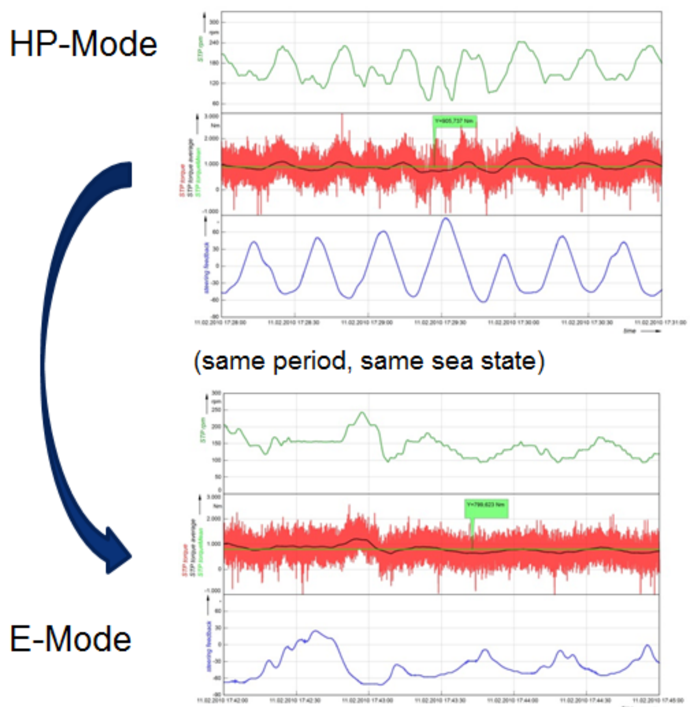
Scheduled maintenances are normally connected with a fixed time frame like operation hours or years. These settings are used for same products but not considering the specific and individual conditions and the resulting effects for single units.

As mentioned earlier, the specific wear and tear is influenced by the individual thruster operation conditions, based on the purpose of the vessel, the currently required accuracy and the weather/sea state.

Today, many DP software's offer a choice of different modes which can be selected individually.
For example there are modes which can be selected for high precision DP operations and there are a couple of others which allow a bit more dislocation of the vessel during station keeping.

The following diagrams show the effects and differences of selectable DP modes on the same thruster units over a similar operation time and at the same sea state.

Here, a high precision (HP) mode and a more relaxed economical mode (E) are displayed for comparison:



(Graph: Operation Modes High-Precision ("HP") and Economical ("E"))

Depending on the selected operation mode wear and tear will be influenced.

The high precision mode is reacting very fast to keep the vessel`s dislocation as low as possible, but a permanent use of these high cycles and loads challenges the thruster components and will degrade them accordingly.

A direct comparison between high precision mode and the economical mode shows the influence at the parameters of a thruster:

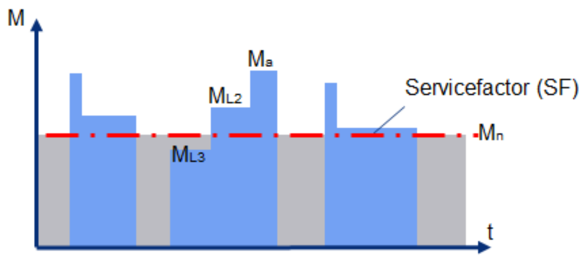
	High Precision DP-Mode	Economical DP-Mode
RPM	larger range & more cycles	smaller range & less cycles
Torque	larger range & higher torque	smaller range & lower torque
Steering	larger range & more cycles	smaller range & less cycles

You will understand that the use of the “economic” or “relaxed” mode has got in this respect also a positive effect on the wear and tear behaviour.

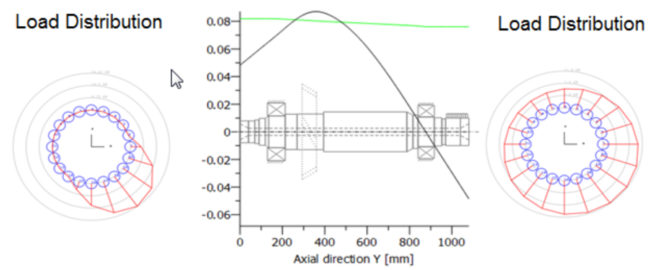
This should be an example for the influence of the specific thruster operation modes if there is a free choice by the operator when circumstances permitting.

Also at the manufactures end precautious actions are taken to prevent an early failure of components. As an example the bearing service life can be evaluated already during the design phase. Besides other high quality industry standards, ISO standards are used.

Individual application load condition and load spectra analysis help to determine and choose the correct bearing arrangement and bearing type. They consider also the inner bearing contact situation after installation and during operation.



(Graph: Servicefactor)



(Graph: Load distribution, shaft and bearing arrangement)

In general the following needs to be determined for the bearing service life:

- Inner geometry of the bearing
- Bearing clearance
- Change of clearance through thermal effects
- Change of clearance due to fits
- Displacement and tilting of the bearing due to deformation of shafting/housing
- Lubrication system
- Lubricants and impurity

By comparing these facts, the overall life time of a bearing can be determined.

Accordingly, the designers are able to choose the correct bearing arrangement and bearing type for each specific rotating part in a thruster.

Preventive Maintenance

Scheduled maintenances are normally not really considering individual thruster operations. They are planned based on experiences with existing units or based on similar applications.
Depending on the application exchanges of oils, sealing's or bearings are scheduled according to a maintenance plans and vary between 5-15 years.

As previously mentioned the time at which the thruster comes to the point of having minor or major failures depends on the individual use and operation. This corresponds also with the overall thrusters' life time.

The aim of an operator is to keep the vessel at the job and usually smaller proactive maintenances like filter changes or minor repairs are performed on a regular basis or when necessary. Unplanned major repairs like an exchange of a bearing do have an even more serious effect since an interruption of the job or even dry-docking may become necessary.

Further to scheduled maintenance actions, preventive maintenance can be performed to avoid such implications. The key is basically to collect as much data as possible from important parameters during similar thruster operation conditions and perform a trending.

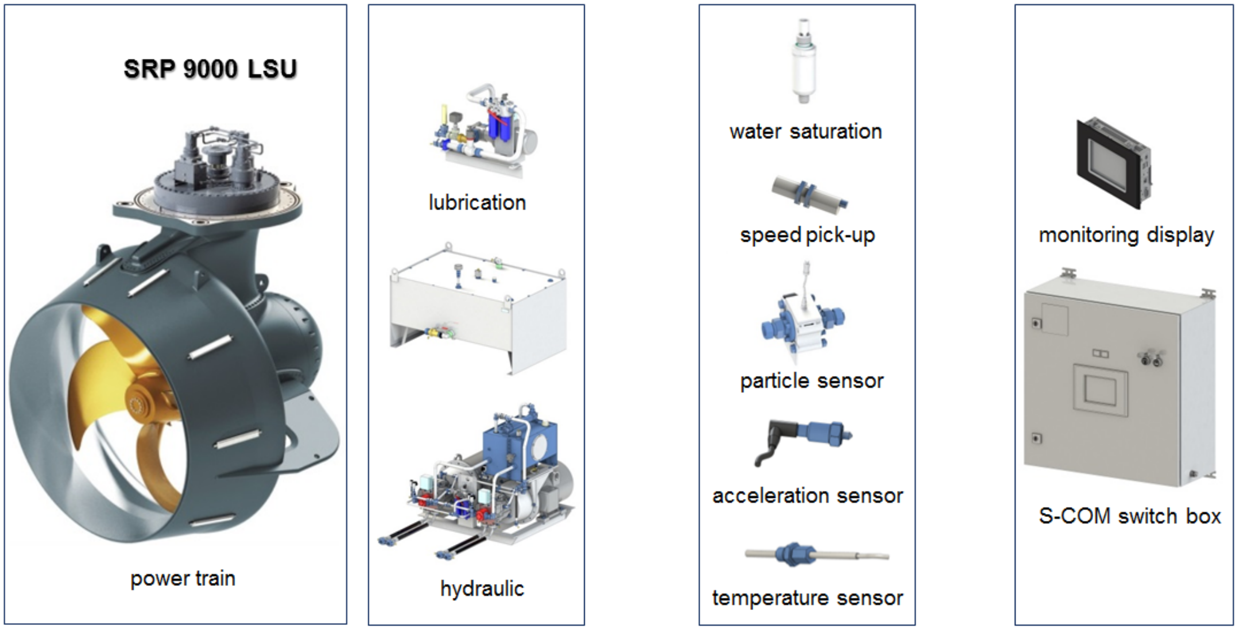
Mainly the following parameters are recorded:

- Temperature
- Vibration
- Saturation of water in oil
- Particles in oil
- Thruster speed
- Thruster steering angles

These data need to be analysed and should be compared with existing service data. Based on experiences and predefined technical limitations the resulting trends can be used to prevent future failures at the thrusters. The trending will also be used to perform a prognosis based on the real component conditions. Also single components can be identified by this method and can be replaced before even minor failures occur.

Thus, surprises can be avoided and if there is a need for a replacement a necessary service action can be planned at the most convenient point of time for the operator.

Diagnostic systems like the S-COM work independently of any ship´s alarm system. All sensors are located in the engine room and are easy accessible for service staff.
Monitoring systems control the actual thruster status, including not only the oil condition but also the condition of the bearings in particular. Thus, foresighted maintenance becomes possible.



(Graphic: Necessary components of an underwater mountable unit)

Various sorts of sensors are installed at the thruster or its components and measure the relevant parameters:

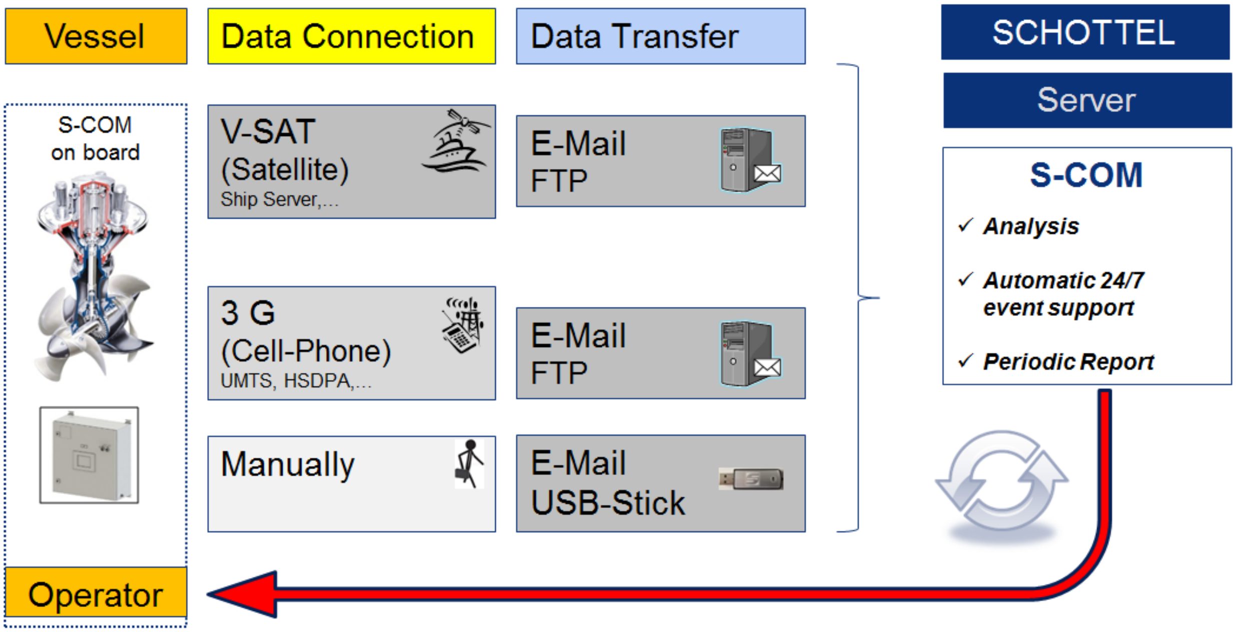
- Particles in the oil are always an early indication of wear.
  Permanent analysis enables you to identify the machine conditions.

- Monitoring the water content can also help you to detect damage to seals.

- Each rotating part e.g. bearing in the unit creates specific frequencies.
  Any change in these frequencies can give evidence to wear or possible damage, which can be detected at an early stage.
  By analysing the frequency it is possible to identify whether a defect at the bearing is e.g. at the outer or inner racer. These defect frequencies are mainly based on the known geometry of the bearing which are used.

All measured values are recorded in a data logger which is situated in the S-COM switch box at the vessel.

Depending on the customers' requirements the stored data can be sent manually to SCHOTTEL for examination or via a permanent internet-based connection which allows a steady survey and examination.

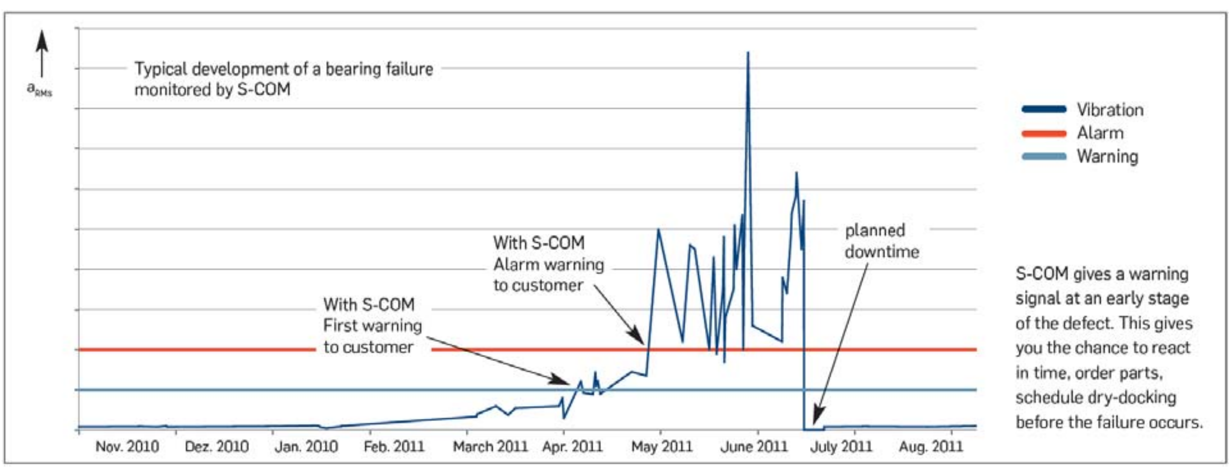


(Graphic: Data transmission and analysis)

The received data will be analysed and compared with professional diagnostics software to identify downtrends over time. On a regular basis the diagnostic system will generate a report and highlight unexpected deviations.

For each parameter different security levels are predefined. A "warning" level will inform at a very early stage before a defect becomes an issue. This ensures the attention for that specific peak or component and allows a careful further monitoring.

If a negative development of this trend is witnessed, the "alarm" level is reached. Also this stage still ensures a safe operation of the thruster. Once the "alarm level" is reached, the operator receives a notice about the findings and will be instructed if quick fixes are possible by himself or not.
Together with the operator specific maintenance recommendation can be defined or adequate repair advice can be given.

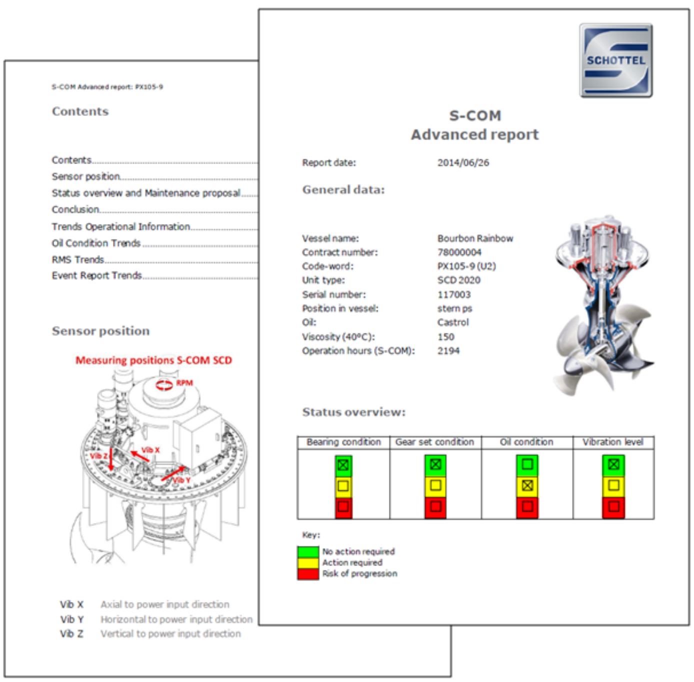


(Graphic: Bearing trending example)

In a worst case scenario a docking could then be planned according to the vessel's operation profile – which is still a lot better than having to act immediately during an ongoing job.

The S-COM system is monitoring the thrusters 24/7 and after the described analysis by the remote diagnostic system the customer will receive:

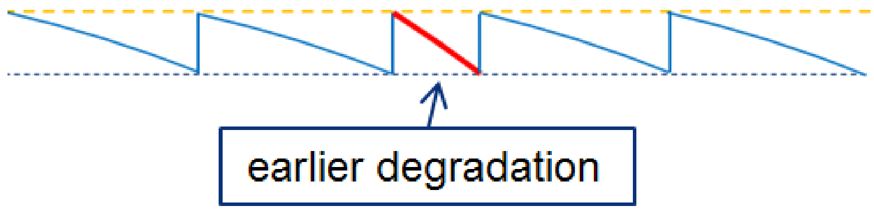
- Periodical reports and status of each thruster (e.g. every 3, 6, 12 months)
- Reports on request by customer
- Automatic event reports when the "alarm" level was reached



(Graphic: S-COM Report Example)

Conclusion

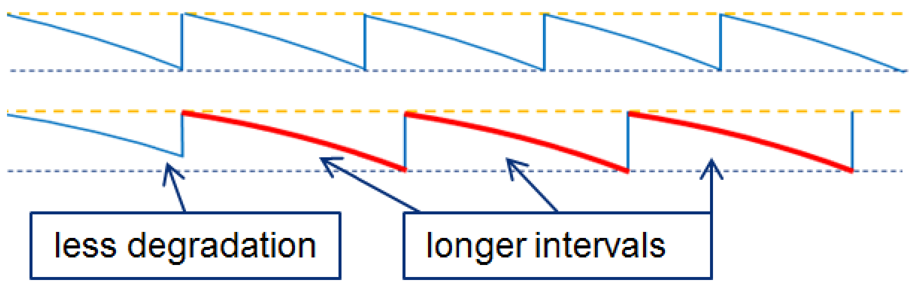
Diagnostic systems measure important parameters and help to forecast unexpected failures before serious damages occur and enhance preventive maintenance.



(Graphic: Detection of unexpected degradation)

Analysed parameters are summarized in periodic or event reports. Preventive actions or necessary maintenance can be performed based on this knowledge.

That can be done during operation if possible or in between operation slots. An early identification will also prevent cost intensive and time absorbing unexpected dry-docking or downtimes for the operator.



(Graphic: Expansion of maintenance intervals)

Even an increase of the maintenance intervals is possible if such a diagnostic system is installed and shows reliable data over time.

2015 DP Conference – Thrusters – Frank Zeller