Preventative Maintenance Methods for Heavy Duty Azimuth Thrusters

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_Schottel_
Preventive maintenance methods for heavy duty azimuth thrusters

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- Preventive actions
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GENERAL INFLUENCES

Harsh Weathers

Calm Weathers
GENERAL INFLUENCES

- corrosion
- hydrodynamic loads
- foreign object damage
- grounding
- steering forces
- structural fatigue
- vibration
- operational loads
- engine loads
- thermal cycles
WEAR AND TEAR

Simplified Explanation

Thruster reliability

- New
- Normal wear
- Start of minor failures
- Start of major failures
- Near to Breakdown

Life time

BREAKDOWN
WEAR AND TEAR

Thruster reliability

Years/Month → Month/Weeks → Weeks/Days → BREAKDOWN

- Unnoticeable Condition Change
- Normal wear
- Start of minor failures
- New
- Start of major failures
- Near to Breakdown

Measurable Increase of Vibration/Pressure/Temperature

Perceptible Increase of Vibration/Pressure/Temperature
WEAR AND TEAR

Influence of operation conditions and maintenance

Degradation

Normal wear
Start of minor failures
Start of major failures
Near to BreakDown

X ?
BREAKDOWN
Y ?
PREVENTIVE ACTIONS

Different Operation Modes (e.g. PSV HAVILA AURORA)
PREVENTIVE ACTIONS

Operation Modes „Precision“ vs. „Relax“

Thrust

Dislocation

Linear Variation

Exponential Variation

„Precision“

„Relax“
PREVENTIVE ACTIONS

Depending on the selected operation modes the wear and tear will be influenced:

(High Precision Mode (HP)/Ecomomical Mode (E))

**RPM:**
- HP: larger range & more cycles
- E: smaller range & less cycles

**Torque:**
- HP: larger range & higher torque
- E: smaller range & lower torque

**Steering:**
- HP: larger range & more cycles
- E: smaller range & less cycles
PREVENTIVE ACTIONS

The bearing service life is determined on the basis of the individual application load conditions, defined by the service factor or an individual load spectra.

- Considers the 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

Complies with
- ISO 281 / 16281 Dynamic load ratings and rating life
- ISO 15312 Thermal speed rating
- DIN 732 Thermally safe operating speed
Scheduled Maintenance

Degradation

Normal wear
Start of minor failures
Start of major failures
Near to BreakDown

Thruster Lifetime

Proactive Maintenance
Minor Repairs
Major Repairs

Preventive Maintenance
Preventive Maintenance

Measure and analyze vibration, pressure, temperature, signals, alarms and liquids

Unnoticeable Condition Change

SCHOTTEL Data

Service Data

+ Experience

Real Condition Prognosis

Optimized Planning

Thruster reliability
CONDITION MONITORING

Diagnostic System „S-COM“

SRP 9000 LSU

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

S-COM (SCHOTTEL Condition Monitoring)

Independent system
No connection and influence at thruster control
CONDITION MONITORING

Necessary components of an underwater mountable unit

- **SRP 9000 LSU**
  - power train
  - lubrication

- **SRP 9000 LSU**
  - hydraulic

- **SRP 9000 LSU**
  - water saturation
  - speed pick-up
  - particle sensor
  - acceleration sensor
  - temperature sensor

- **SRP 9000 LSU**
  - monitoring display
  - S-COM switch box
CONDITION MONITORING

Schematic of system:

- Control parameters
- switch box steering
- switch box prime mover
- galvanic isolated
- S-COM switch box
- S-COM terminal box
- Temperature, water saturation, particle count, speed sensors
- Acceleration sensors

Firewall
Internet
CONDITION MONITORING

Examples for monitored parameters

- water saturation
- speed pick-up
- particle sensor
- acceleration sensor
- temperature sensor

SRP 9000 LSU

- e.g. water saturation in oil:

- e.g. time signal acceleration at specific rpm:
  - x, y, z-axis
  - z-axis
**CONDITION MONITORING**

Detection of bearing defects:

Each roller bearing has specific defect frequencies depending on the geometry.

\[
f_R = \frac{D_m \times n}{D_b \times 60} \times (1 - \left(\frac{D_b}{D_m}\right)^2 \times \cos^2 \beta)
\]

\[
f_I = \frac{n \times z}{2 \times 60} \times (1 + \left(\frac{D_b}{D_m}\right) \times \cos \beta)
\]

\[
f_O = \frac{n \times z}{2 \times 60} \times (1 - \left(\frac{D_b}{D_m}\right) \times \cos \beta)
\]

**signal preparation in S-COM**

Identification of typical defect frequencies
CONDITION MONITORING

Development of bearing defects

S-COM gives a warning signal at an early stage of the defect. This gives you the chance to react in time, order parts, schedule dry-docking before the failure occurs.
CONDITION MONITORING

Vessel
- S-COM on board

Data Connection
- V-SAT (Satellite)
  - Ship Server,…
- 3 G (Cell-Phone)
  - UMTS, HSDPA,…
- Manually

Data Transfer
- E-Mail
- FTP

SCHOTTEL
- S-COM
- Analysis
- Automatic 24/7 event support
- Periodic Report

Operator

YOUR PROPULSION EXPERTS
CONDITION MONITORING

Monitoring Report:

Content:

- General project data
- Status overview
- Summary
- Log Book
- Maintenance proposal

Issued:

- Periodical reports (e.g. every 3, 6, 12 months)
- On request by customer
- Automatic event reporting when the “alarm” level was reached
TYPICAL APPLICATIONS

RIVERCRUISER VIKING
4 x SCHOTTEL STP 200 FP

128 T BP OFFSHORE TUG LUZ DE MAR
2 x SCHOTTEL Rudder Propeller Type SRP 3040 CP

DOUBLE-ENDED FERRY BERGENSFJORDE
4 x SCHOTTEL Combi Drive Type SCD 2020

PSV BOURBON MISTRAL
2 x SCHOTTEL Combi Drive Type SCD 2020
EXAMPLE FROM THE FIELD

PSV vessel with S-COM operating in the Gulf of Guinea, next Benin

- S-COM detected bearing failure at upper gear box
- Customer contacted and repair solution agreed
- Service engineer sent with spares for the exchange of the failed bearing
- Job done within few days
SUMMARY

**Current situation:**

- Maintenance in regular fixed intervals
- Unexpected repair and downtime in case of damage
- Dismantling even if not required
- Short-term planning of docking times
- Short-term, unexpected staff assignment
- Loss of job or business
SUMMARY

**Situation with S-COM:**

- Condition based maintenance
- Early detection of damages

- Dismantling in case of indication of wear / damages
- Running systems are not touched
- Improved planning of dockings, better coordination
- Short ‘off hire’ period for customers
SUMMARY

Situation with S-COM:

- advance warning to avoid emergencies
- specific maintenance recommendation or repair advices
- scheduled docking

- Increased knowledge of operating conditions due to data recording (speed, load, steering angle, etc.)
- Increase of maintenance intervals possible

less degradation  longer intervals
THANKS!