CONDITION BASED MAINTENANCE OF OFFSHORE WIND TURBINES BY 24 / 7 MONITORING OF OIL QUALITY, OIL AGING AND ADDITIVE CONSUMPTION:

IDENTIFICATION OF CRITICAL OPERATION CONDITIONS & DETERMINATION OF THE NEXT OIL EXCHANGE

Dr.-Ing. Manfred R. Mauntz
Dr. rer. nat. Jörn Peuser
Contents

- Introduction - Existing measurement techniques
- Innovative measurement principle WearSens®
- How WearSens® identifies critical operation conditions of wind turbines?
- Results of a wind turbine field installation
Existing techniques

Existing techniques start working after particle formation, after damage is done

**Standard** solutions provide information after damage occurred.

No detection!
Comparison: Optical particle counter and WearSens®

Tribological layer gets depleted!

Particle counter detects damage!

No detection!
Comparison: Optical particle counter and WearSens®

Tribological layer gets depleted!

Particle counter
REDUCED DETECTION!

Source

Detector

LOW DETECTION!
The presented sensor system enables a continuous monitoring already from the first day, providing comparative data.

- Optimizing load
- Indicating service
- Predicting damage due to direct feedback and optimized load regulation.

- Development and optimization of new gearboxes / components by extended test stands analysis.

**WearSens®**

- **continuous Oil condition monitoring**
- **Particle-Measurement**
- **Advanced warning time**

**Machine condition**

- **Start of damage**
- **Vibration sensor**

**Sound**

**Temperature**

**Smoke emission**

**time**

- Minutes
- Days
- Weeks
The WearSens® unit measures three components:

- Specific electrical conductivity $\kappa$
- Relative permittivity $\varepsilon_r$
- Temperature $T$

→ the values $\kappa$ and $\varepsilon_r$ are determined independently.

→ Identification of the additive consumption by $\varepsilon_r$

→ Self learning, adaptive temperature compensation of $\kappa$ and $\varepsilon_r$
How WearSens® identifies critical operation conditions of wind turbines?

WearSens Index \( WS_i \)
Condition Based Maintenance with WearSens® - Monitoring of oil aging

Short and long-term changes in the lubricant are considered in the model. The stress of the lubricant is based on the actual wind conditions/fluctuations and wind turbine settings resulting in changes of the conductivity and relative permittivity. Frequent critical operation conditions lead to faster degradation of the Oil-Additive-Complex.
Offshore oil change with SWOC 1.0 Container system

- SWOC 1.0 fully offshore certified
- Pre-heated oil for short pump times
- Flushing oil for optimal gearbox cleaning

Source: www.speedwind-offshore.com
Field installation – results of a wind turbine

Data 11/2015

Comparison of

Vibration monitoring and WearSens®
Comparison vibration monitoring – competitive CMS
Early detection of events

Even at a low time resolution setting, the important peaks are clearly visible!

Later response
Low time resolution
Comparison vibration monitoring – competitive CMS with cmc CMS

**WS\textsubscript{i} cmc**

Early detection of events
At maximum time resolution:
→ Full control with high information density

**CMS Competitor**

Later response
Low time resolution
Condition Based Maintenance with WearSens® - Monitoring of oil aging

PMM

CBMS

PROTECTION & SAVINGS

Condition Based Maintenance

Time window oil exchange

Planned maintenance

PMM: 101,164 €

CBMS: 30,604 €

Total: 202,328 €

Total: 30,604 €

Machine condition

Continuous oil condition monitoring

Start of damage

Alarm sensor

Sound

Temperature

Smoke emission

Time: Minutes Days Weeks

Power [uA]

WS: WearSens Index

Planned maintenance

Time window

WS
Server-Interface via Internet Browser – REMOTE ACCESS 24 / 7

Customer Sensors

<table>
<thead>
<tr>
<th>Status</th>
<th>Windpark</th>
<th>Anlage</th>
<th>Typ</th>
<th>Getriebe</th>
<th>Oeltyp</th>
<th>Oelmenge</th>
<th>OWEANR</th>
<th>OelwechselAlt</th>
<th>OelwechselNeu</th>
<th>Komponente</th>
<th>Seriennummer</th>
<th>Active</th>
<th>to sensor data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Südwind S77, Winergy</td>
<td>FAG Getrie</td>
<td>Addinol Eco Gear 320 S</td>
<td>345</td>
<td>0</td>
<td>8/7/2016 12:00:00 AM</td>
<td>1/1/2017 12:00:00 AM</td>
<td>Bypass, Getriebe</td>
<td></td>
<td></td>
<td></td>
<td>to sensor data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Südwind S77, Winergy</td>
<td>FAG Getrie</td>
<td>Total Carter SH 320</td>
<td>345</td>
<td>0</td>
<td>3/15/2016 12:00:00 AM</td>
<td>1/1/2022 12:00:00 AM</td>
<td>Bypass, Getriebe</td>
<td></td>
<td></td>
<td></td>
<td>to sensor data</td>
</tr>
</tbody>
</table>

Automatic notification

WearSens® Report

High-quality reports and real-time monitoring of the condition of the machine components.

Phone screen showing WearSens® Report.
Benefits of the combination of Condition Based Maintenance & Online Monitoring

Extended oil change interval

→ Reduced costs

→ Preserve the environment

→ Resource protection

→ Real-time information about the current oil status

Online Monitoring

→ Detection of critical operation conditions

→ Prevent damage and increase life time

→ Prevent expensive downtimes and additional maintenance costs
Questions?

Dr.-Ing. Manfred R. Mauntz
cmc Instruments GmbH
Hauptstrasse 388
65760 Eschborn / Germany
Phone +49 6173 32 00 78
MRM@cmc-instruments.de
Contact:

Dr.-Ing. Manfred Mauntz
cmc Instruments GmbH
Hauptstraße 388
65760 Eschborn
+49 6173 32 00 78
MRM@cmc-instruments.de