



Experience from industrial practice with
impedance-based monitoring of the
lubrication condition in bearings



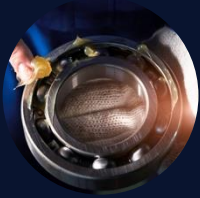
HCP Sense monitors lubrication in journal and rolling bearings, opening up new possibilities in predictive maintenance.

- Founded 2021
- Spin-off TU Darmstadt

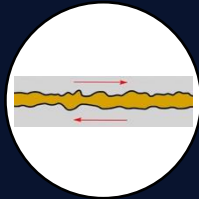
References



Agenda



Why do bearings fail?



Theoretical fundamentals

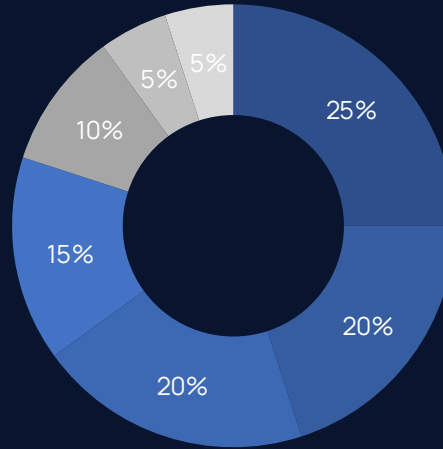


Measurement technology



Practical examples

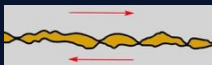
Why do rolling bearings fail?



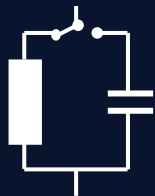
■ Contaminated lubricant ■ Unsuitable lubricant ■ Aged lubricant ■ Lack of lubricant ■ Unsuitable bearing selection ■ Mounting error ■ Others

80% of premature bearing failures are due to lubrication
and can be prevented!

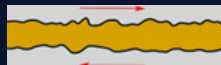
Technology



Boundary
lubrication



Mixed lubrication



Hydrodynamic
lubrication

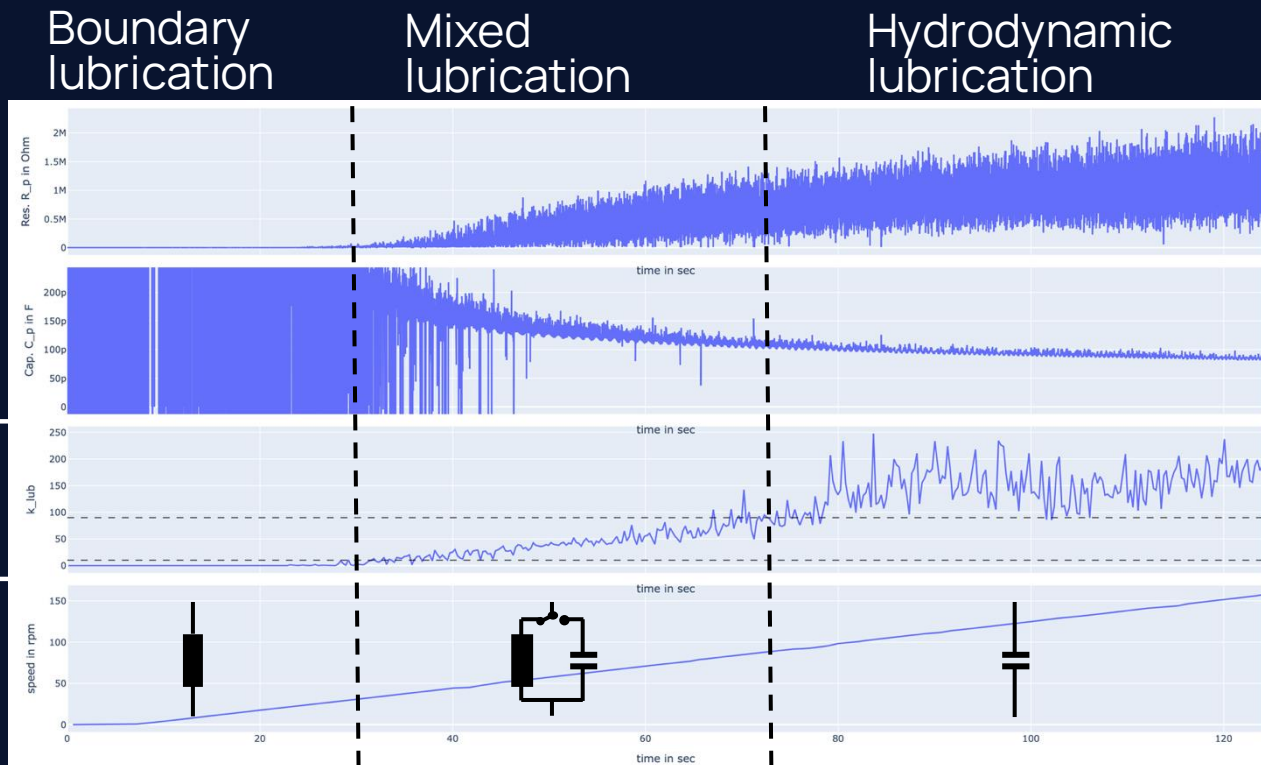


Example measurement

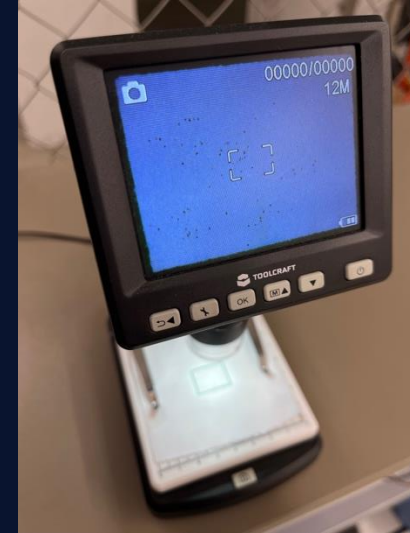
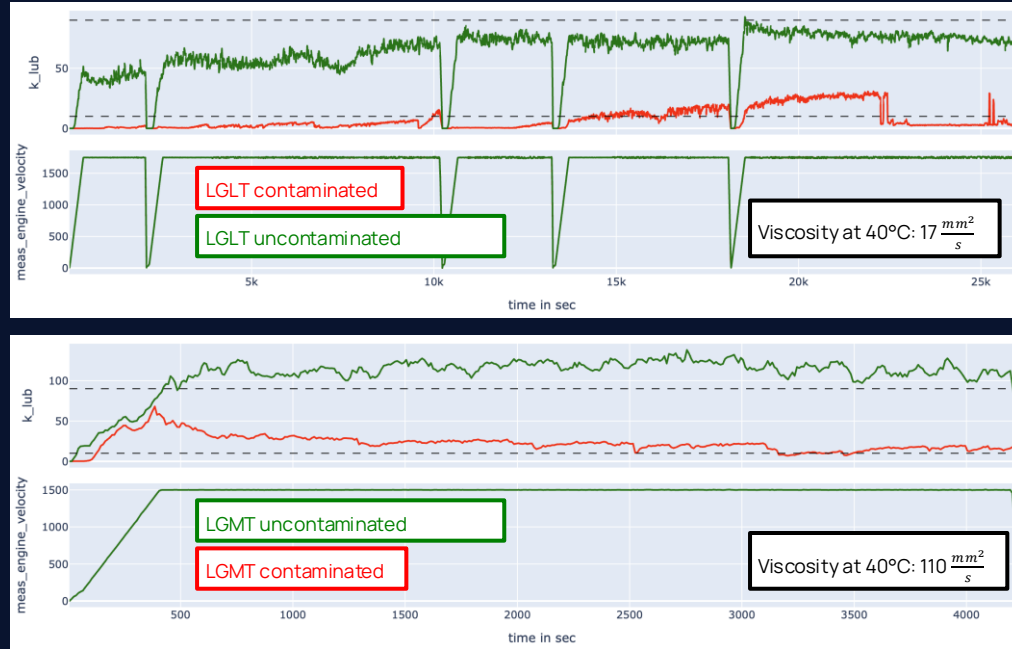
Raw data

Output
value

Speed



Test results – contamination 50 particles corundum 63-106 μm – 1750 rpm – 1000 N radial load

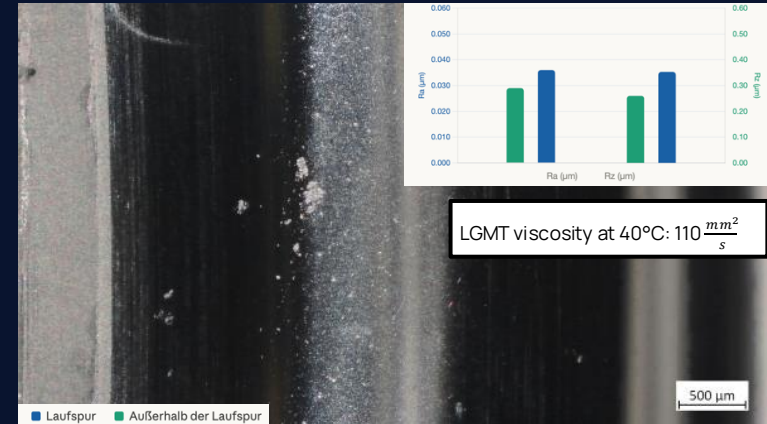
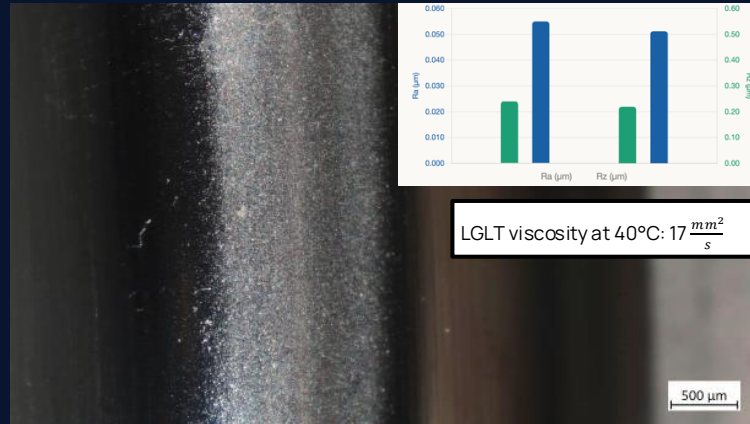


- Contamination lowers the lubrication parameters
- A more viscous lubricant provides better lubrication

Results of the bearing analysis



- Both bearings show abnormal running noise with frequency bands outside the tolerance
- Roughness measurements on the inner and outer ring raceways of both bearings show increased roughness values in the running track areas



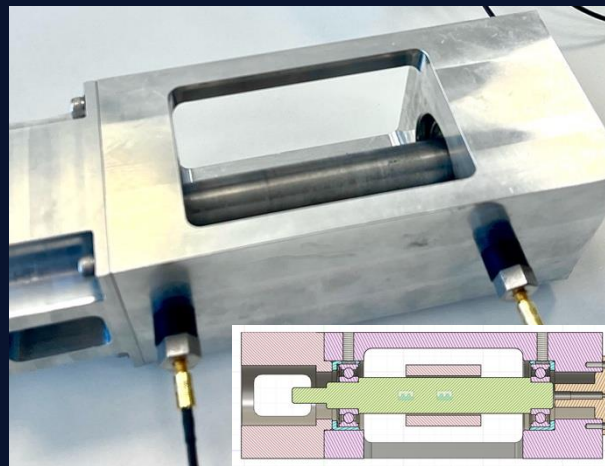
- Operation under contamination with a lower lubrication parameter damages the surfaces more severely

Impedance measurement

Inductive measurement system



Contact-based measurement system



Field test: run-to-failure in a single-stage spiral casing pump

HITACHI

Detecting misalignment

- Detection of axial and radial force asymmetries that indicate shaft misalignment or one-sided wear

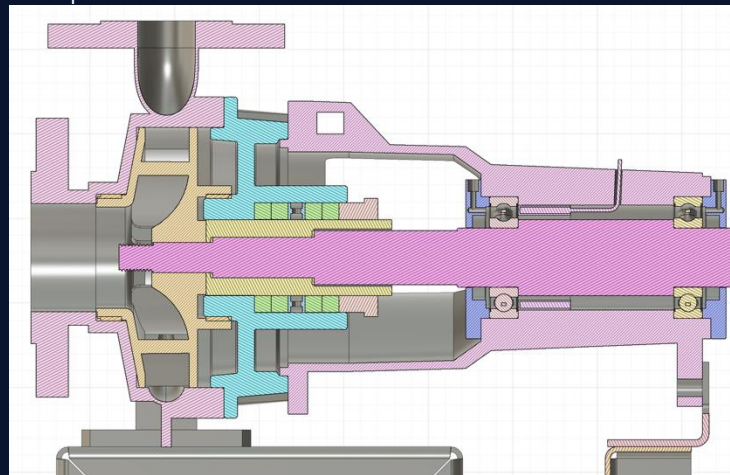
Extending bearing service life

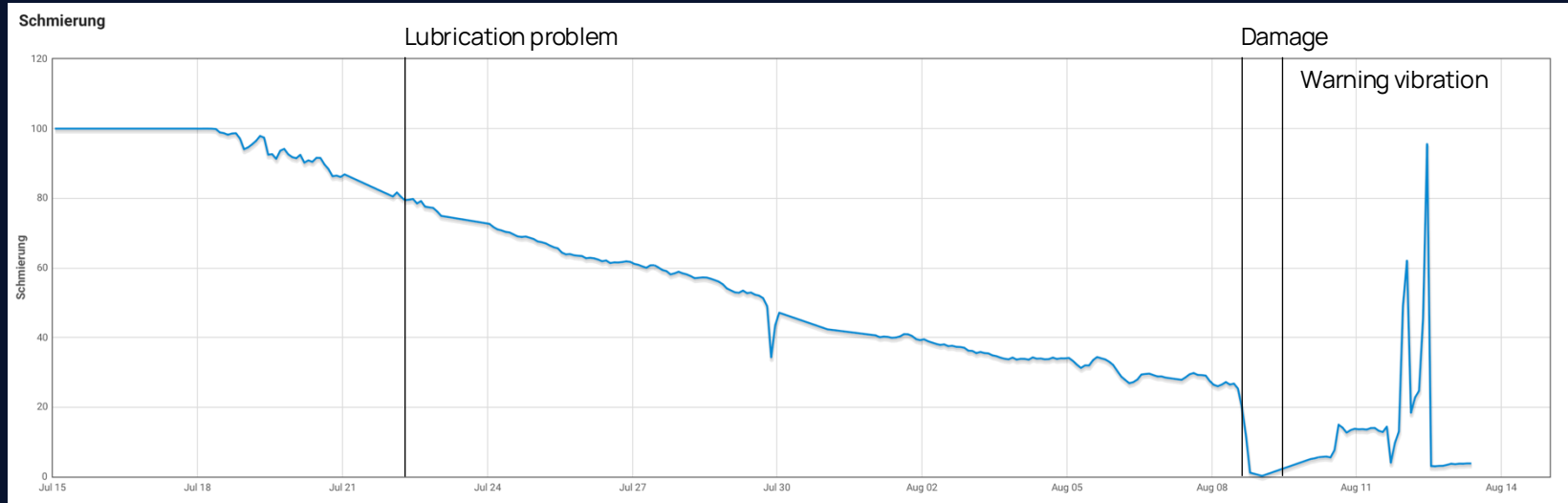
- Protection of the rolling bearings by initiating countermeasures, before fatigue damage becomes irreversible

Permanently avoiding unplanned downtime

- Significant extension of bearing service life through data-based operational optimisation
- Basis for a predictive maintenance strategy

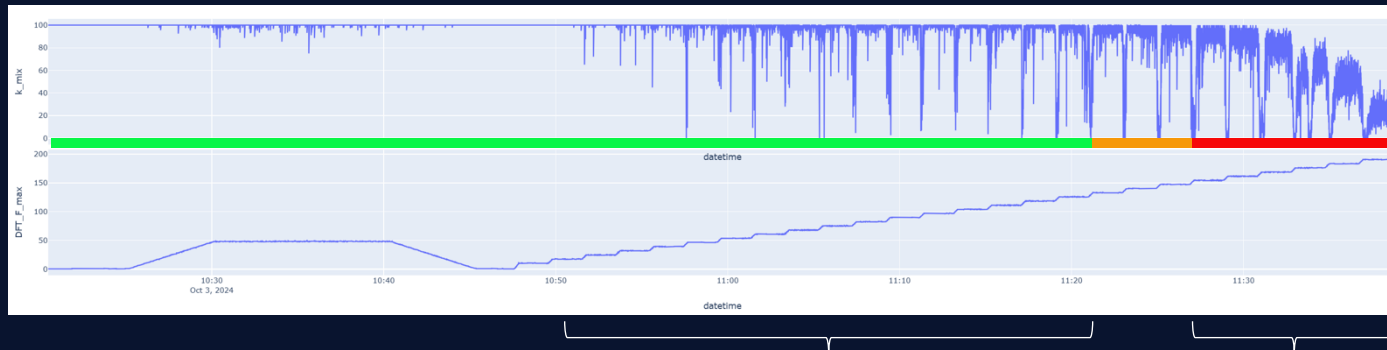
Example: not Hitachi





- Cause of damage detected three weeks before the damage occurs
- Damage detected 24 hours before other systems

Load increase in the journal bearing up to seizure damage



Reference/source: Miba AG
https://www.miba.com/fileadmin/user_upload/Advanced_digital_methods.pdf

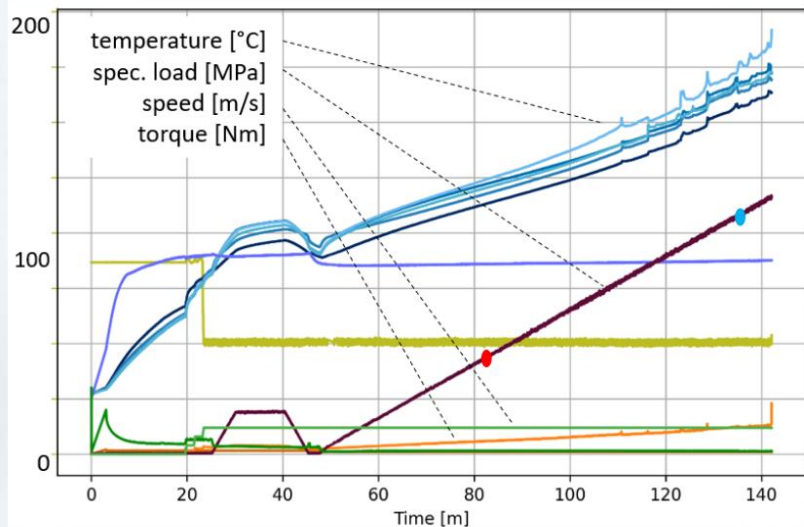
Stepwise load increase leads to edge loading, but the system recovers (running-in) → stable condition, no bearing damage

System permanently in mixed lubrication, no recovery → thermal runaway of the bearing up to seizure damage

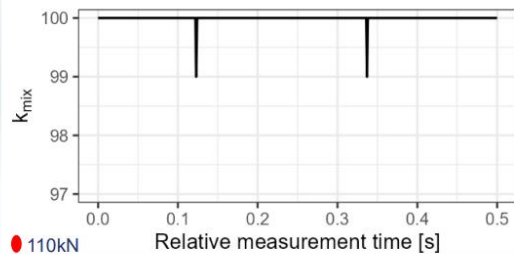
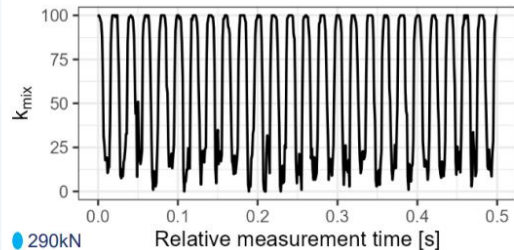
- Lubrication condition of the journal bearings clearly detectable → seizure damage can be prevented



Dynamic seizure load results



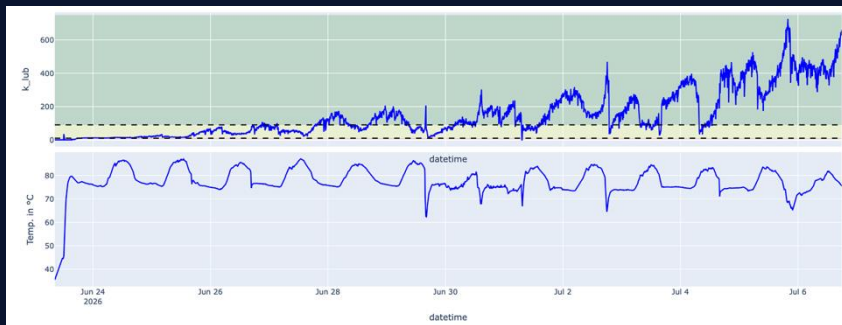
Impedance evaluation (for mixed friction)



Hager, G. Laubichler, C. Kiesing, C. Bakk, E.: Advanced digital methods for condition monitoring of bearing systems for large-bore ICEs

CIMAC Congress Zurich, May 2025

Continuous operation in a pump on a gas field

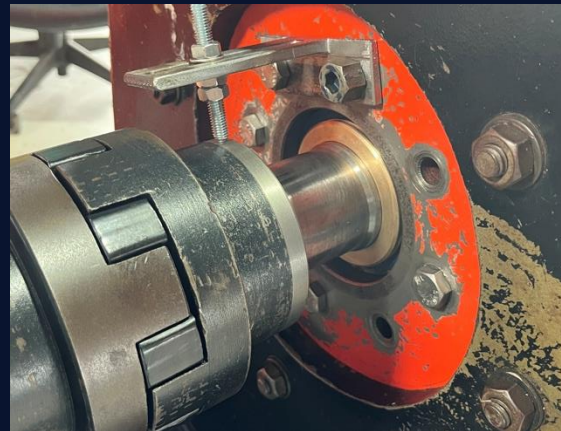


Detecting bearing damage

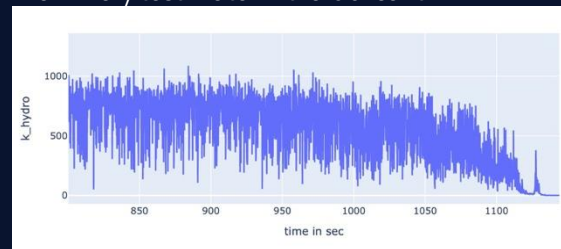
- Recurring bearing damage leads to downtime and costs
- Detecting bearing damage makes maintenance plannable and prevents secondary damage

Detecting water in the lubricant

- Water from the process reaches the bearings and causes lubrication problems and bearing damage
- Relubrication is initiated as soon as the lubrication condition becomes critical, so the damage is prevented.



Preliminary test: water in the lubricant



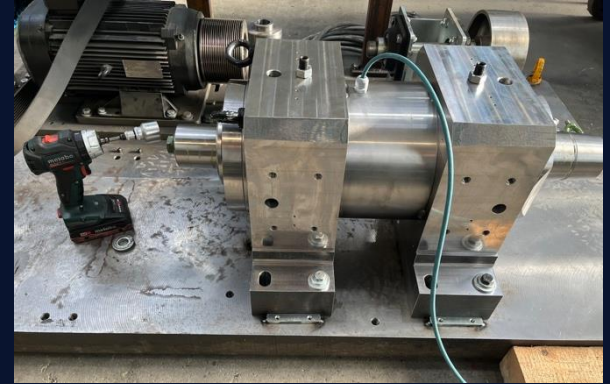
Choosing the right lubrication intervals under wood dust exposure

Detecting contamination

- Wood dust penetrates the bearing grease
- Contamination leads to damage
- Relubrication is intended to flush the dirt out of the bearing

Defining relubrication intervals

- Too much grease in the bearing leads to high temperatures and reduced grease service life
- Fire hazard
- As much as necessary, as little as possible



Concrete dust causes damage and clogs lubrication systems

Detecting bearing damage

- High loads and contamination lead to bearing damage
- Undetected bearing damage leads to dramatic secondary damage
- Vibration-based systems do not work

Detecting lubrication problems

- Concrete dust contaminates the lubrication system
- Lines cannot be monitored all the way to the bearing
- Lack of lubricant leads to bearing damage



Summary

Hitachi

Lubrication problems are detected well before damage occurs, and the damage can be prevented by relubrication

Miba

Lubrication in the journal bearing is captured, and seizure damage is detected early and can be prevented

Pump in a gas field

Water in the lubricant is detected; the maintenance it triggers reduces downtime and repair costs

Wood dust in the lubricant:

Detecting wood dust and the correct relubrication quantity increases service life and reduces the fire hazard

Concrete dust

Contamination of the lubricant and lubrication system is detected and damage is prevented



Design more efficient machines together!



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