FAG

Condition Monitoring of Greases in Rolling Bearings

Demand-controlled relubrication by means of grease analysis during operation

SCHAEFFLER

Foreword

Demand-controlled relubrication

Incorrect lubrication is a major cause of bearing failure. Through correct monitoring of the grease condition, it is possible to see the point at which relubrication is required before damage occurs in the rolling bearing.

With FAG GreaseCheck, it is possible to see the actual requirement for relubrication based on the special electronic evaluation system. This means that grease lubrication can in future be carried out as a function of condition and not simply as a function of time.

Higher cost-effectiveness

Against the background of the fact that 95% of rolling bearings are lubricated using grease and approximately two thirds of bearing failures can be attributed to incorrect lubrication, demand-controlled relubrication is valuable and also give savings in resources.

Through greater practical application of tribological knowledge, it is possible to make considerable savings in the following areas:

- reduction in failure times that can be attributed to operational malfunctions
- lower lubricant costs
- lower costs for maintenance and replacement parts
- reduction in plant costs through increased efficiency levels.

For your success

In the long term, the use of FAG GreaseCheck gives higher plant availability, optimised grease quantities and longer lubrication intervals as well as lower maintenance and lubricant costs.

Products and service for your success: reliable, versatile and competent. Evan after the purchase of a product, Schaeffler offers lasting solutions relating to mounting and maintenance. With the aid of the diverse portfolio of products and services, operating life and performance capability of production plant can be increased and overall costs can be reduced.

Local competence, worldwide presence

In the Global Technology Network, Schaeffler combines its local competence in the regions with the knowledge and innovative strength of its experts worldwide under a single structure. Through this combination, you will experience optimum support anywhere in the world and, thanks to our bundled knowledge, innovative and customised solutions of the highest quality. This makes it possible to achieve sustainable reductions in the overall costs of your machinery and plant and thus improvements in efficiency and competitiveness.

With our local centres of competence under the name “Schaeffler Technology Center”, we bring our portfolio of services and our engineering and service expertise directly to your area.

Further information

- Details on the Global Technology Network can be found at www.schaeffler.de/gtn.

Foreword

Mounting Toolbox – mounting made easy

The Schaeffler Mounting Toolbox, *Figure 1*, brings together valuable knowledge relating to mounting and dismounting. In individual video sequences, the service experts present step by step the points that must be paid close attention for correct mounting, lubrication and alignment.

http://mounting-toolbox.schaeffler.com

Figure 1
Mounting Toolbox

Contents

Condition monitoring of greases in rolling bearings

Grease sensor

GREASE-CHECK

Condition monitoring of greases in rolling bearings

Features

FAG GreaseCheck monitors the condition of the grease in the rolling bearing during ongoing operation. Grease relubrication is thus oriented to the actual demand, replacing relubrication carried out as a function of time.

Functional principle

In the past, bearings were regreased as a function of time. The grease quantities and lubrication intervals were calculated numerically. If the grease sensor is used, regreasing can be carried out as a function of condition.

The grease sensor has a diameter of 5 mm and is inserted in a hole in the housing as close as possible to the rolling bearing. The sensor is positioned in the lubricant. This grease sensor optically measures the water content, turbidity, thermal and mechanical wear and the grease temperature directly in the bearing arrangement. This information is transferred by cable to the evaluation unit, *Figure 1*. The evaluation unit generates an analogue signal that gives the user rapid and simple information on the condition of the grease.

Advantages

The grease sensor facilitates:

- lubrication appropriate to needs
- lower lubricant costs
- prevention of unplanned downtime
- lower maintenance costs
- lower equipment costs.

① Grease sensor
② Electronic evaluation system

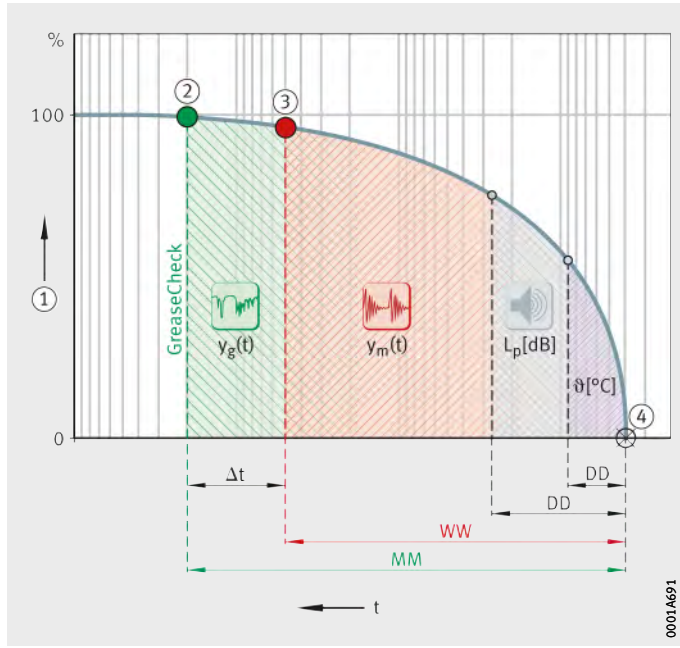
Figure 1
Grease sensor and electronic evaluation system

Condition monitoring of greases in rolling bearings

Extended advance warning time

Through the use of the grease sensor and the associated electronic evaluation system, it is possible to detect changes in the condition of the grease long before damage in the rolling bearing becomes measurable by means of changes in vibration, *Figure 2*.

As a result, the replacement of grease can be planned with precision. The customer can then decide whether to refresh the grease by means of targeted relubrication or to carry out complete replacement of the grease.



① Machine condition
t = advance warning time

Δt = extended advance warning time
DD = minutes to days
WW = weeks
MM = months
$y_g(t)$ = grease monitoring
$y_m(t)$ = conventional vibration monitoring
L_p[dB] = noise measurement
ϑ[°C] = temperature measurement

② Changes in grease condition
③ Changes in vibration in the bearing
④ Machine failure

Figure 2
Extended advance warning time by means of FAG GreaseCheck

Design of the sensor head

The penetration depth of the signal extends from the surface of the sapphire glass to a few millimetres into the grease, *Figure 3*. The optimum mounting position will vary from one application to another. The important factor here is the knowledge of the Schaeffler application engineers, who can specify precisely the position at which the grease sensor should be mounted in the particular application.

d = outside diameter
l = length of sensor head
h = penetration depth

① Housing
② Electronic system
③ Printed circuit board
④ LED
⑤ Reference detector
⑥ Measurement detector
⑦ Grease
⑧ Sapphire glass
⑨ Cast material

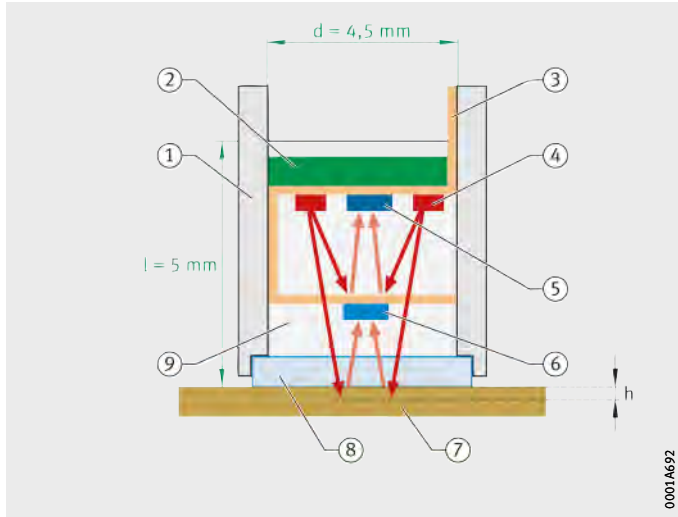


Figure 3
Design of the sensor head

Condition monitoring of greases in rolling bearings

Analysis of the grease condition

The condition of the grease during ongoing operation of the rolling bearing is determined by means of an optical near infrared reflection method. For this purpose, the sensor head is immersed in the grease.

The know-how involved lies not only in the design of the sensor but especially in the evaluation of the measured signals. The method used involves the rotationally symmetrical irradiation of the grease at an angle of 45° using certain wavelengths within the infrared spectrum by the sensor, *Figure 4*.

A cable provides communication between the sensor head and the electronic evaluation system. The measurement depth of the grease sensor extends only a few millimetres into the grease. There must be grease directly in front of the sensor for measurement. Air inclusions can lead to incorrect measurements.

Tests carried out on the rolling bearing lubricant test rig FE8 in accordance with DIN 51819-1 have shown that the sensor must not record grease in direct rolling contact. The areas adjacent to the raceway also contain highly homogeneous grease conditions. As a result, comparable measurement results can be obtained.

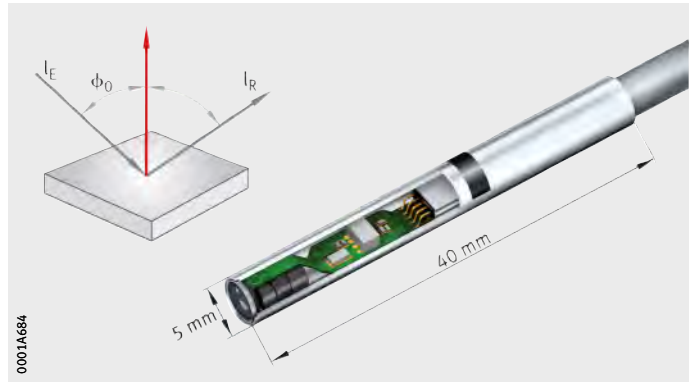


Figure 4
Rotationally symmetrical irradiation of the grease

Characteristic changes

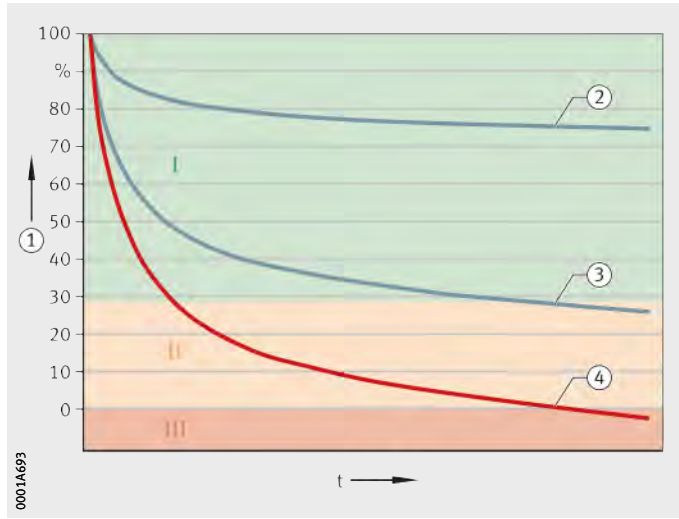
Monitoring of the grease is carried out on the basis of characteristic changes for automatic condition assessment.

FAG GreaseCheck measures four parameters:

- relative ageing
- relative turbidity
- relative water content
- current temperature of the grease.

The grease condition is a synthetic characteristic value and is determined from the total and weighting of the parameters ageing, turbidity, water content and temperature. Based on these parameters, an analogue signal (I = 4 – 20 mA) is generated in the electronic evaluation system from which the customer can quickly and easily see the condition of the grease, *Figure 5*.

A limit value can also be set in the form of a trigger threshold to generate a digital signal that indicates whether the grease condition is good or poor.



① Grease condition
t = time

I = grease condition good
II = grease condition borderline
III = grease condition inadequate

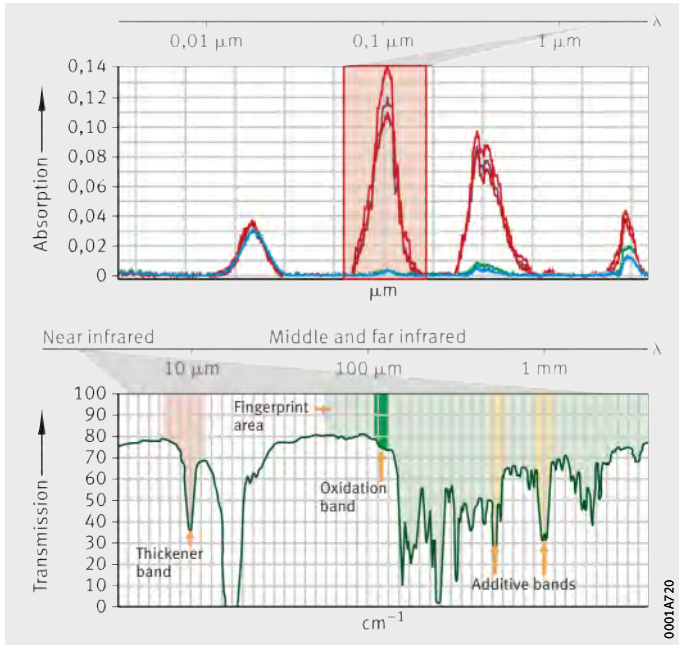
Type of load:
② Thermal
③ Mechanical
④ Thermal and mechanical

Figure 5
Grease conditions

Condition monitoring of greases in rolling bearings

Infrared spectroscopy as a measurement method

The infrared spectroscopy of grease samples is an established method in laboratory practice that can be used to evaluate not only turbidity but also the development of various bands over time. The knowledge gained as a result gives the experts information for assessment of the grease condition. Monitoring of the grease is carried out on the basis of characteristic changes in the near infrared spectrum for automatic condition assessment, *Figure 6*.



λ = wavelength

Figure 6
Sensor signal and analysis of the grease

Greases

FAG GreaseCheck is suitable for most Arcanol greases from Schaeffler and also, following prior calibration, for other greases available on the market.

The optimum lubrication of rolling bearings is a science in itself, since greases are highly complex mixtures that must be optimally matched to the specific application conditions. Greases generally comprise a base oil, various thickening agents and additives, *Figure 7*. The mixture sometimes includes solid lubricants.

In terms of preventive maintenance, the grease operating life is the decisive value if it is less than the bearing life. In this case, bearings are generally relubricated once an operating time of half the grease operating life is reached.

The major disadvantage of this commonly used method is that the condition of the grease is completely unknown. Could it have been used for longer? Had it already been changed so significantly by external influences such as temperature or the ingress of water that damage had already occurred in the bearing? If the user wanted information on the condition of the grease in the bearing, the only option previously available to him was to take a sample and subject it to expensive and time-consuming analysis in the laboratory.

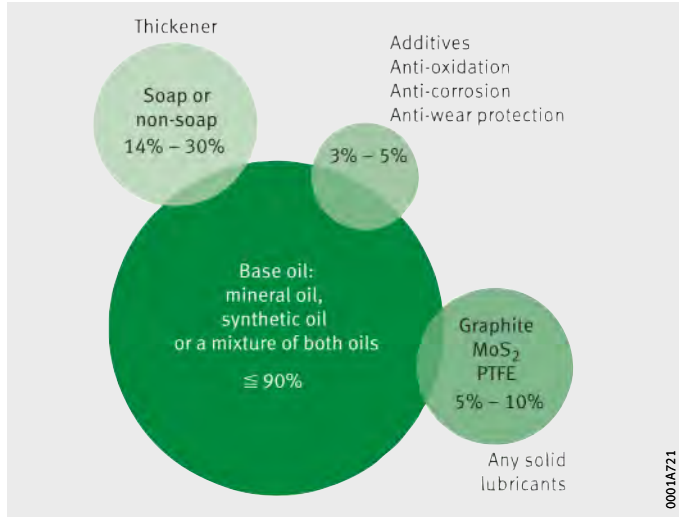


Figure 7
The basic composition of greases

Condition monitoring of greases in rolling bearings

Available variants and replacement parts

FAG GreaseCheck is available in a number of variants, see table Available variants. Replacement parts are available as stated, see table Replacement parts.

Available variants

Article number	Description
081791828-0000-10	**GREASE-CHECK-COM** Sensor head with 800 mm connection cable, cable end with plug for evaluation unit Electronic evaluation system in evaluation unit with 5 m, connection cable (twin paired, shielded, bare cable end) Clamping screw M8 User manual USB adapter and bootloader
081747098-0000-10	**GREASE-CHECK** See GREASE-CHECK-COM Without USB adapter and bootloader

Replacement parts

Article number	Description
081805845-0000-10	**GREASE-CHECK.OPTIC** Sensor head with connection cable
081806124-0000-10	**GREASE-CHECK.JB** Electronic evaluation system

Ordering examples

The grease sensor FAG GreaseCheck is supplied with an electronic evaluation system.

Scope of delivery

1 electronic evaluation system with connection cable
1 sensor head with connection cable
1 internal clamping screw M8
1 replacement seal
1 user manual

Ordering designation **GREASE-CHECK**

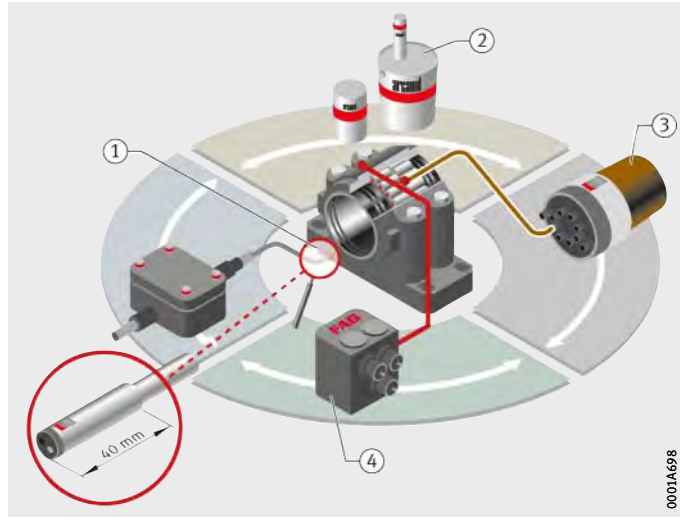
Applications

The grease sensor is generally used in the following areas of application and, in particular, where rolling bearings with grease lubrication are difficult to access:

- wind energy
- raw material extraction and processing
- pulp and paper (paper machinery and ancillary equipment)
- power generation.

Comprehensive monitoring

The innovative system combines grease and vibration diagnosis with a lubricator that is controlled by the monitoring devices. In this way, any critical change during ongoing operation can be detected and rectified before damage occurs in the rolling bearing.
In particular, plant that is difficult to access or failure-critical can be comprehensively monitored and always provided with a optimum supply of grease, without the need for someone to be present on site, *Figure 8*.



① FAG GreaseCheck
② Arcanol greases
③ FAG CONCEPT 8
④ FAG SmartCheck

Figure 8
Comprehensive monitoring of rolling bearings

Installation

For installation, the important factor is the knowledge of the Schaeffler application engineers, who can specify precisely the position at which the grease sensor should be mounted in the particular application.

Technical data for FAG GreaseCheck

The grease sensor FAG GreaseCheck has the following mechanical and physical characteristics, see table.

Technical data

Description		Unit	Value
Measurement factor	Water	%	0 to +100
	Turbidity	%	0 to +100
	Ageing	%	0 to +100
	Temperature	°C	–20 to +100
Analogue output of grease condition		mA	+4 to +20
Switching output of power supply (24 VDC)[1)]		mA	+3 to +150
Working range of sensor		°C	+5 to +80
Storage temperature range		°C	–20 to +90
Protection type	Complete system	IP	67
	Sensor head without plug	IP	68
Power supply		VDC	24 ±20%
CAN-Bus connection		–	–
Protection class		–	3
Mass	Sensor head and cable	g	680
	Sensor head	g	30
Current consumption	Typical	mA	43
	Maximum	mA	250
Cable length of electronic evaluation system, twisted pair, shielded		mm	5 000
Cable length of sensor head		mm	800
Diameter of sensor head		mm	5

1) The switching output must be subjected to a load such that it carries a minimum of 3 mA and a maximum of 150 mA.

Mounting

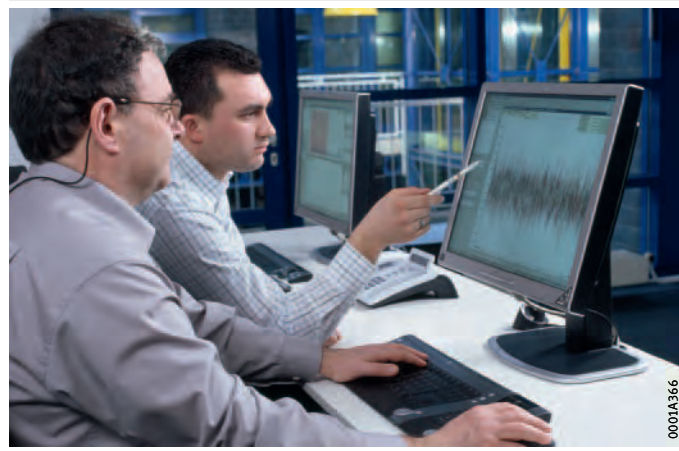
MOUNT-HOUR

Lubrication

ARCA-PUMP

Condition monitoring

CM-HOUR-ENGINEER



Services

In addition to FAG GreaseCheck, Schaeffler can provide numerous solutions for your specific requirements. Here are some examples from the product portfolio of Schaeffler Industrial Aftermarket.

Mounting

Our experienced fitters can support you in the mounting and dismounting of rolling bearings and advise you on the selection of suitable mounting tools. Correct mounting is an essential precondition for achieving the maximum operating life of bearings. In the case of the London Eye, Schaeffler supplied the rolling bearings and carried out the mounting operations, *Figure 1*.

Figure 1
Double row FAG spherical roller bearing in the London Eye

Lubrication

Unsuitable lubrication can impair the operating life of rolling bearings and cause damage. In order to achieve the most suitable lubrication, Schaeffler can provide specifically designed and tested greases, *Figure 2*.

Figure 2
Rolling bearing grease for every bearing arrangement

Rolling bearing grease Arcanol

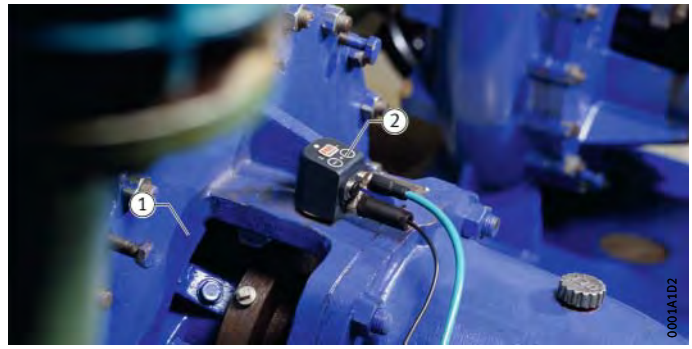
The 17 different greases cover almost all applications. They are developed by experienced application engineers and are produced by the best manufacturers in the market. Different greases are used depending on the particular application. At high operating temperatures, the thermally stable special grease Arcanol TEMP120 is used.

Rolling bearing greases under the name Arcanol are subject to 100% quality inspection. The inspection methods at Schaeffler are among the most demanding in the market.
As a result, Arcanol rolling bearing greases fulfil the highest quality requirements.

Condition monitoring

The malfunction-free and optimised operation of complex machinery and plant can only be achieved by means of condition-based maintenance. In many cases, Schaeffler uses vibration diagnosis. For example, FAG SmartCheck is an innovative measuring system for real time monitoring with a patented diagnosis technology. Due to the low purchase costs, it can be used economically even on smaller subassemblies.

The compact measuring device can be installed quickly, is easy to use and contributes through its trendsetting characteristics to process optimisation and the reduction of life cycle costs.
In this way, you receive the best information on the condition of your machinery, *Figure 3*.



① Pump
② FAG SmartCheck

Figure 3
FAG SmartCheck, application example

Notes

Notes

Further information

Industrial Aftermarket
Products and services for your success
www.schaeffler.com/services

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