



Condition Monitoring of Greases in Rolling Bearing Arrangements

Demand-controlled relubrication by means of grease monitoring during operation

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 Schaeffler 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 gives 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
- a reduction in plant costs through increased efficiency levels

For your success

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

Even 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 one philosophy.

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 Centers”, 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 <https://www.schaeffler.de/gtn>

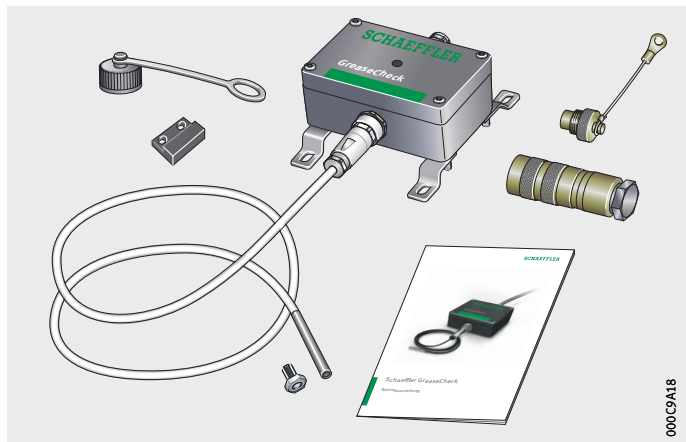
Contents

	Page
Product overview	4
Features	
Functional principle	5
Design of the sensor head.....	7
Analysis of the grease condition.....	8
Greases	11
Available variants and replacement parts	12
Ordering examples.....	12
Applications	13
Holistic monitoring	13
Installation	13
Technical data	14

Product overview Condition monitoring of greases in rolling bearing arrangements

Grease sensor

GreaseCheck



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Condition monitoring of greases in rolling bearing arrangements

Features

Schaeffler 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, grease deterioration (a combination of ageing, softening and turbidity) and the grease temperature directly in the bearing arrangement. The measurement signals are 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.

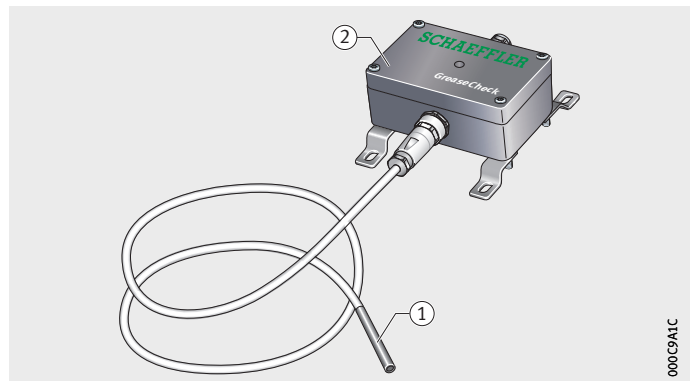
Advantages

The grease sensor facilitates:

- online grease condition monitoring
- lubrication appropriate to needs
- lower lubricant costs
- prevention of unplanned downtime
- lower maintenance costs
- lower plant costs

- ① Grease sensor
- ② Electronic evaluation system

Figure 1
Grease sensor and electronic evaluation system



Condition monitoring of greases in rolling bearing arrangements

Extended advance warning time

Through the use of Schaeffler GreaseCheck 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

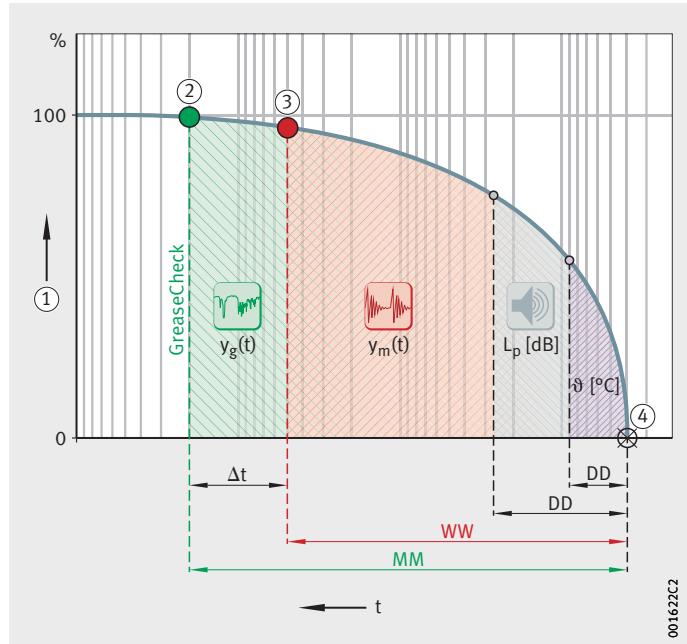


Figure 2
Extended advance warning time by means of Schaeffler GreaseCheck

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

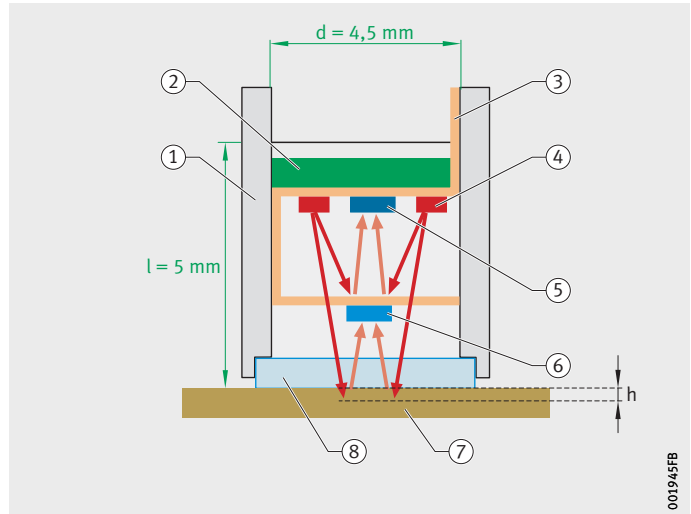


Figure 3
Design of the sensor head

Condition monitoring of greases in rolling bearing arrangements

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.

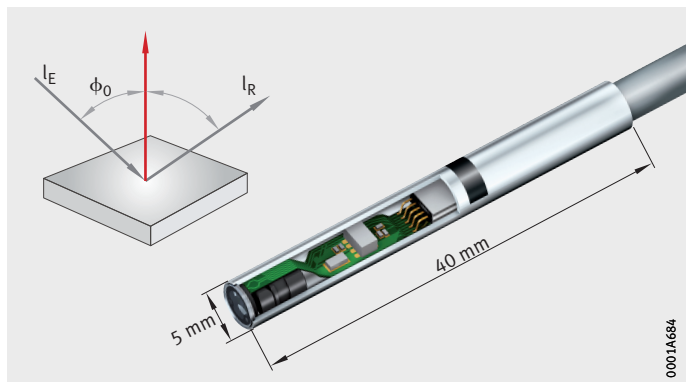
The know-how involved lies not only in the design of the sensor but but especially in the evaluation of the measured signals. The method used involves the rotationally symmetrical irradiation of the grease at an angle of 45° using certain wavelengths within the near-infrared spectrum, *Figure 4*.

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.

I_E = incidence of light
 φ = angle of incidence equal to angle of reflection
 I_R = reflection of light

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.

Schaeffler GreaseCheck measures three parameters:

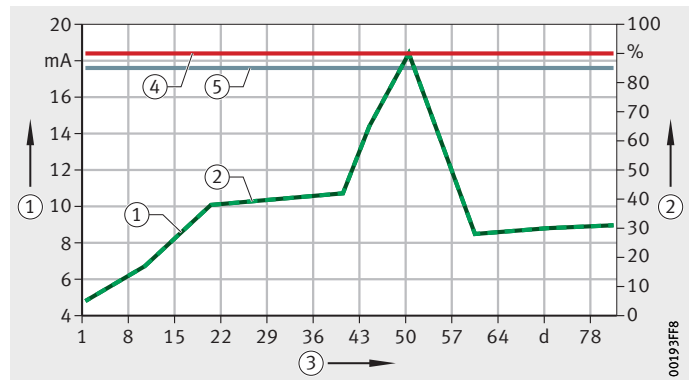
- relative grease deterioration
(deterioration = combination of turbidity, softening and ageing)
- relative water content
- current grease temperature

The grease condition is described by the relative water content and the relative grease deterioration. All parameters can be output via a CAN bus interface. The analogue output (I = 4 mA to 20 mA) always delivers the poorer of the two values (deterioration and water content) in the ratio 0% = good = 4 mA to 100% = poor = 20 mA, *Figure 5*.

By setting limit values for water and deterioration in the form of a trigger threshold, it is possible to generate a digital signal that indicates whether the condition level is good = 0 V or poor = 24 V.

- ① Analogue output signal
- ② Grease condition
- ③ Time in days
- ④ Alarm threshold for deterioration
- ⑤ Alarm threshold for water

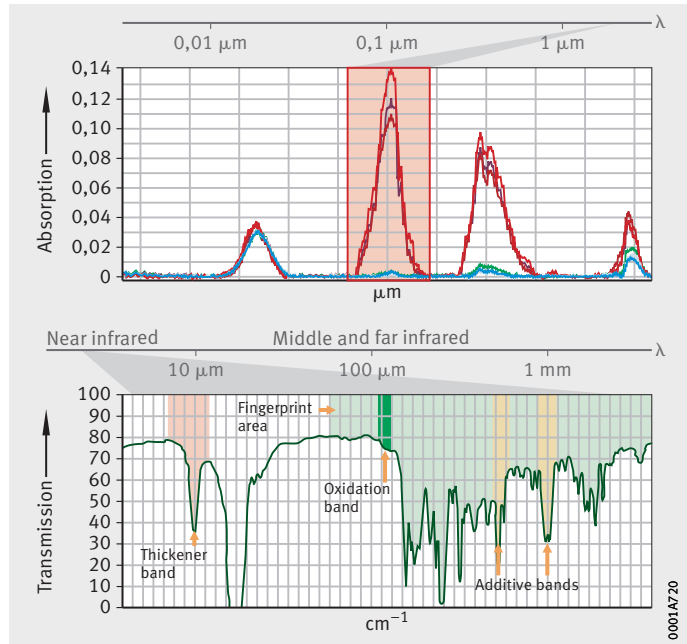
Figure 5
Grease condition at
analogue output



Condition monitoring of greases in rolling bearing arrangements

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

Schaeffler GreaseCheck is suitable for most Arcanol greases from Schaeffler and also, following prior calibration, for other greases available on the market. Usability can be clarified in the form of a quick test, for which 30 g of a fresh and used grease sample is usually required.

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.

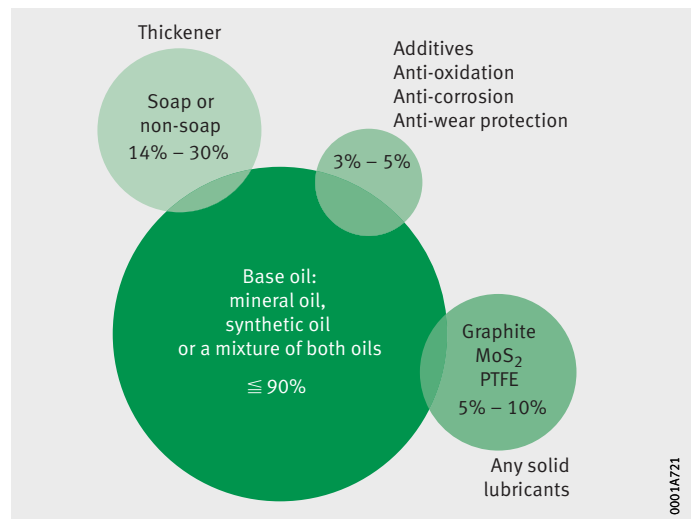


Figure 7
The basic composition
of greases

Further information

- Technical Product Information
TPI 176, Lubrication of Rolling Bearings

Condition monitoring of greases in rolling bearing arrangements

Available variants and replacement parts

Schaeffler GreaseCheck is only available in one variant, see table. The adjustment to the grease which is to be monitored is controlled via a configuration file (EEPROM file). This is installed on the system prior to delivery so that the sensor can be used immediately and is assigned to a specific grease.

Available variants

Article number	Description
081791828-0000-10	GREASE-CHECK: <ul style="list-style-type: none"> ■ Sensor head with 800 mm connection cable, cable end with plug for electronic evaluation system ■ Electronic evaluation system ■ Internal clamping screw M8 ■ User manual ■ Connection plug for electronic evaluation system ■ 1 magnet for offset adjustment of fresh grease

Ordering examples

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

Scope of delivery

- 1 electronic evaluation system
- 1 sensor head with connection cable
- 1 internal clamping screw M8
- 1 connection plug for electronic evaluation system
- 3 closing plugs
- 1 user manual
- 1 magnet for offset adjustment of fresh grease

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 plant

Holistic monitoring

The innovative system combines grease and vibration diagnosis with a lubricator. In this way, any critical change during ongoing operation can be detected and rectified at an early stage 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 an optimum supply of grease, without the need for someone to be present on site, *Figure 8*.

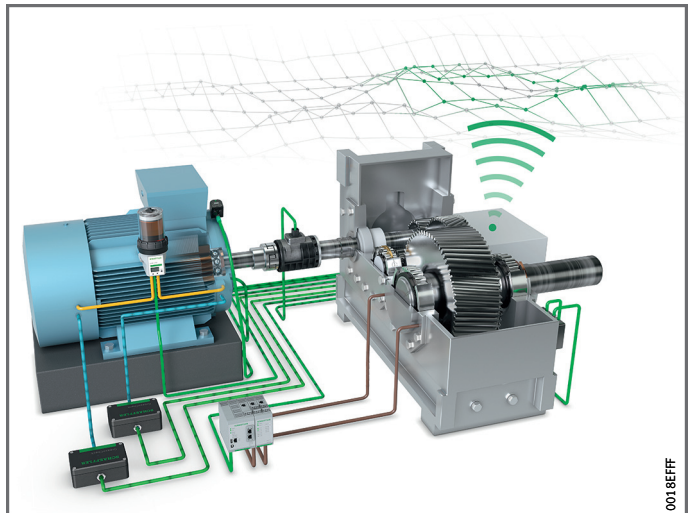


Figure 8
Drive train with
Schaeffler GreaseCheck

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 application.

Condition monitoring of greases in rolling bearing arrangements

Technical data The grease sensor Schaeffler GreaseCheck has the following mechanical and physical characteristics.

Description		Value		Unit
		from	to	
Measurement factor	Water content	0	100	%
	Grease deterioration	0	100	%
	Temperature	-20	+100	°C
Analogue output of grease condition		4	20	mA
Switching output DC (load 3 mA to 150 mA) ¹⁾		0	24	V
Working range of sensor		+5	+80	°C
Storage temperature range		-20	+90	°C
Power supply DC		24 ± 20%		V
Protection class		IP67		-
Mass	Electronic evaluation system	310		g
	Sensor head	40		g
Current consumption	typical	43		mA
	max.	250		mA
Sensor head	Cable length	800		mm
	Diameter	5		mm
Electronic evaluation system	Housing L×W×H	100×65×50		mm
	Fixture L×W	90×110 (M4)		mm

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.

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