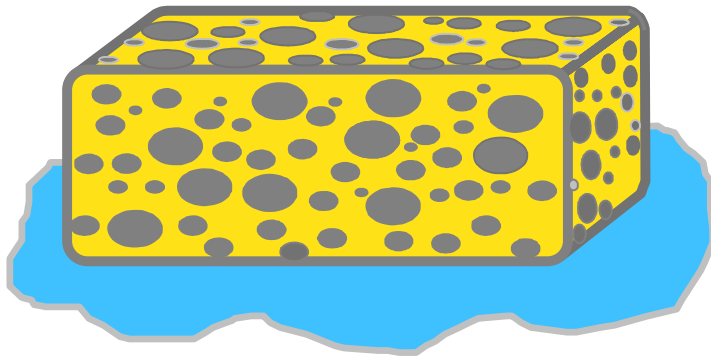


Lubrication

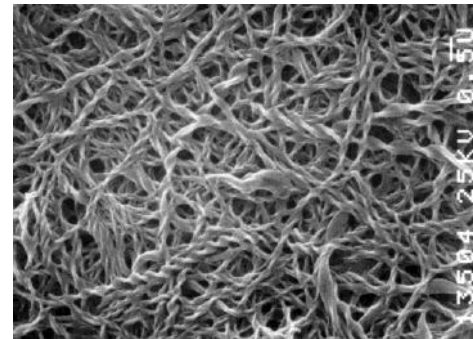
Definition

- A grease is a "THICKENED" oil



think of it as
a sponge

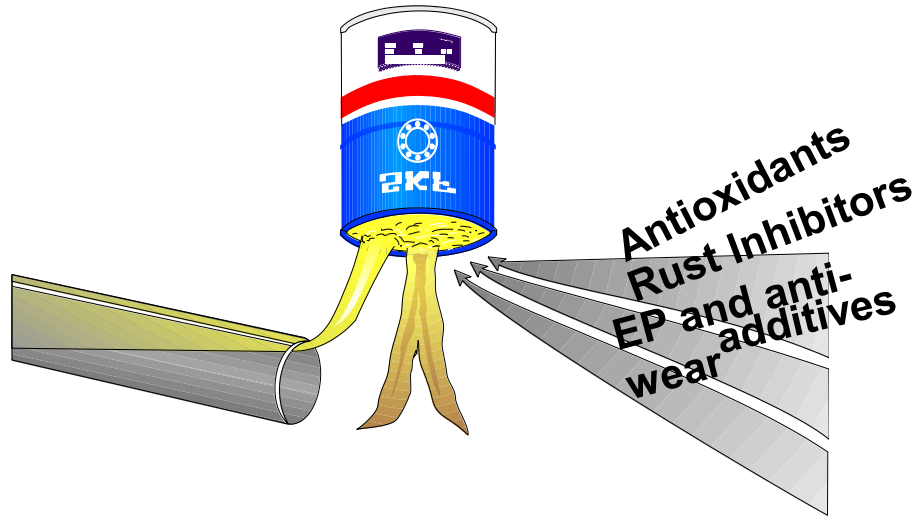
It is NOT a thick oil or a solid oil
(wax)



What is inside a grease?

Grease = Base oil + Thickener + Additives + Manufacturing

(70 - 95%) (5 - 30%) g



What is poor lubrication?

Incorrect intervals:

- under-greasing
- over-greasing

Incorrect lubricant selection:

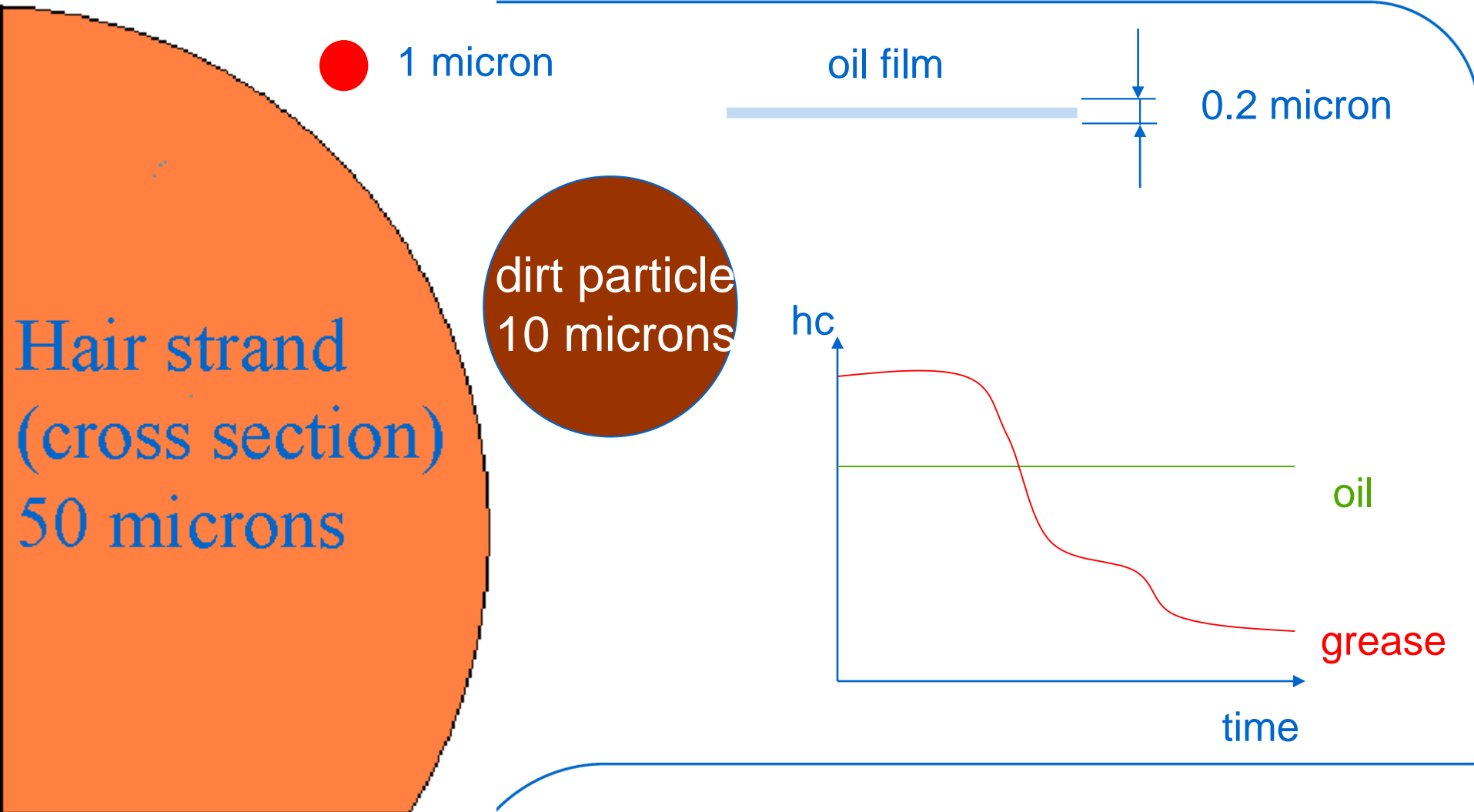
- poor quality lubricant
- lubricant type is unsuitable for the application

Contamination:

- impurities can mix with the lubricant
- poor handling (e.g. dirt on grease fitting)

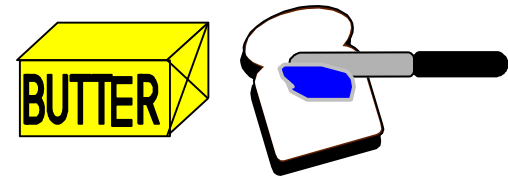


How thick is an oil film?



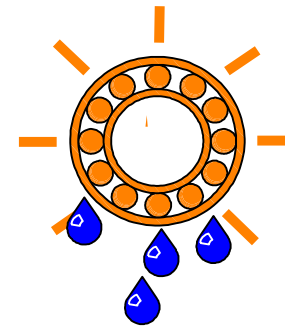
Grease consistency

- **Consistency** = 'degree of stiffness'

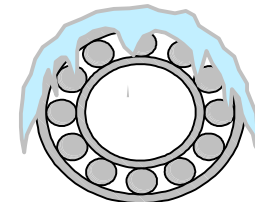


compare with butter

- Too low consistency results in grease leakage

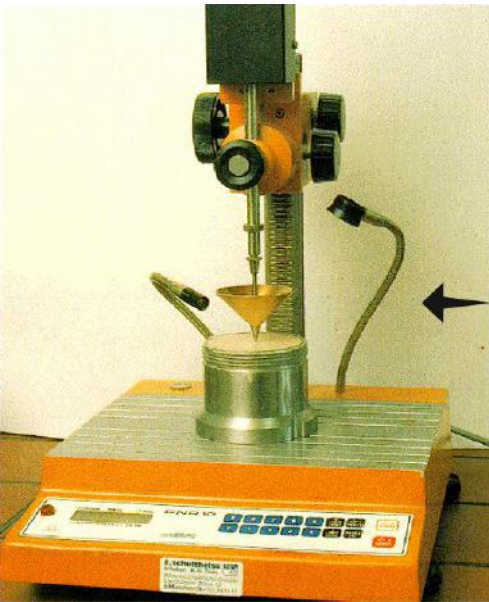


- Too high consistency results in sliding of rollers



Grease consistency

Test method for determination of the consistency



falling
cone

Penetromete
r

NLGI Number	ASTM Worked Penetration [tenths of a millimeter]	Appearance at Room Temperature	Use
000	445 - 475	Very Fluid	
00	400 - 430	Fluid	Gears
0	355 - 385	Semi-Fluid	
1	310 - 340	Very Soft	
2	265 - 295	Soft	Bearings
3	220 - 250	Medium Hard	
4	175 - 205	Hard	
5	130 - 160	Very Hard	Sealings
6	85 - 115	Extremely Hard	

Grease lubricating mechanism

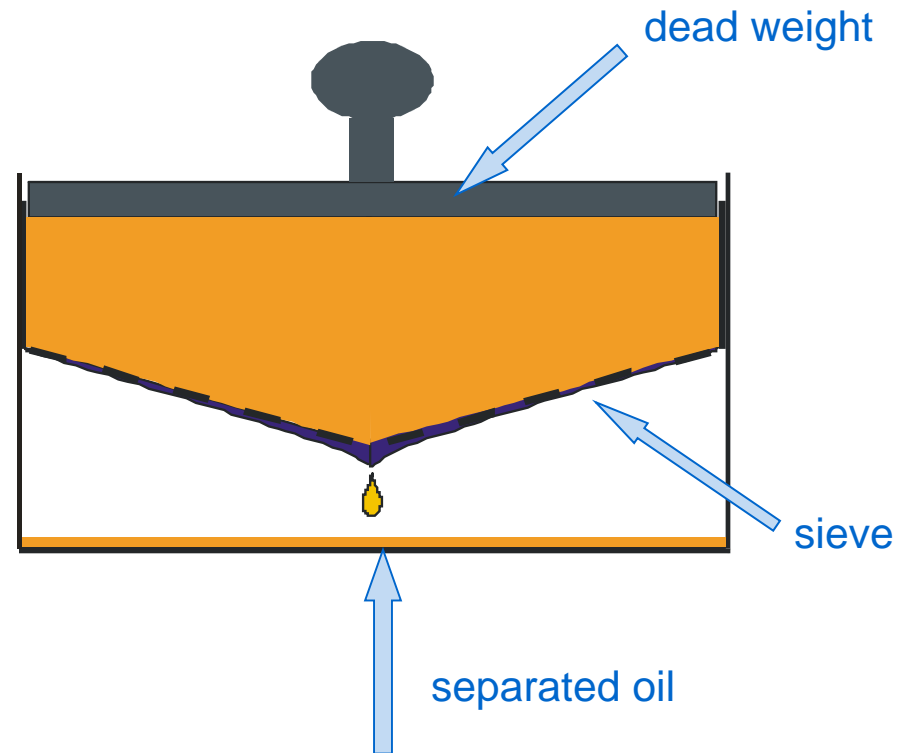
Three important mechanisms

- oil bleeding
- grease shearing from cage
- grease bulk motion

Oil bleeding

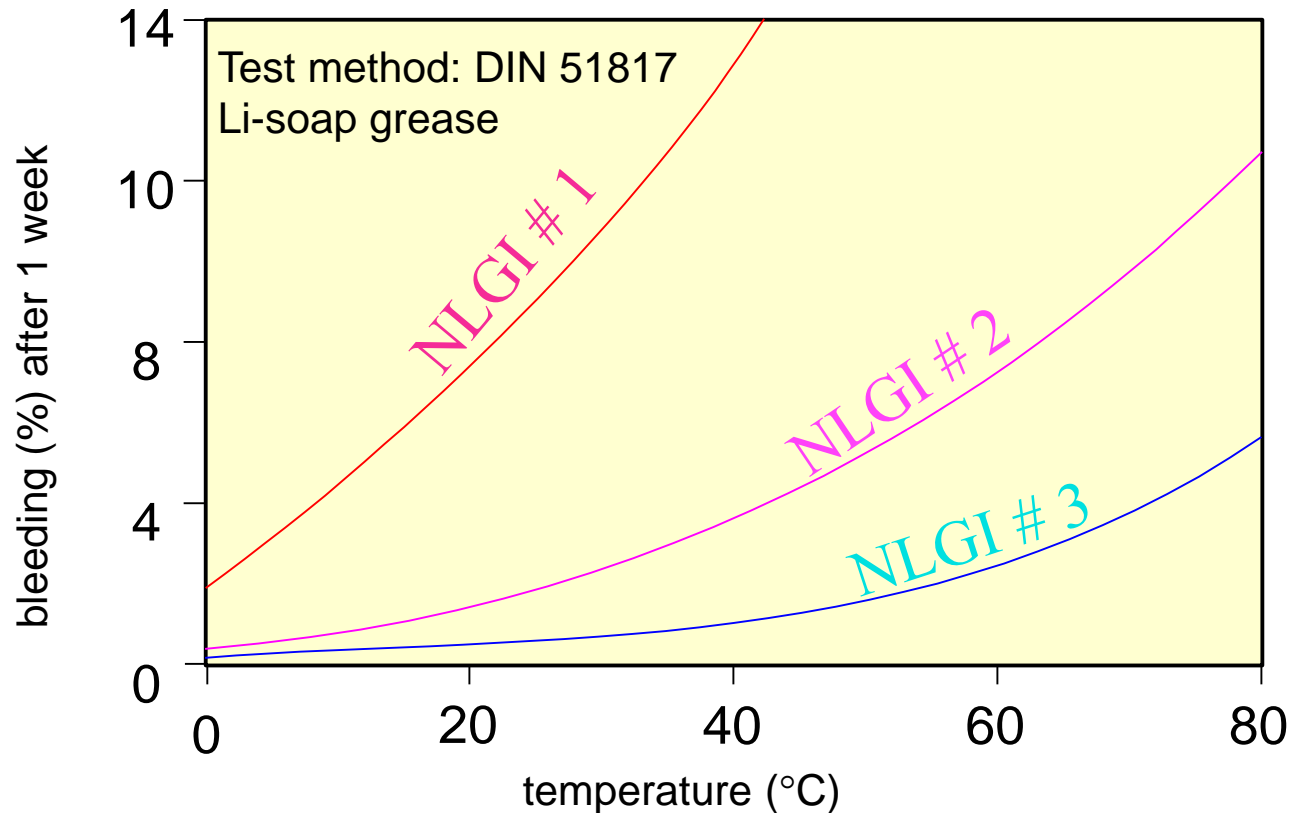
Main influencing factors:

- Temperature
- Operating time
- Grease consistency
- Pressure (e.g. by centrifugal forces)
- Oil viscosity
- Thickener type
- Grease manufacturing process



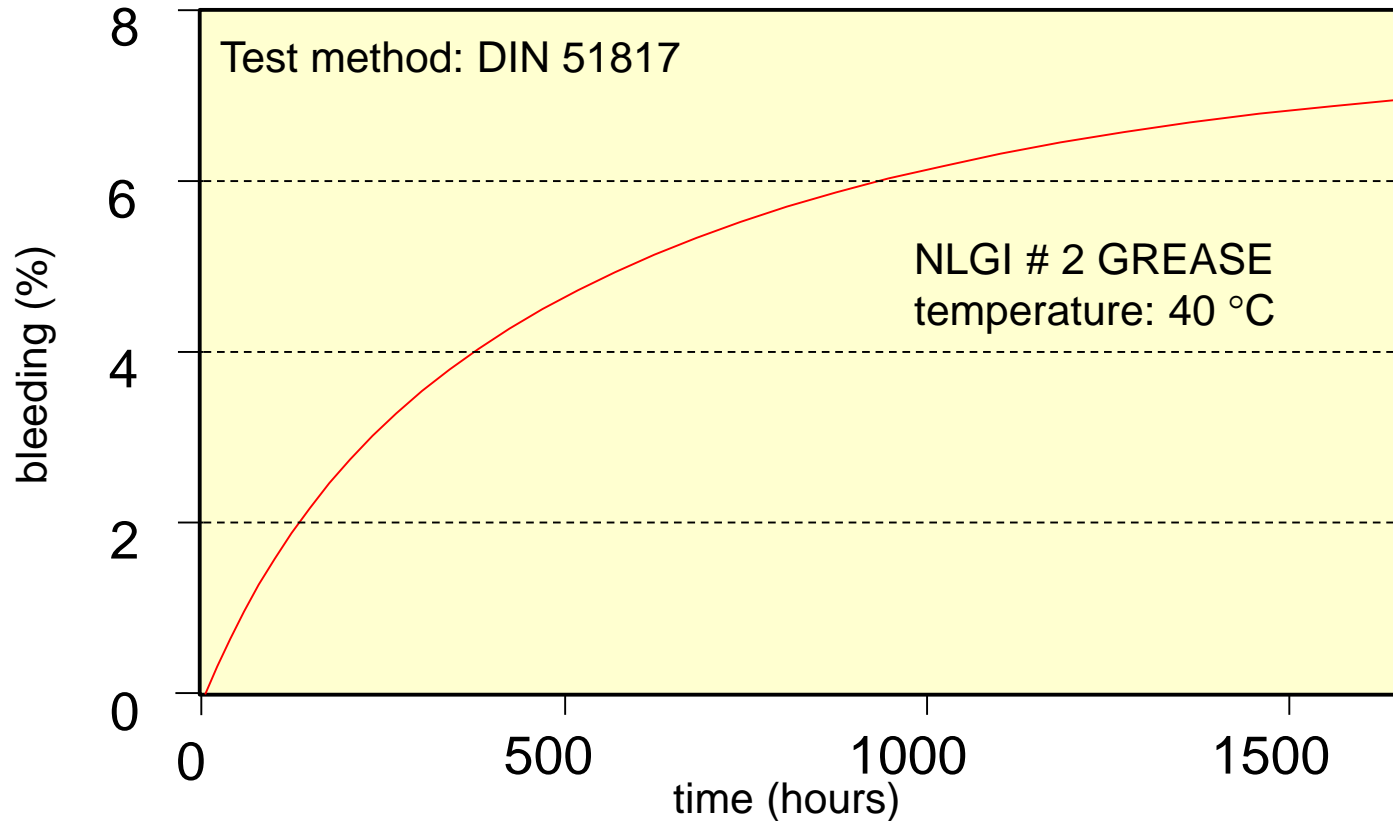
test device for measuring oil bleeding tendency (DIN 51817)

Oil bleeding vs temperature vs consistency



For low operating temperatures: NLGI # 1 grease !

Oil bleeding as a function of time

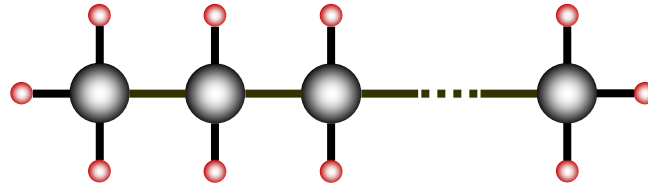


After long operating time this mechanism of lubricant supply will become too low to compensate for the lubricant losses in the contact: “dead” grease

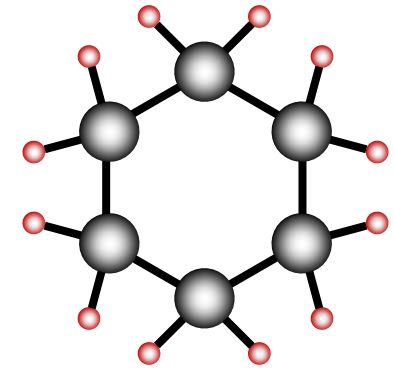
Oil types

Mineral oils (~90%)

- standard applications
- Mineral base oils consist mainly of organic matter (hydrocarbons) but also some inorganic compounds such as nitrogen, oxygen, sulphur, minerals (metal compounds) etc.



n-Alkanes, n-Paraffins



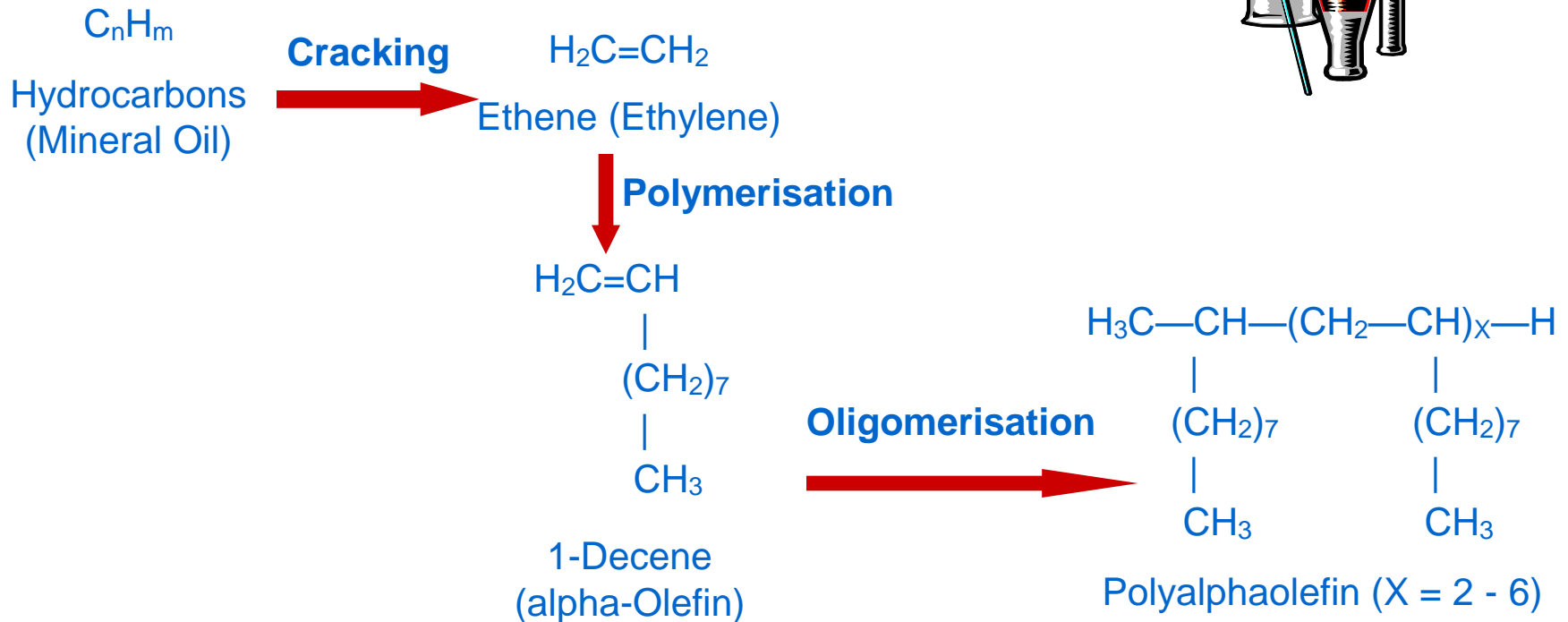
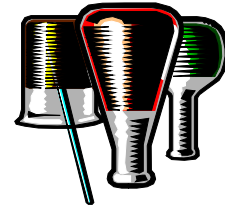
cyclo-Alkanes,



Oil types

Synthetic oils (~10%)

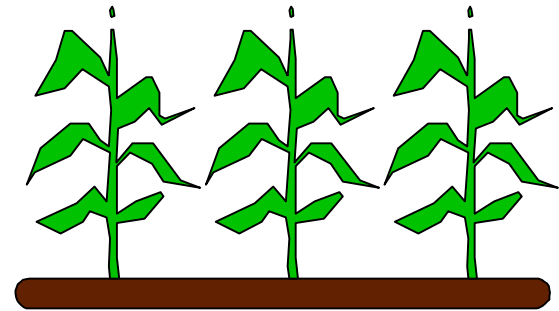
- special properties, more expensive



Oil types

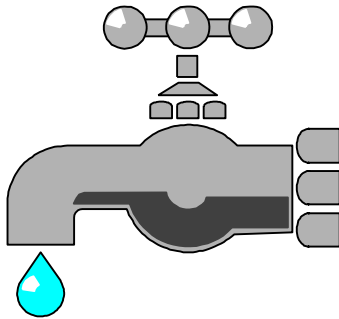
Natural oils (~ 1%)

- food compatible, biodegradable
- low toxicity, high VI, high lubricity
- low oxidation stability, high pour point



Oil viscosity

- **VISCOSITY** = "resistance to flow" of a fluid



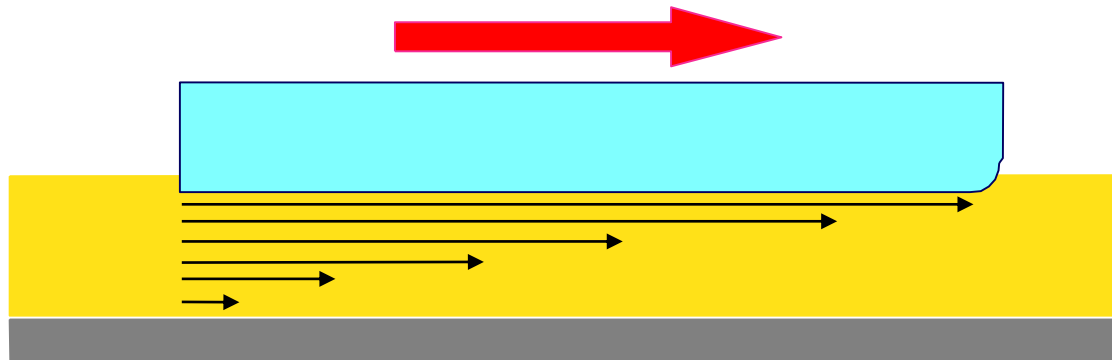
- water: low viscosity
(1 cSt at 20 °C)



- honey: high viscosity
(~1200 cSt at 20 °C)

Viscosity

Viscosity is a measure of a fluids resistance to flow

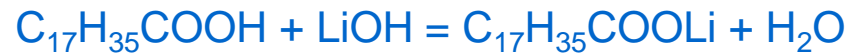


Dynamic viscosity is the measure of the force needed to shear
one fluid layer over the other

Thickener types, the 'sponge'

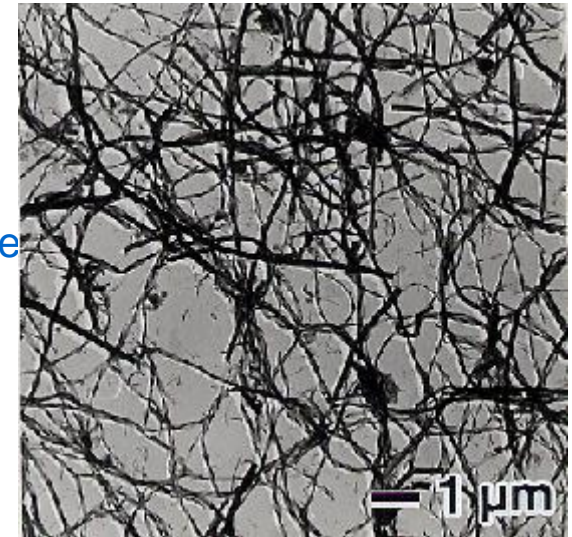
Metal soap thickener (~70%)

- Acid + Base = Salt + water



Stearic acid + Lithium hydroxide = Lithium Stearate + Water

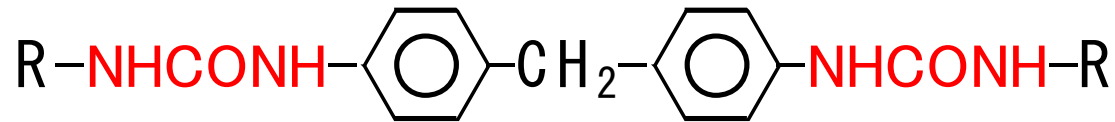
- Lithium, also Calcium and others



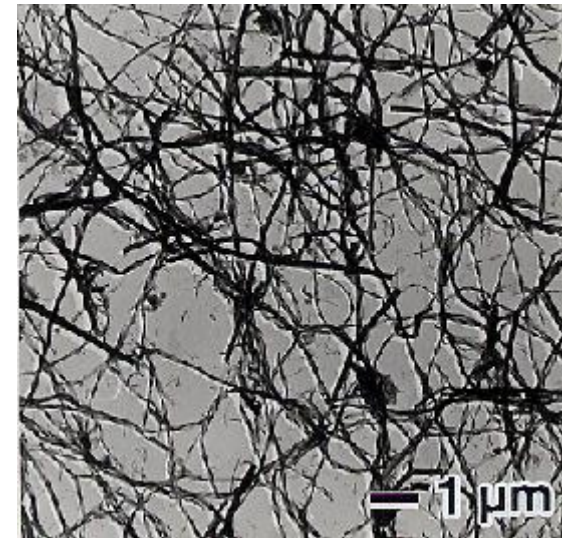
Thickener types, the 'sponge'

- **Non Soap thickener**

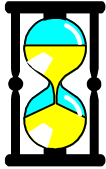
- Polyurea thickener (~5%)
alternative for metal soap



- Silicon / Clay thickener (~5%)
wide temperature range
- PTFE ('Teflon') thickener (~1%)
very high temperatures, expensive



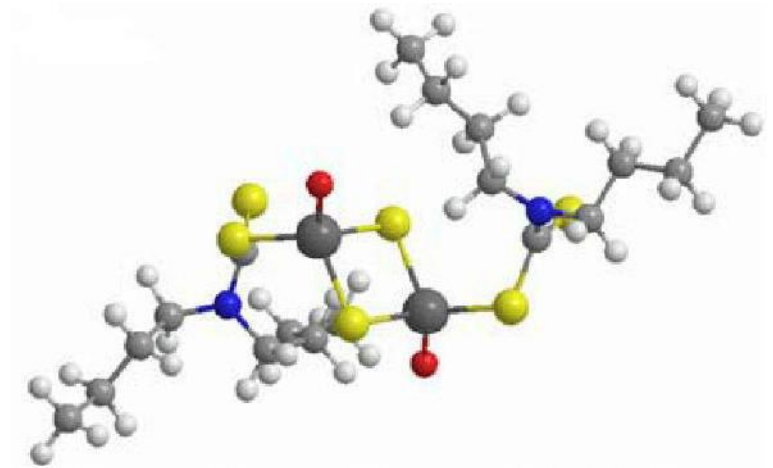
Additive types



- Anti-oxidants for longer grease life
- Extreme Pressure (EP) against cold welding
- Anti-corrosion additives for bearing protection



- Solid additives (graphite, MoS₂) when liquid lubrication fails



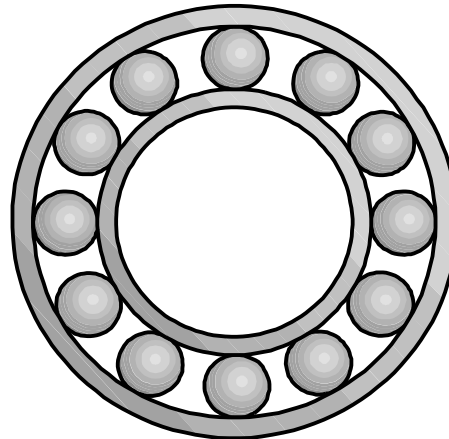
Grease or oil?

Grease

- + Simple installation (less expensive)
- + Additional bearing protection (against dirt, moisture)

Oil

- - Additional cooling
 - - High volume
 - - High cost



80% of all bearings are grease lubricated, but 97% of all lubricant produced is oil based.

Selecting a grease

Involves two translation steps:



1. What are the conditions of the **bearing application**?

translate into:

2. What are important **grease properties** for this application?

translate into:

3. Which **grease performance requirements** can be defined?
(for example grease test results)

Application profiling

Application & running conditions

- bearing size / type
- operating temperature
 - start
 - normal running
 - peak
- operating speed
 - constant, oscillating
 - IR/OR rotation
 - starts/stops
- load
 - axial, radial, C/P
- vibration
- shaft orientation

Environment & lubrication conditions

- life requirements
 - system, bearing, lubricant
- grease mode
 - greased-for-life
 - relubricated
- contamination
 - moisture, dirt, gasses, process fluids
- vacuum, air flow
- environment
- noise
- contacting materials
 - seals, cage

Bearing operating parameters

Bearing operating parameters

Temperature

L = Low	<50 °C / 122 °F
M = Medium	50 to 100 °C / 122 to 230 °F
H = High	>100 °C / 212 °F
EH = Extremely high	> 150 °C / 302 °F

Speed for ball bearings

EH = Extremely High	n.dm over 700 000
VH = Very High	n.dm up to 700 000
H = High	n.dm up to 500 000
M = Medium	n.dm up to 300 000
L = Low	n.dm below 100 000

Note : $n \text{ .dm} = n \text{ (rpm)} \times 0.5 \text{ (d+D)}$

Bearing operating parameters

Speed for roller bearings

H = High
M = Medium
L = Low
VL = Very Low

| SRB/TRB/CARB®

n.dm over 210 000
n.dm up to 210 000
n.dm up to 75 000
n.dm below 30 000

CRB

n.dm over 270 000
n.dm up to 270 000
n.dm up to 75 000
n.dm below 30 000

Load

VH = Very high
H = High
M = Medium
L = Low

|

C/P < 2
C/P ~ 4
C/P ~ 8
C/P 15

Note : $n \cdot dm = n \text{ (rpm)} \times 0.5 \text{ (d+D)}$

Choice of (base) oil viscosity

if:

- high speed; low load; low temp.
- low speed; high load

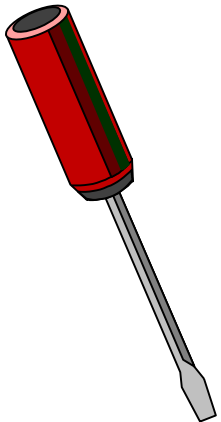
select:



low (base) oil viscosity

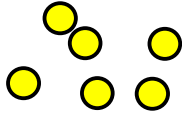


high (base) oil viscosity



- viscosity (at 40 °C): application (indication)
10-25 cSt low temp, (very) high speed
- 70-200 cSt standard applications
- 300-1000 cSt (very) heavy load, (very) low speed

When is grease life over?



Contamination (dirt, wear particles, etc.)



Grease hardening/ageing

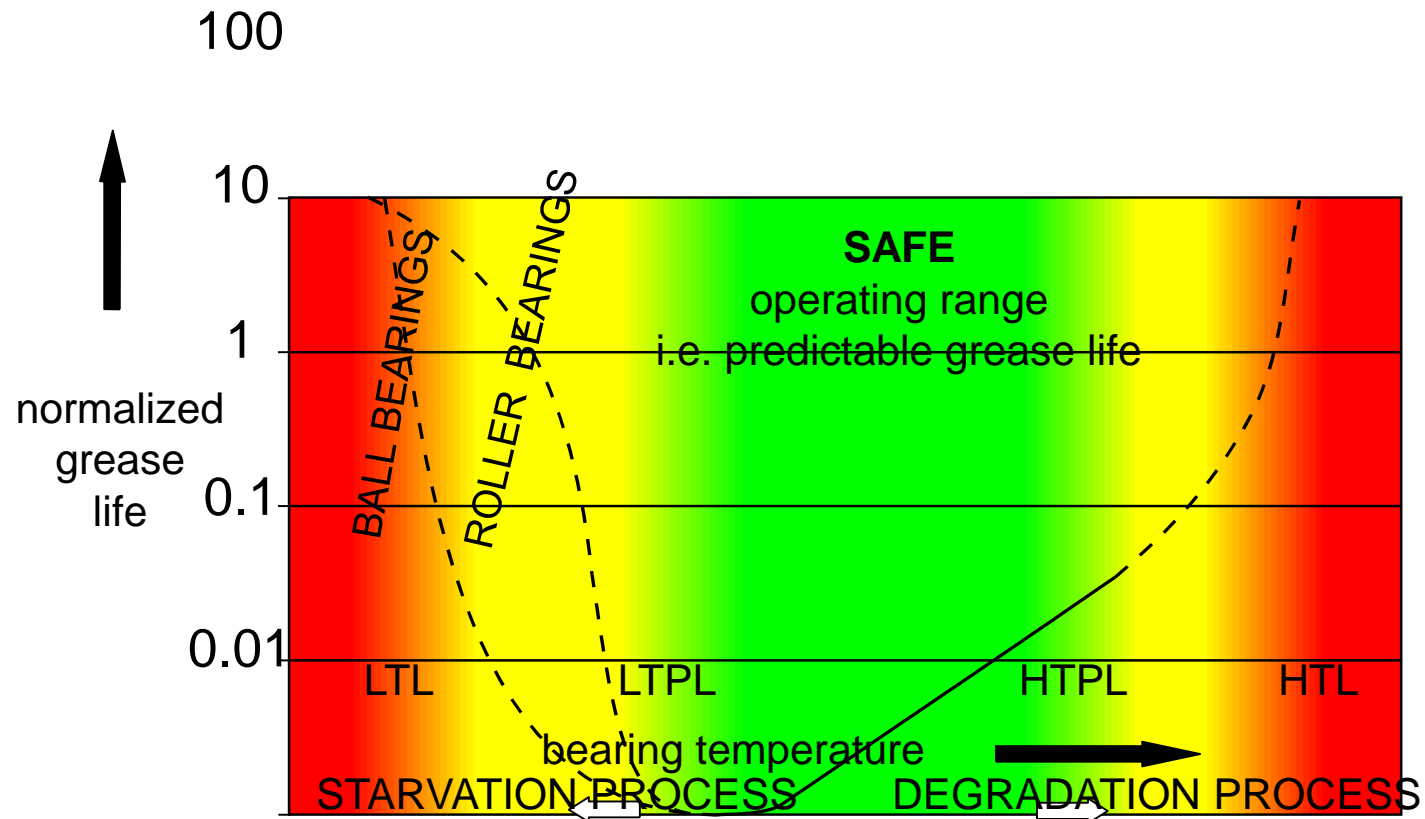
- The oil in the grease is oxidised or lost
- As oil is lost hardening takes place



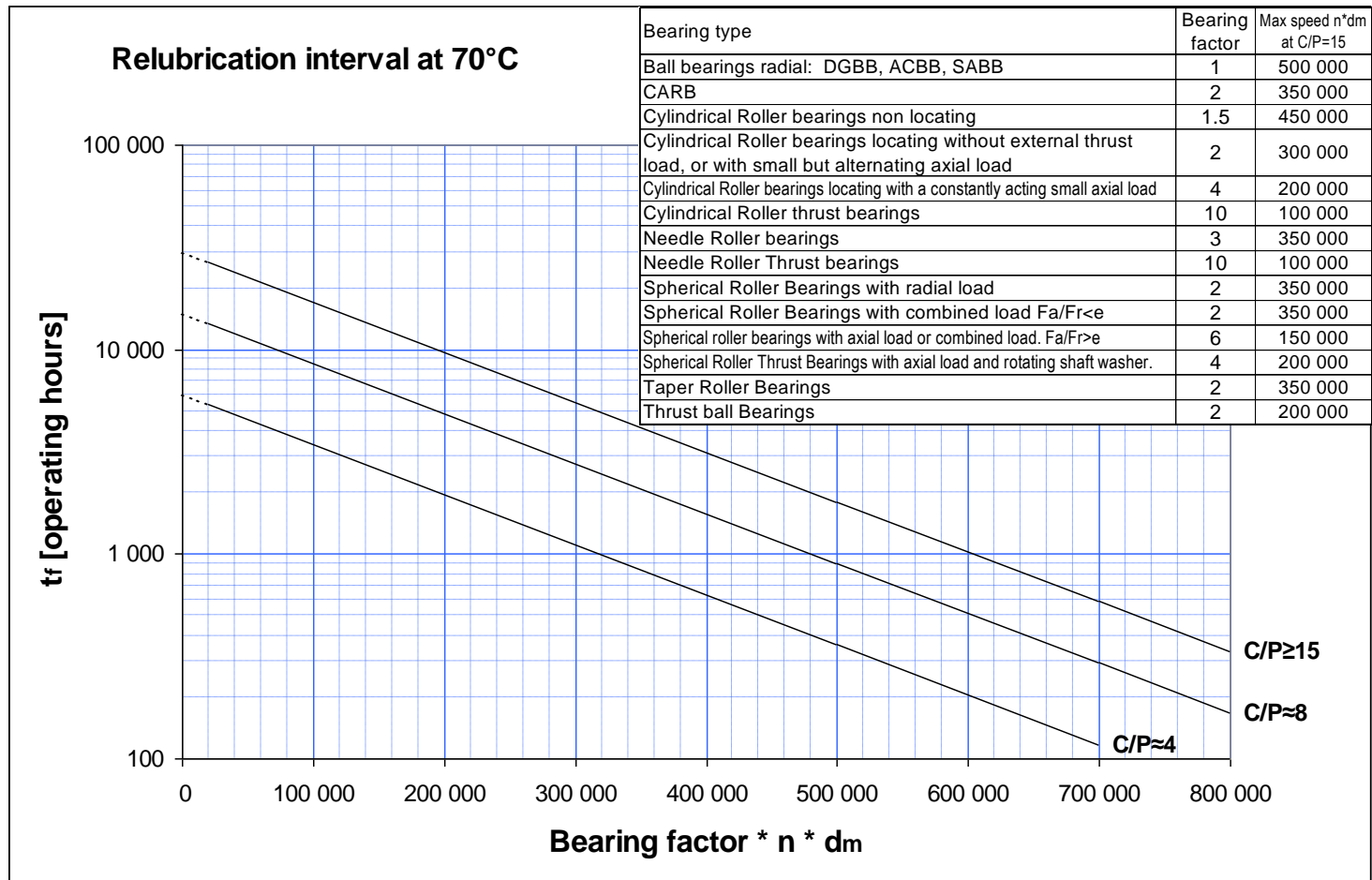
Grease softening

- Poor mechanical stability
- Contamination with water or oil

Effect of temperature on grease functionality



Re-lubrication intervals



Re-lubrication intervals

Application constraints for General Catalogue method

- normal operating conditions
- good quality Li-based grease

Calculation for temperatures deviating from 70°C

- for every 15°C higher (up to 110 °C), halve grease life
- at lower temperatures only once double grease life

Life Adjustment Factor L_a

Difference between grease life and relubrication interval

Relubrication interval: apply L_{01} grease life

L_{01} confidence interval of 99%

Grease life for not relubricated bearings: apply L_{10} grease life

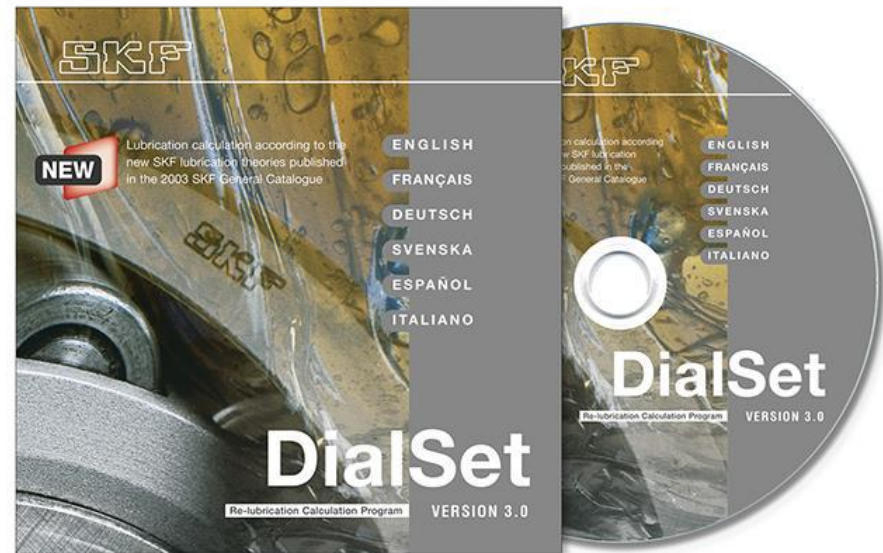
From many grease life testing it has been established:

$$L_{10} = 2.7 \times L_{01}$$

Re-lubrication interval

Dialset

- Calculations are based on the latest SKF General Catalogue
- Calculated lubrication interval depends on:
 - operating conditions, vertical shaft, outer ring rotation, shock load
 - selected grease
 - contamination level



Typical lubrication mistakes

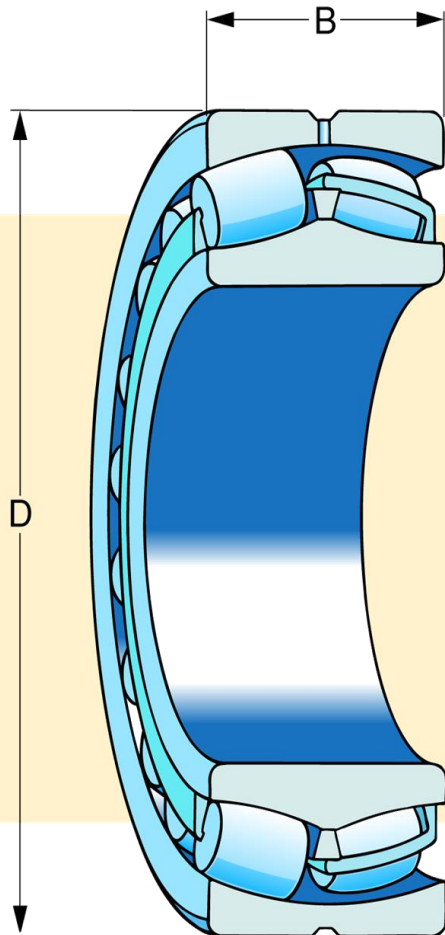


Initial bearing lubrication

- **Bearing:**
 - 100% filled
- **Housing:**
 - 40% when replenishing is made from the side of the bearing.
 - 20% when replenishing is made through the outer or inner ring.
 - 100% when low speed and risk of contamination.



How much grease for Re-lubrication?



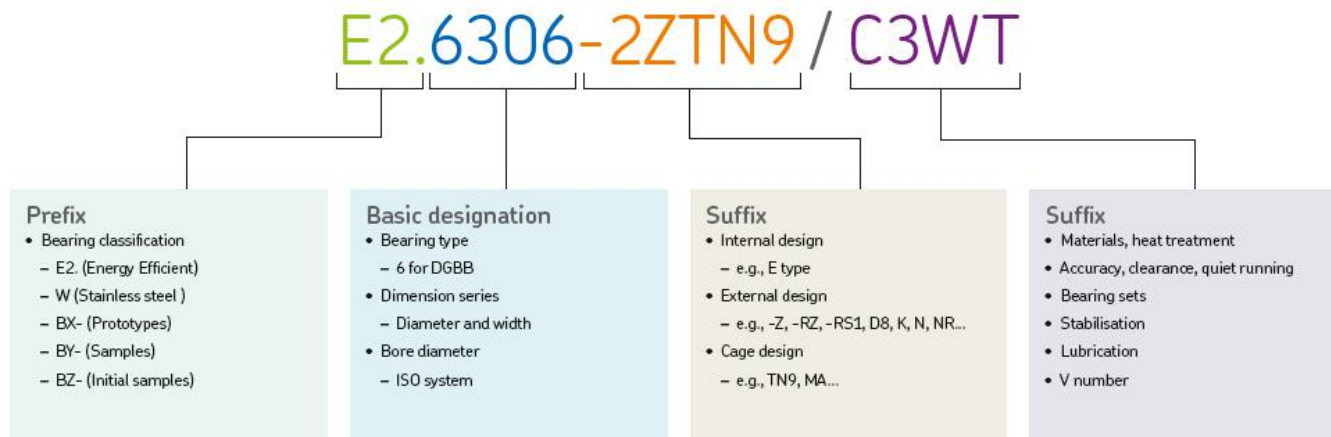
LAGM 1000E

**From the side of the bearing
 $G_p = 0,005 D B$**

**Through the outer or inner ring
 $G_p = 0,002 D B$**

Designation

Designation system overview



*This designation is an example for training purposes.
It is not an actual bearing designation.*



Designation

Technical specifications	Standard grease		High temperature grease		Low temperature grease	Wide temperature grease	Wide temperature and silent running grease	Non-toxic grease	
Grease suffix in bearing designation	-	-	-	G/N	HT	LT	WT	LHT23	VT378
Grease code	MT47	HT33	GE2	G/N	G/N	LT20	GWB	LHT23	VT378
Bearing range	D ≤ 62 mm	D > 62 mm	E2 range	All	All	All	All	All	Stainless steel
Consistency class (according to NLGI)	2	3	2	2	2	2	2-3	2	2
Thickener	Lithium soap	Lithium soap	Lithium soap	Polyurea soap	Diana	Lithium soap	Polyurea soap	Lithium soap	Aluminium complex soap
Base oil	Mineral oil	Synthetic	Synthetic	Mineral oil	Mineral oil	Diolester oil	Ester oil	Ester oil	PAO
Temperature range (°C)	-30 to +130	-30 to +120	-50 to +150	-30 to +150	-40 to +150	-55 to +130	-40 to +160	-50 to +140	-20 to +120

Grease filling rate rules for capped variants

Grease filling code	Quantity of grease
F1	Smallest grease filling
F2	
F3	
No grease code	Standard grease filling, not specified in the designation
F4	Higher grease filling
F5	
F6	
F7	
F8	
F9	



SKF grease recommendations

SKF grease LGEP 2

SKF grease for jaw crushers, work roll bearings in steel industry, vibrating screens, crane wheel & sheaves

SKF grease LGEP 2

SKF LGEP 2 is a mineral oil based, lithium soap thickened grease with extreme pressure additives. It provides good lubrication in general applications subjected to harsh conditions and vibration.



Excellent mechanical stability

Extremely good corrosion inhibiting properties

Excellent EP performance



SKF grease

LGEM 2

**SKF grease for applications of low speed
and very high loads, mechanical & crane
arms**

SKF grease LGEP 2

SKF LGEM 2 is a high viscosity mineral oil based grease using a lithium soap. Its content of molybdenum disulphide and graphite provides extra protection for harsh applications subjected to high loads, heavy vibrations and slow rotations.



High oxidation stability



Molybdenum disulphide and graphite provide lubrication even if the oil film breaks down

SKF grease LGEV 2

SKF grease for trunnion bearings on rotating drums, thrust rollers on rotary kilns & dryers, bucket wheel excavators, slewing bearings, high pressure roller mills

SKF grease LGEV 2

SKF LGEV 2 is a mineral oil based grease using a lithiumcalcium soap. Its high content of molybdenum disulphide and graphite, in conjunction with an extremely high viscosity oil, provide outstanding protection under the harshest conditions involving high loads, slow rotations and severe vibrations.

✓ Extremely suitable for lubricating large sized spherical roller bearings subject to high loads and slow rotations, a situation where microslip is likely to occur.

✓ Extremely mechanically stable providing good water resistance and corrosion protection.



SKF grease LGHB

2

SKF grease for plain bearings, continuous casting machines, work roll bearings in steel industry

SKF grease LGHB 2

SKF LGHB 2 is a high viscosity mineral oil based grease using the latest complex calcium-sulphonate soap technology. Formulated to withstand high temperatures and extreme loads, it is suitable for a wide range of applications especially in the cement, mining and metals segments.



Excellent anti-oxidation and anti-corrosion properties.



Excellent performance in applications running at high



Withstands peak temperatures of 200 C.



SKF grease LGHP 2

SKF grease for electric motors, high speed fans, water pumps, vertical shaft applications and kiln trucks & rollers

SKF grease LGHP 2

SKF LGHP 2 is a premium quality mineral oil based grease, using a modern Polyurea (di-urea) thickener. It is suitable for electric motors and similar applications.



Extremely long life at high temperatures.



Excellent corrosion protection.



High thermal and mechanical stability.



SKF grease dispensing tools

SKF grease dispensing tools



SKF grease gun LAGP 400



SKF grease gun TLGH 1
delivered
with a long extension pipe



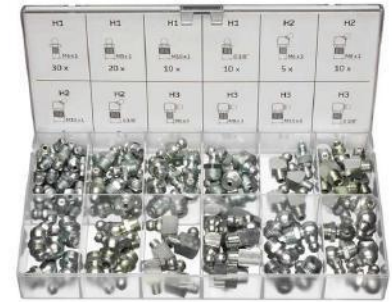
SKF grease gun 1077600/SET
delivered with 3 extension pipes and
high pressure hose.



SKF grease gun (battery)



SKF grease meter



SKF grease nipples

SKF grease dispensing tools



SKF manual and air-operated grease pumps available in 18, 50 or 180 kg drums with high pressure of 420 bar for air driven models.

SKF automatic grease dispensing

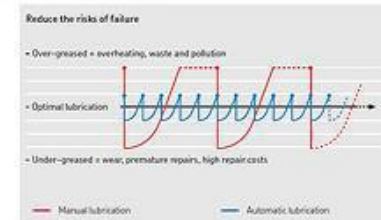
SKF lubricators LAGD series

SKF gas driven single point automatic lubricators consist of a transparent container filled with a specified lubricant and a cartridge containing an electrochemical gas cell. Once activated, the internal batteries are electrically connected and gas production can begin building up the pressure until the piston moves, pushing the lubricant into the application.

- * Dispense rate from 1 to 12 months
- * Intrinsic safety rating: ATEX Zone 0

Typical applications

- * Applications in restrictive and hazardous locations
- * Bearing housing lubrication
- * Electric motors, fans & pumps, conveyors, cranes, chains (oil), elevators & escalators



SKF lubricators TLSD series

SKF electro-mechanical single point automatic lubricators are the first choice when a simple and reliable automatic lubricator is required under variable temperatures, or when the application conditions (such as vibration, limited space or hazardous environments) require a remote mounting.

- * Dispense rate from 1 to 12 months
- * Temperature independent dispense rate
- * Max discharge pressure of 5 bar
- * Dispense rate available in various settings
- * Red-yellow-green LEDs indicate lubricator status

Typical applications

- * Critical applications where extreme reliability and additional monitoring is required; applications in restrictive locations; applications requiring high volumes of lubricant.



- A** The unit can be programmed to dispense lubricant in 1, 2, 3, 4, 6, 8, 9, 10 and 12 month settings.
- B** The same drive unit can be used with both cartridge versions by simply adjusting the 125/250 ml switch.
- C** Traffic light LEDs are visible from all sides because of the presence of dual LEDs on the sides of the lubricator. The meaning of the lights is as follows:
 - Green light: The lubricator is properly functioning.
 - Yellow light: The lubricator is still functioning, but soon same action will be required. Yellow light serves as a pre-warning light.
 - Red light: The lubricator stopped operating.

SKF lubricators TLMR series

SKF electro-mechanical single point automatic lubricators TLMR have relatively high pressure of 30 bars and can operate at long distances providing optimum results for difficult-to-reach and unsafe locations.

Typical applications

- * Applications requiring high lubricant consumption
- * Applications experiencing high vibration in operation
- * Excellent water and dust protection (IP 67) makes it suitable for applications in food processing industry
- * Excellent high temperature performance makes it suitable for engine rooms and hot fan applications

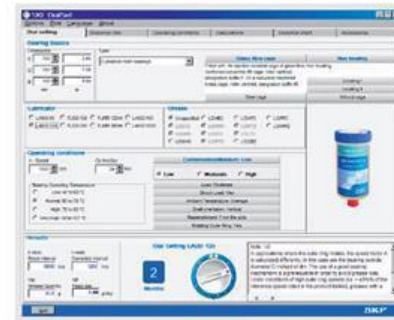


A special bracket makes TLMR easy to mount onto a surface

The cartridges are easily replaceable

SKF DialSet

SKF DialSet has been designed to help set up your SKF automatic lubricators. After selecting the criteria and grease appropriate for your application, the program provides the correct settings for your SKF automatic lubricators. It also provides a quick and simple tool for relubrication intervals and quantity calculations.



SKF Lubricator LAGD 400

SKF multi-point automatic lubricator LAGD 400 keeps up to 8 lubrication points simultaneously and automatically lubricated preventing both over and under-greasing.

User-friendly and cost-effective, its compact design combined with electronically controlled accuracy makes it an excellent solution for longer bearing-life.

Features

- * Up to 8 feed lines
- * Long feed lines (maximum 5 m)
- * Alarm function for blocked feed lines & empty cartridge
- * Machine steering (ie. Lubricator only operates while machine is running)
- * High pressure capability (40 bar)



SKF Lubricator LAGD 1000

SKF multi-point automatic lubricator LAGD 1000 keeps up to 20 lubrication points lubricated. It uses a high-pressure pump and a progressive feeder for lubricating from 10 to 20 lubrication points.

- * Suitable for greases from NLGI 000 to NLGI 2
- * Sturdy, robust design with IP65 rating
- * Progressive divider ensuring same amount of grease reaches each lubrication point
- * 1 litre refillable grease container
- * Extensive programming options allowing flexibility to suit most applications

Typical applications

- * Series of lubrication points with similar requirements
- * Components requiring large amounts of grease
- * Critical applications requiring continuous monitoring



SKF oil levelers

SKF oil levelers are designed for automatic adjustment of the optimal lubricating oil level within a bearing housing, gear box, crank case or similar oil bath lubrication application.

They allow the effective adjustment of the oil level during running conditions and automatically compensate for lubricating oil leakage.

